

University of Louisiana
at Lafayette

New Iberia Research Center
Finish-Out of
Novel Macaque Breeding Run
Shell Building 4 (56D)

Specifications
Construction Document Phase

To the Drawings Issued December 19th, 2025

d+b Architecture

December 19th, 2025

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DIVISION 01-
GENERAL REQUIREMENTS

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**SECTION 01 10 00
SUMMARY**

PART 1 GENERAL

1.1 SUMMARY

- A. Project Identification: The Finish-Out of Novel Macaque Breeding Run Bldg 4 (a.k.a. Bldg 56D) at the University of Louisiana - New Iberia Research Center.
- B. Project Summary: The scope of work shall consist of, but not be limited to, the finish-out to the building shell of Building 4 (56D) to provide a Novel Macaque Breeding Run at the University of Louisiana's New Iberia Research Center. The project includes, but is not limited to, the finish-out of one multi-run housing building, including above ground electrical, water, heating units, and air circulation. The building will house 20 indoor/outdoor runs.
- C. Particular Project Requirements: Existing site conditions and restrictions: Use of the existing site shall be limited to the area of work as shown on the construction drawings.
- D. Permits and Fees: Apply for, obtain, and pay for permits, fees, and utility company back charges required to perform the work. Submit copies to Architect.
- E. Codes: Comply with applicable codes and regulations of authorities having jurisdiction. Submit copies of inspection reports, notices, and similar communications to Architect.
- F. Dimensions: Verify dimensions indicated on drawings with field dimensions before fabrication or ordering of materials. Do not scale drawings.
- G. Existing Conditions: Notify Architect of existing conditions differing from those indicated on the drawings. Do not remove or alter structural components without prior written approval.
- H. Coordination:
 - 1. Coordinate the work of all trades.
 - 2. Prepare coordination drawings for areas above ceilings where close tolerances are required between building elements and mechanical and electrical work.
 - 3. Verify location of utilities and existing conditions.
- I. Installation Requirements, General:
 - 1. Inspect substrates and report unsatisfactory conditions in writing.
 - 2. Do not proceed until unsatisfactory conditions have been corrected.
 - 3. Take field measurements prior to fabrication where practical. Form to required shapes and sizes with true edges, lines and angles. Provide inserts and templates as needed for work of other trades.
 - 4. Install materials in exact accordance with manufacturer's instructions and approved submittals.
 - 5. Install materials in proper relation with adjacent construction and with proper appearance.
 - 6. Restore units damaged during installation. Replace units which cannot be restored at no additional expense to the Owner.
 - 7. Refer to additional installation requirements and tolerances specified under individual specification sections.
- J. Limit of Use: Limit of use shall be
 - 1. Limits of use shall be dictated by the facility manager. The facility manager has the authority to limit construction use of facility coinciding with public use of the facility.
 - 2. Timing of high levels of noise produced by construction activities shall be coordinated with the facility manager. The facility manager has the authority to limit noise

production coinciding with public use of the facility.

- K. Existing Construction: Maintain existing building in a weathertight condition. Repair damage caused by construction operations. Protect building shell and its occupants.

Existing Site Improvements: Maintain existing site improvements, such as fencing and aggregate driveways. Repair damage caused by building shell construction operations. Protect the existing building shell and its occupants. Protect adjacent existing building 56C and its occupants.

- L. Definitions:

1. Provide: Furnish and install, complete with all necessary accessories, ready for intended use. Pay for all related costs.
2. Approved: Acceptance of item submitted for approval. Not a limitation or release for compliance with the Contract Documents or regulatory requirements. Refer to limitations of 'Approved' in General and Supplementary Conditions.
3. Match Existing: Match existing as acceptable to the Owner.

- M. Intent: Drawings and specifications are intended to provide the basis for proper completion of the work suitable for the intended use of the Owner. Anything not expressly set forth but which is reasonable implied or necessary for proper performance of the project shall be included.

- N. Writing Style: Specifications are written in the imperative mode. Except where specifically intended otherwise, the subject of all imperative statements is the Contractor. For example, 'Provide tile' means 'Contractor shall provide tile.'

PART 2 PRODUCTS - Not Applicable To This Section

PART 3 EXECUTION - Not Applicable To This Section

END OF SECTION

**SECTION 01 20 00
PRICE AND PAYMENT PROCEDURES**

PART 1 GENERAL

1.1 SUMMARY

- A. Price and Payment Procedures:
 - 1. Alternates.
 - 2. Allowances.

1.2 ALTERNATES

- A. Total Price: Provide total price for each alternate in Bid Form. Include cost of modifications to other work to accommodate alternate. Include related costs such as overhead and profit.
- B. Acceptance of Alternates: Owner will determine which alternates are selected for inclusion in the Contract.
- C. Coordination of Alternates: Modify or adjust affected adjacent work as necessary to integrate work of the alternate into Project. Coordinate alternates with related work to ensure that work affected by each selected alternate is properly accomplished.
- D. List of Alternates:
 - 1. Alternate No. 1 – If necessary, to be determined.
 - 2. Alternate No. 2 – If necessary to be determined.

PART 2 PRODUCTS - Not Applicable To This Section

PART 3 EXECUTION - Not Applicable to This Section

END OF SECTION

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SECTION 01 30 00
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. Administration of Contract: Provide administrative requirements for the proper coordination and completion of work including the following:
 - 1. Supervisory project superintendent.
 - 2. Preconstruction conference.
 - 3. Project meetings, minimum of two per month.
- B. Reports: Submit special reports required for coordination of work or for clarification of work.
- C. Work Schedule: Submit progress schedule, updated monthly.
- D. Submittal Schedule: Prepare submittal schedule; coordinate with progress schedule.
- E. Schedule of Values: Submit schedule of values.
- F. Emergency Contacts: Submit and post a list of emergency telephone numbers and address for individuals to be contacted in case of emergency.
- G. Record Documents: Submit record drawings and specifications; to be maintained and annotated by Contractor as work progresses.

1.2 SUBMITTALS

- A. Types of Submittals: Provide types of submittals listed in individual sections and number of copies required below.
 - 1. Shop drawings, reviewed and annotated by the Contractor – 1 digital copy. A limit of 3 printed copies when requested by Architect.
 - 2. Product data – 1 digital copy.
 - 3. Samples - 2, When requested by Architect required to indicate range of color, finish, and texture to be expected.
 - 4. Warranties – 1 digital copy.
 - 5. Closeout submittals – 1 digital copy.
 - 6. Project photographs - Digital images each month as required to document / capture existing conditions and progress of new work.
- B. Submittal Procedures: Comply with project format for submittals. Comply with submittal procedures established by Architect including Architect's submittal and shop drawing stamp. Provide required resubmittals if original submittals are not approved. Provide distribution of approved copies including modifications after submittals have been approved.
- C. Samples and Shop Drawings: Samples and shop drawings shall be prepared specifically for this project. Shop drawings shall include dimensions and details, including adjacent construction and related work. Note special coordination required. Note any deviations from requirements of the Contract Documents.
- D. Warranties: Provide warranties as specified; warranties shall not limit length of time for remedy of damages Owner may have by legal statute. Contractor, supplier or installer responsible for performance of warranty shall sign warranties.

PART 2 PRODUCTS - Not Applicable To This Section

PART 3 EXECUTION - Not Applicable To This Section

END OF SECTION

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SECTION 01 40 00
QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. Quality Monitoring: Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality. Perform quality control procedures and inspections during installation.
- B. Standards: Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- C. Tolerances: Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate. Comply with manufacturers' tolerances.
- D. Reference Standards: For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- E. Manufacturer's Field Services: When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to perform the following as applicable, and to initiate instructions when necessary.
 - 1. Observe site conditions.
 - 2. Conditions of surfaces and installation.
 - 3. Quality of workmanship.

PART 2 PRODUCTS - Not Applicable To This Section

PART 3 EXECUTION - Not Applicable To This Section

END OF SECTION

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**SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS**

PART 1 GENERAL

1.1 SUMMARY

- A. Temporary Services: Provide temporary services and utilities, including payment of utility costs including the following.
 - 1. Utilities for use of construction activities only.
 - 2. Secure materials storage enclosure.

- B. Security and Protection: Provide security and protection requirements including the following.
 - 1. Fire extinguishers.
 - 2. On site secure material storage enclosure.
 - 3. Secured public intrusion protection during non-work hours.
 - 4. Temporary protection of site around the work area, including areas immediately outside of the area of work used for daily construction activities. Including activities such as personnel access and material transporting.

- C. Personnel Support: Provide personnel support facilities including the following.
 - 1. Portable temporary sanitary facilities.
 - 2. Cleaning.

PART 2 PRODUCTS

2.1 TEMPORARY JOBSITE PROTECTION

- A. Temporary Jobsite Protection of the Following Types:
 - 1. Paved surface protection.
 - 2. Dust containment.
 - 3. Job site fence and gate protection.

PART 3 EXECUTION - Not Applicable To This Section

END OF SECTION

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**SECTION 01 60 00
PRODUCT REQUIREMENTS**

PART 1 GENERAL

1.1 SUMMARY

- A. **Manufactures:** Provide products from one manufacturer for each type or kind as applicable. Provide secondary materials as acceptable to manufacturers of primary materials.
- B. **Product Selection:** Provide products selected or equal approved by Architect. Products submitted for substitution shall be submitted with complete documentation and shall include impact on related work as applicable.
- C. **Substitutions:** Request for substitution must be in writing. Conditions for substitution include:
 - 1. An 'or equal' phrase in the specifications.
 - 2. Specified material cannot be coordinated with other work.
 - 3. Specified material is not acceptable to authorities having jurisdiction.
 - 4. Substantial advantage is offered to the Owner in terms of cost, time, or other valuable consideration.
- D. **Substitution Requests:** Substitutions shall be submitted no less than seven days prior to bid date, unless otherwise acceptable.
 - 1. Approval of shop drawings, product data, or samples containing substitutions is not an approval of a substitution unless an item is clearly presented as a substitution at the time of submittal.

PART 2 PRODUCTS - Not Applicable To This Section

PART 3 EXECUTION - Not Applicable To This Section

END OF SECTION

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SECTION 01 70 00
EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. Substantial Completion: The following are prerequisites to substantial completion. Provide the following.
 - 1. Punch list prepared by Contractor and subcontractors as applicable.
 - 2. Supporting documentation, Warranties, Certifications.
- B. Final Acceptance: Provide the following prerequisites to final acceptance.
 - 1. Final payment request with supporting affidavits.
 - 2. Completed punch list.
- C. As-Built Drawings: Provide a marked-up set of drawings including changes, which occurred during construction.
- D. Project Closeout: Provide the following during project closeout.
 - 1. Submission of record documents.
 - 2. Submission of maintenance manuals.
 - 3. Final cleaning and touch-up.
 - 4. Removal of temporary facilities.

PART 2 PRODUCTS - Not Applicable To This Section

PART 3 EXECUTION

3.1 CUTTING AND PATCHING

- A. Cutting and Patching: Provide cutting and patching work to properly complete the work of the project, complying with project requirements for:
 - 1. Fire resistance ratings.
 - 2. Inspection, preparation, and performance.
 - 3. Cleaning.
- B. Means and Methods: Do not cut and patch in a manner that would result in a failure of the work to perform as intended, decrease energy performance, increase maintenance, decrease operational life, or decrease safety performance.
- C. Inspection: Inspect conditions prior to work to identify scope and type of work required. Protect adjacent work. Notify Owner of work requiring interruption to building services or Owner's operations.
- D. Performance of Operations: Perform work with workmen skilled in the trades involved.
- E. Cutting: Use cutting tools, not chopping tools. Make neat holes. Minimize damage to adjacent work. Inspect for concealed utilities and structure before cutting.
- F. Patching: Make patches, seams, and joints durable and inconspicuous. Comply with tolerances for new work.
- G. Cleaning: Clean work area and areas affected by cutting and patching operations.

END OF SECTION

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DIVISION 05-
METALS

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**SECTION 05 40 00
COLD FORMED METAL FRAMING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal stud interior wall framing.

1.2 RELATED SECTIONS

Not Applicable

1.3 REFERENCES

- A. AISI SG-971 - Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 1996, with 2000 supplement.
- B. AISI SG-973 - Cold-Formed Steel Design Manual; American Iron and Steel Institute; 1996.
- C. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2001a.
- D. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2001a.
- E. ASTM C 955 - Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Metal Wall Panels; 2001.
- F. ASTM C 1007 - Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories; 2000.
- G. AWS D1.1 - Structural Welding Code - Steel; American Welding Society; 2002.
- H. AWS D1.3 - Structural Welding Code - Sheet Steel; American Welding Society; 1998.

1.4 SYSTEM DESCRIPTION

- A. Horizontal Deflection: Design to permit maximum deflection of 1/400 span.
- B. Vertical Deflection: Design non-axial loadbearing framing to accommodate not less than 1/2 in vertical deflection.
- C. Design wall system to provide for movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges.
- D. Design system to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.

1.5 SUBMITTALS

- A. See Section 01300 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on standard framing members; describe materials and finish, product criteria and limitations.
- C. Product Data: Provide manufacturer's data on factory-made framing connectors, showing compliance with requirements.
- D. Shop Drawings: Indicate component details, framed openings, bearing, anchorage, loading, welds, and type and location of fasteners, and accessories or items required of related work.
 - 1. Indicate stud and ceiling joist layout.
 - 2. Describe method for securing studs to tracks and for bolted framing connections.
 - 3. Provide calculations for loadings and stresses of specially fabricated framing that have been stamped by a Professional Structural Engineer.
 - 4. Provide details and calculations for factory-made framing connectors, stamped by a Professional Structural Engineer.
- E. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

1.6 QUALITY ASSURANCE

- A. Calculate structural properties of framing members in accordance with requirements of AISI Specification for the Design of Cold-Formed Steel Structural Members.
 - 1. Maintain one copy of document on project site.
- B. Manufacturer: Company specializing in manufacturing the types of products specified in this section, and with minimum three years of documented experience.
- C. Installer: Company specializing in performing the work of this section with minimum 5 years of experience.
- D. Design structural elements under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the place where the Project is located.

1.7 PROJECT CONDITIONS

- A. Verify that field measurements are as indicated on the drawings.
- B. Coordinate work of this section with the placement of components within the stud framing system as specified drawings.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Provide manufacturer's standard performed insulation units, sized for proper fit in indicated applications.
 - 1. Dietrich Metal Framing, Inc; Product
 - 2. Marino-Ware;
 - 3. MiTek Industries, Inc;
 - 4. Substitutions: See Section 01600 - Product Requirements.
- B. Metal Framing Connectors and Accessories:
 - 1. Same manufacturer as framing.
 - 2. The Steel Network Inc: www.SteelNetwork.com.
 - 3. Substitutions: See Section 01600 - Product Requirements.

2.2 FRAMING MATERIALS

- A. Studs and Track: ASTM C 955; studs formed to channel shape with punched web; U-shaped track in matching nominal width and compatible height.
 - 1. Gage and depth: As required to meet specified performance levels.
 - 2. Gage and depth: As indicated on the drawings.
 - 3. Galvanized in accordance with ASTM A 653/A 653M G60 coating.
- B. Framing Connectors: Factory-made formed steel sheet, ASTM A 653/A 653M SS Grade 50, with G60/Z180 hot dipped galvanized coating and factory punched holes.
 - 1. Structural Performance: Maintain load and movement capacity required by applicable code, when evaluated in accordance with AISI Specification for the Design of Cold Formed Steel Structural Members; minimum 16 gage, 0.06 inch thickness.
 - 2. Movement Connections: Provide mechanical anchorage devices that accommodate movement using slotted holes, screws and anti-friction bushings, while maintaining structural performance of framing. Provide movement connections where indicated on drawings.
 - a. Where top of stud wall terminates below structural floor or roof, connect studs to structure in manner allowing vertical and horizontal movement of slab without affecting studs; allow for minimum movement of 1/2 inch.
 - b. Provide top track preassembled with connection devices spaced to fit stud spacing indicated on drawings; minimum track length of 12 feet.
 - c. Acceptable Products: VertiClip(r) or DriftClip(tm) manufactured by The Steel Network Inc.

3. Provide non-movement connections for tie-down to foundation, floor-to-floor tie-down, roof-to-wall tie-down, joist hangers, gusset plates, and stiffeners.

2.3 WALL SHEATHING

- A. Not Applicable

2.4 ACCESSORIES

- A. Bracing, Furring, Bridging: Formed sheet steel, thickness determined for conditions encountered; finish to match framing components.
- B. Plates, Gussets, Clips: Formed Sheet Steel, thickness determined for conditions encountered; finish to match framing components.
- C. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.5 FASTENERS

- A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot dip galvanized per ASTM A 153/A 153M.
- B. Anchorage Devices: Power actuated.
- C. Welding: In conformance with AWS D1.1.

2.6 SHOP FABRICATED ASSEMBLIES

- A. Shop fabricate metal framing to the greatest extent possible.
- B. Fabricate assemblies of framed sections of sizes and profiles required; with framing members fitted, reinforced, and braced to suit design requirements.
- C. Fit and assemble in largest practical sections for delivery to site, ready for installation.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work.

3.2 INSTALLATION OF STUDS

- A. Install components in accordance with manufacturers' instructions and ASTM C 1007 requirements.
- B. Align floor and ceiling tracks; locate to wall layout. Secure in place with fasteners at maximum 24 inches on center. Coordinate installation of sealant with floor and ceiling tracks.
- C. Place studs at 16 inches on center; not more than 2 inches from abutting walls and at each side of openings. Connect studs to tracks using clip and tie method.

- D. Construct corners using minimum of three studs. Install double studs at wall openings, door and window jambs.
- E. Install load bearing studs full length in one piece. Splicing of studs is not permitted.
- F. Install load bearing studs, brace, and reinforce to develop full strength and achieve design requirements.
- G. Coordinate placement of insulation in multiple stud spaces made inaccessible after erection.
- H. Install intermediate studs above and below openings to align with wall stud spacing.
- I. Provide deflection allowance in stud track, directly below horizontal building framing at non-load bearing framing.
- J. Attach cross studs to studs for attachment of fixtures anchored to walls.
- K. Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.
- L. Touch-up field welds and damaged primed surfaces with primer.

3.3 INSTALLATION OF JOISTS AND PURLINGS

- A. Not Applicable

3.4 WALL SHEATHING

- A. Not Applicable

3.5 ERECTION TOLERANCES

- A. Maximum Variation from True Position: 1/4 inch.
- B. Maximum Variation of any Member from Plane: 1/4 inch.

END OF SECTION 05 40 00

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SECTION 05 50 00
METAL FABRICATIONS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS

- A. 03 30 00 – Cast-In-Place Concrete

1.3 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
- C. Samples representative of materials and finished products as may be requested by Architect.
- D. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.
- E. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include a list of completed projects with project name, addresses, names of architects and owners, and other information specified.

1.4 QUALITY ASSURANCE

- A. Warrant coated finish against cracking, peeling, blistering, chalk in excess of 8 units, and fade in excess of 5 NBS points, for a period of 20 years, without reducing or otherwise limiting any other rights to correction which the owner may have under the contract documents.
- B. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code--Steel," AWS D1.2 "Structural Welding Code--Aluminum," and AWS D1.3 "Structural Welding Code--Sheet Steel."
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.5 PROJECT CONDITIONS

- A. Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit by accurate field measurements before fabrication. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabricating products without field measurements. Coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

PART 2 PRODUCTS

2.1 FERROUS METALS

- A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- B. Steel Plates, Shapes, and Bars: ASTM A 36 (ASTM A 36M).
- C. Steel Pipe: ASTM A 53, standard weight (schedule 40), unless otherwise indicated, or another weight required by structural loads.
- D. Cast-in-Place Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant materials capable of sustaining, without failure, the load imposed within a safety factor of 4, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47 (ASTM A 47M) malleable iron or ASTM A 27 (ASTM A 27M) cast steel. Provide bolts, washers, and shims as required, hot-dip galvanized per ASTM A 153.
- E. Welding Rods and Bare Electrodes: Select according to AWS specifications for the metal alloy to be welded.

2.2 PAINT

- A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements of FS TT-P-664, selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

2.3 FASTENERS

- A. General: Provide plated fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating, for exterior use or where built into exterior walls. Select fasteners for the type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568, Property

Class 4.6), with hex nuts, ASTM A 563 (ASTM A 563M), and, where indicated, flat washers.

- C. Machine Screws: ANSI B18.6.3 (ANSI B18.6.7M).
- D. Lag Bolts: ANSI B18.2.1 (ANSI B18.2.3.8M).
- E. Plain Washers: Round, carbon steel, ANSI B18.22.1 (ANSI B18.22M).
- F. Lock Washers: Helical, spring type, carbon steel, ANSI B18.21.1.
- G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
 - 1. Material: Carbon steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Material: Group 1 alloy 304 or 316 stainless-steel bolts and nuts complying with ASTM F 593 (ASTM F 738M) and ASTM F 594 (ASTM F 836M).
- H. Toggle Bolts: FS FF-B-588, tumble-wing type, class and style as required.

2.4 GROUT

- A. Nonshrink, Metallic Grout: Factory-packaged, ferrous-aggregate grout complying with ASTM C 1107, specifically recommended by manufacturer for heavy-duty loading applications.
- B. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- C. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
- D. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Nonshrink, Metallic Grouts:
 - a. Supreme Plus; Cormix Construction Chemicals.
 - b. Hi Mod Grout; Euclid Chemical Co.
 - c. Embeco 885 and 636; Master Builders Technologies, Inc.
 - d. Ferrolith G Redi-Mix and G-NC; Sonneborn Building Products--ChemRex, Inc.
 - e. Met-ox; The Spray-Cure Company.
 - 2. Nonshrink, Nonmetallic Grouts:
 - a. B-6 Construction Grout; W. R. Bonsal Co.
 - b. Diamond-Crete Grout; Concrete Service Materials Co.

- c. Supreme; Cormix Construction Chemicals.
- d. Sure-grip High Performance Grout; Dayton Superior Corp.
- e. Euco N-S Grout; Euclid Chemical Co.
- f. Five Star Grout; Five Star Products.
- g. Vibropruf #11; Lambert Corp.
- h. Crystex; L & M Construction Chemicals, Inc.
- i. Masterflow 928 and 713; Master Builders Technologies, Inc.
- j. Sealtight 588 Grout; W. R. Meadows, Inc.
- k. SonogROUT 14; Sonneborn Building Products--ChemRex, Inc.
- l. Kemset; The Spray-Cure Company.

2.5 CONCRETE FILL

- A. Concrete Materials and Properties: Normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa), unless higher strengths are indicated.

2.6 FABRICATION, GENERAL

- A. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.
- B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- C. Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.
 - 1. Temperature Change (Range): 100 deg F (55.5 deg C).
- D. Shear and punch metals cleanly and accurately. Remove burrs.
- E. Ease exposed edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- F. Remove sharp or rough areas on exposed traffic surfaces.
- G. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.
- H. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- K. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- L. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports for applications indicated that are not a part of structural steel framework as required to complete the Work.
- B. Fabricate units to sizes, shapes, and profiles indicated and required to receive other adjacent construction retained by framing and supports. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitered joints for field connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.
1. Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed.
 - a. Except as otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.
- C. Galvanize miscellaneous framing and supports in the following locations:
1. Exterior locations.
 2. Interior locations where indicated.

2.8 FINISHES, GENERAL

- A. Comply with NAAMM "Metal Finishes Manual" for recommendations relative to applying and designing finishes.
- B. Finish metal fabrications after assembly.

2.9 STEEL AND IRON FINISHES

- A. Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:
 - 1. Exteriors (SSPC Zone 1B): SSPC-SP 6 "Commercial Blast Cleaning."
 - 2. Interiors (SSPC Zone 1A): SSPC-SP 3 "Power Tool Cleaning."
- B. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes or to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with requirements of SSPC-PA 1 "Paint Application Specification No. 1" for shop painting.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 EXECUTION

3.1 PREPARATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.
- B. Set sleeves in concrete with tops flush with finish surface elevations. Protect sleeves from water and concrete entry.

3.2 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.
- D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop-welded because of shipping size limitations. Do

not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.

- E. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing, and contour of welded surface matches those adjacent.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.3 SETTING LOOSE PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.
- B. Set loose leveling and bearing plates on wedges or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the bearing plate before packing with grout.
 - 1. Use nonshrink, metallic grout in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations, unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a 2.0-mil minimum dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of the shop paint on miscellaneous metal is specified in Division 9 Section "Painting."
- C. For galvanized surfaces, clean welds, bolted connections, and abraded areas, and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 05 50 00

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DIVISION 07-
THERMAL AND MOISTURE
PROTECTION

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SECTION 07 41 10
METAL ROOF AND WALL PANELS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Manufactured Metal Wall Panels

1.2 SYSTEM DESCRIPTION

- A. Structural Requirements: Interior Metal Wall Panels attached to Metal Stud Framing.

1.3 SUBMITTALS

- A. Product Data.
- B. Shop Drawings.
- C. Samples for Selection of Coated Finishes: Coating manufacturer's full range of color selection data.
- D. Samples for Verification of Coated Finishes: 12-inch-square pieces of actual panel material for each finish type, texture, and color.
- E. Structural Calculations: Where metal roof and wall panels are integral to Metal Building Systems (131200), structural calculations shall be prepared, stamped, and signed by an engineer licensed in the state in which the project is located.

1.4 WARRANTY

- A. Warrant coated finish against cracking, peeling, blistering, chalk in excess of 8 units, and fade in excess of 5 NBS points, for a period of 20 years, without reducing or otherwise limiting any other rights to correction which the owner may have under the contract documents.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Products of the following manufacturers, provided they comply with requirements of the contract documents, will be among those considered acceptable:
 - 1. Berridge Manufacturing Company.
 - 2. MBCI Metal Roof and Walls Systems.

2.2 FASTENERS

- A. Threaded fasteners – general: Provide manufacturer's standard corrosion-resistant fasteners of size and type required for intended application.
 - 1. Use of cadmium-plated fasteners is not allowed.

- B. Rivets: Noncorrosive metal, compatible with metals to be fastened.

2.3 ACCESSORIES

- A. Flexible closures: Closed-cell neoprene rubber, formed to fit panel profile with 5 to 10 percent compression when secured in place.
- B. Sheet metal closures, flashing, and trim: Fabricate from same type of sheet metal, and with same finish, as adjacent roof panel.
- C. Concealed sealants and gaskets: Manufacturer's standard.
- D. Exposed joint sealant: As specified elsewhere in Division 7.

2.4 FINISHES

- A. Manufacturer's Standard Siliconized Polyester Signature 200 finish Use of cadmium-plated fasteners is not allowed.
 - 1. Primer: As per manufacturer's standards
 - 2. Finish coat: Siliconized Polyester finish coat, minimum 0.8 mil thick; bake to cure.
 - a. Color: Selected by architect, after contract award, from manufacturer's standard color selection. See also 131200 for preliminary color selections.
 - 3. Protective film: Provide strippable plastic film, applied to finish of coil stock before forming.

PART 3 EXECUTION

3.1 INSTALLATION

- A. General: Install manufactured metal panels in accordance with panel manufacturer's recommended practices.
- B. Metal Panel System Installation:
 - 1. Install metal wall panels in a single, continuous piece.

END OF SECTION 07 41 10

SECTION 07 90 00 JOINT SEALERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. The sealing of joints indicated on schedule at the end of this section.
 - 2. The sealing of other joints indicated on drawings.
- B. Joints of a nature similar to that of joints indicated on the schedule shall be sealed with same sealer, whether indicated on drawings to be sealed or not.

1.2 DEFINITIONS

- A. Substrates:
 - 1. M-type substrates: Concrete.
 - 2. A-type substrates: Metals.
 - 3. O-type substrates: Substrates not included under other categories.

1.3 SUBMITTALS

- A. Product Data.
- B. Samples for Color Selection. (Products exposed to view only.)
- C. Samples for Color Verification. (Products exposed to view.)
- D. Certified Product Test Reports.
- E. Manufacturer' certificates.
- F. Installer Qualifications: Minimum five (5) years experience, and for approval by the architect.

1.4 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install sealers if any of the following conditions exist:
 - 1. Air or substrate temperature exceeds the range recommended by sealer manufacturers.
 - 2. Substrate is wet, damp, or covered with snow, ice, or frost.
- B. Dimensional Limitations: Do not install sealers if joint dimensions are less than or greater than that recommended by sealer manufacturer; notify the architect and get sealer manufacturer's recommendations for alternative procedures.

PART 2 PRODUCTS

2.1 MATERIALS – GENERAL

- A. All sealants exposed to weather are to be Ultra-violet light (U.V.) resistant.
- B. Color selected by Architect from manufacturers standard color chart.
- C. General: Provide only products which are recommended and approved by their manufacturer for the specific use to which they are put and which comply with all requirements of the contract documents.
 - 1. Provide only materials which are compatible with each other and with joint substrates.
 - 2. Colors of exposed sealers: As selected by the architect from manufacturer's standard colors.

2.2 ELASTOMERIC SEALANTS

- A. Elastomeric Sealants – General: Chemically curing elastomeric sealants of types indicated, complying with ASTM C 920, including specific Type, Grade, Class, and Uses indicated, as well as all other requirements specified.
 - 1. Where movement capability exceeding that measured by ASTM C 920 is specified, sealant shall withstand the total movement indicated while remaining in compliance with the other requirements specified, when tested in accord with ASTM C 719, with base joint width measured at the time of application.
 - 2. For M-type substrates: Comply with requirements for Use M.
 - 3. For A-type substrates: Comply with requirements for Use A.
 - 4. For O-type substrates: Comply with requirements for Use M (minimum) and Use O for the particular substrate.
- B. Polysulfide Sealant for Water Immersion: Type M, Grade NS, Class 12 - ½, Use T, specifically recommended by the manufacturer for sealing joints immersed continuously in water.
- C. Medium Movement Silicone Sealant: One- or two-part non-acid-curing, Grade NS, Class 25, Use NT, plus movement capability of more than 25 percent but less than 50 percent in both extension and compression.
- D. Silicone Sealant for Use T: One-part, non-acid curing, Type S, Grade NS, Class 25, Use T, Use M, plus movement capability of 50 percent in both extension and compression.

2.3 PAVING JOINT SEALANTS

- A. Rubber/Asphalt Paving Sealant (ASTM D 3405): Hot-poured, one-part rubber/asphalt blend; complying with ASTM D 3405.

2.4 SOLVENT-RELEASE-CURING SEALANTS

- A. Acrylic Sealant: Nonsag, one-part, solvent-release-curing; complying with ASTM C 920, Type S, Grade NS, Use NT, with the following exceptions.
 - 1. Weight loss: 15 percent, maximum.
 - 2. Movement capability: 12 - ½ percent in both extension and compression, minimum.
- B. Butyl Sealant: Nonsag, one part, solvent-release-curing; complying with FS A-A-272, Type III; nonstaining; paintable.

2.5 LATEX SEALANTS

- A. Acrylic-Latex Emulsion Sealant: One-part, nonsag, mildew-resistant, paintable; complying with ASTM C 834.

2.6 MATERIALS – GENERAL

- A. Noncuring Butyl Sealant: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic rubber sealant.
- B. Butyl Polyisobutylene Sealant: Noncuring, nondrying, solvent-release; complying with 809.2, as described in AAMA 800.

2.7 SEALANT BACKERS

- A. Backers – General: Nonstaining; recommended or approved by sealant manufacturer for specific use.

PART 3 EXECUTION

Do not begin joint sealer work until unsatisfactory conditions have been corrected.

3.1 PREPARATION

- A. Masking Tape: Use masking tape to keep primers and sealers off of adjacent surfaces which would be damaged by contact or by cleanup. Remove tape as soon as practical.

3.2 INSTALLATION

- A. Comply with sealer manufacturers' installation instructions and recommendations, except where more restrictive requirements are specified.

3.3 SCHEDULE OF JOINT SEALERS

- A. Exterior Joints for Which No Other Sealers Is Indicated:

- 1. Use one of the following sealants:
 - a. Medium movement silicone sealant.

- b. Two-part nonsag low-modulus urethane sealant.
 - c. Acrylic sealant.
 - 2. Backer: Backer rod.
 - 3. Joint shape: Concave joint configuration.
- B. Interior Joints for Which No Other Sealers Is Indicated:
 - 1. Use one of the following sealants:
 - a. Acrylic-emulsion latex sealant.
 - 2. Backer: Backer rod.
 - 3. Joint shape: Concave joint configuration.
- C. Below-Grade Joints:
 - 1. Use one of the following sealants:
 - a. Polysulfide sealant for water immersion.
 - 2. Backer: Backer rod.
 - 3. Joint shape: Concave joint configuration.
- D. Exterior Joints Well Protected from Weather and Not Subject to Movement:
 - 1. Use one of the following sealants:
 - a. Backer: Backer Rod

E. Interior Floor Joints and Pedestrian Paving Joints, Less than 1-½ Percent Slope:

1. Use one of the following sealants:
 - a. Silicone sealant for Use T.
2. Backer: Backer rod.
3. Joint shape: Concave joint configuration.
4. Use one of the following sealants:

F. Joints in Interior Wet Areas:

1. Use one of the following sealants:
 - a. Mildew-resistant silicone sealant.
2. Backer: Backer rod.
3. Joint shape: Concave joint configuration.

END OF SECTION 07 90 00

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DIVISION 08-
DOORS AND WINDOWS

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**SECTION 08 11 00
STEEL DOORS AND FRAMES**

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Standard steel insulated doors and frames.

1.2 REFERENCES

- A. SDI 100-1991 – Recommended Specifications: Standard Steel Doors and Frames; Steel Door Institute; 1991.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's printed product information indicating compliance with specified requirements.
- B. Shop Drawings: Submit drawings for fabrication and installation of specified items, coordinated with opening schedule included in contract documents.
- C. Oversized Assembly Certification: Submit manufacturer's certification that oversized door assemblies required to be fire-rated have been constructed identically to corresponding labeled assemblies.

1.4 QUALITY ASSURANCE

- A. Quality Standard: Comply with SDI 100.
- B. Coordination: Transmit copy of final shop drawings to wood door manufacturer to allow prefitting of wood doors to steel frames.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in crates or cartons suitable for storage at the site.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Steel Sheets, Hot-Rolled: ASTM A 569 and ASTM A 568, commercial quality, pickled and oiled.
- B. Steel Sheets, Cold Rolled: ASTM A 366 and ASTM A 568, commercial quality, matte finish exposed, oiled.
- C. Steel Sheets, Galvanized: ASTM A 526 and ASTM A 525, commercial quality, A60 zinc-iron or G60 zinc coating, mill phosphatized.
- D. Steel sheets, Galvanized: ASTM A 591, electrolytic zinc-coated, Class A mill phosphatized.
- E. Anchorages: Galvanized steel, minimum 18 gage.

- F. Anchorages: Galvanized steel, minimum 18 gage.
- G. Exterior walls: AASTM A 153, hot-dip galvanized, Class C or D.
- H. Paint:
 - 1. Primer: Manufacturer's standard rust-inhibitive coating, suitable to receive finish coatings specified.

2.2 FABRICATION

- A. Exposed Door Faces: Fabricate from cold-rolled steel.
- B. Frames: Fabricate from cold-rolled or hot-rolled steel.
- C. Exterior Doors: Fabricate from hot-dip galvanized steel.
- D. Seal top and bottom edges integrally with door construction or use minimum 16 gage steel channels to form flush closure.
- E. Interior Doors: Fabricate from hot-dip or electrolytic galvanized steel at restrooms.
- F. Exterior Frames: Fabricate from galvanized steel.
- G. Interior Frames: Fabricate from galvanized steel
- H. Exposed Screws and Bolts: Where required, provide only countersunk, flat Philips-head fasteners.
- I. Insulated Assemblies: At location scheduled, provide insulating door and frame assemblies which have been tested in accordance with ASTM C 236 for thermal resistance.
 - 1. U-value: 0.24 BTU per hour per square per degree F, minimum.
- J. Hardware Preparation: Comply with DHI A115 series specifications.
 - 1. Locations: Comply with final shop drawings.
- K. Shop Painting:
 - 1. Primer: Apply primer evenly to achieve full protection of all exposed surfaces.

2.3 STEEL DOORS

- A. General: Fabricate steel doors in accordance with requirements of SDI 100.
- B. Interior Doors: Insulated Assemblies: At location scheduled, provide insulating door and frame assemblies which have been tested in accordance with ASTM C 236 for thermal resistance.
 - 1. Grade II – Heavy –Duty, Model 2 – Seamless.
- C. Exterior Doors: resistance.
 - 1. Grade II – Heavy –Duty, Model 2 – Seamless.

2.4 STEEL FRAMES

- A. General: Fabricate steel frames for scheduled openings, in styles and profiles as shown, using concealed fasteners.
 - 1. Minimum thickness: 16 gage interior; 14 gage exterior.
 - 2. Construction: Mitered and welded corners, except that frames for installation in drywall partitions may be slip on drywall type and frames for installation in existing concrete or masonry walls may be knocked down for field assembly.
- B. Guards: Weld protective covers to back of hardware openings at locations where grout, plaster, or other materials might interfere with hardware operation.

PART 3 EXECUTION

3.1 INSTALLATION

- A. General: Install steel doors, frames, and accessories to comply with manufacturer's recommendation.
 - 1. Comply with detailed installation requirements if final shop drawings.
- B. Frame Installation:
 - 1. General: Adhere to provisions of SDI 105.
 - 2. Anchors: Provide 3 wall anchors per jamb at hinge and strike levels and minimum 18 gage base anchors.
 - 3. Fire-rated openings: Comply with requirements of NFPA 80.
 - 4. Drywall partitions: At in-place drywall partitions, install knock down slip on drywall frames.
- C. Door Installation:
 - 1. General: Comply with requirements and clearances specified in SDI 100.
 - 2. Fire-rated Doors: Comply with NFPA 80 requirements and clearance.

3.2 ADJUST AND CLEAN

- A. Touch-up: At Locations where primer has been abraded or minor rusting has occurred, sand smooth and spray-apply compatible primer.
- B. Final Operating Adjustments: Check hardware at all openings for proper operation of doors, making final corrections as required to assure that work if this section is complete and undamaged.
- C. After adjusting for ease of operation, clean and paint all exposed steel surface (primed steel or galvanized) with enamel as applicable under Division-9 Painting Specifications.

END OF SECTION 08 11 00

SECTION 08 33 23
OVERHEAD COILING STORM SHUTTERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Overhead coiling storm shutters.

1.2 SUBMITTALS

- A. Product Data.
- B. Shop Drawings.
- C. Samples:
 - 1. Metal finish: 4-by 6-inch piece of base metal with specified finish.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Iron Castings: ASTM A 48.
- B. Steel: ASTM A 446, structural quality, cold-rolled steel sheets, Grade A.
 - 1. Galvanizing coating: ASTM A 525, G90 coating.

2.2 MANUFACTURED UNITS

- A. Overhead Coiling Storm Shutter:
 - 1. As manufactured by Raynor, Wayne Dalton, Overhead Door, or equal as approved by the Architect.
 - 2. Wind resistance: 134 mph.
- B. Curtain:
 - 1. Material: Galvanized steel.
 - 2. Gage: 18.
 - 3. Slat profile: Manufacturer's standard S-shaped slat.
 - 4. Finish: As selected from Manufacturer's standard colors.
- C. Guides:
 - 1. Material: Galvanized steel.
 - 2. Finish: Manufacturer's standard prime paint finish.

- D. Provide manufacturer's standard integral jamb and sill trim.
- E. Hood:
 - 1. Material: Galvanized steel, minimum 24 gage.
 - 2. Finish: Match curtain finish.
- F. Operator: Manual push-up with lift handle.
- G. Locking device: Cylinder lock; cylinders furnished elsewhere in Division 8, mater-keyed to other building locks.

2.3 COMPONENTS

- A. End Locks (doors): Galvanized iron castings, ASTM A 48; fasten to each end of curtain at about 24 inches on center to resist lateral force.
- B. Bottom Bar:
 - 1. Bottom bar, overhead coiling doors: Tubular bar; match curtain finish.
 - 2. Bottom seal: Replaceable vinyl or neoprene bumper.
- C. Curtain Guides (doors):
 - 1. Construct doors guides from steel angles of a size and in configuration necessary to support curtain loads.
- D. Counterbalance Mechanism:
 - 1. Adjustable steel helical torsion spring, on a steel shaft.
- E. Hood:
 - 1. Enclose curtain coil and counterbalance mechanism with sheet metal hood.
 - 2. Close hood ends at surface-mounted installations.
- F. Manual Operators:
- G. Manual push Operation:
 - 1. Overhead curtain, lift-up operation force: 25 pounds, maximum.

2.4 ACCESSORIES

- A. Door Curtain:
 - 1. Interlocking slats continuous for entire door width; designed to resist indicated wind loads.
- B. Shop/Factory Finishing: Clean and shop-prime paint ferrous metal and galvanized materials using door manufacture's standard rust-inhibitive paint. Do not paint surfaces requiring lubrication.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's directions and approved submittal information.

3.2 ADJUSTING

- A. Test and adjust doors to operate easily and be weather sealed when closed.

3.3 CLEANING

- A. Clean door assembly surfaces, removing dust, dirt, and grease before final acceptance.

END OF SECTION 08 33 23

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**SECTION 08 71 00
DOOR HARDWARE**

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes items known commercially as finish or door hardware that are required for swing, sliding, and folding doors, except special types of unique hardware specified in the same sections as the doors and door frames on which they are installed.
- B. This Section includes the following:
 - 1. Hinges.
 - 2. Pivots.
 - 3. Key control system.
 - 4. Lock cylinders and keys.
 - 5. Lock and latch sets.
 - 6. Bolts.
 - 7. Exit devices.
 - 8. Closers.
 - 9. Miscellaneous door control devices.
 - 10. Door trim units.
 - 11. Protection plates.
 - 12. Weatherstripping for exterior doors.
 - 13. Automatic drop seals (door bottoms).
 - 14. Thresholds.
- C. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 8 Section "Standard Steel Doors and Frames" for silencers integral with hollow metal frames.
- D. Products furnished but not installed under this Section include:
 - 1. Final replacement cores and keys to be installed by Owner.

1.3 HARDWARE REQUIREMENTS

- A. Selection and Ordering: Furnish door hardware as specified in the "Hardware Sets" listed at the end of this section.
- B. Door hardware supplier's responsibilities shall be as follows:
 - 1. Submittals: Submit through Contractor required product data, final hardware schedule, separate keying schedule, and samples as specified in this Section, unless otherwise indicated.
 - 2. Construction Schedule: Inform Contractor promptly of estimated times and dates that will be required to process submittals, to furnish templates, to deliver hardware, and to perform other work associated with furnishing door hardware for purposes of including this data in construction schedule. Comply with this schedule.
 - 3. Coordination and Templates: Assist Contractor as required to coordinate hardware with other work in respect to both fabrication and installation. Furnish Contractor with templates and deliver hardware to proper locations.
 - 4. Product Handling: Package, identify, deliver, and inventory door hardware specified in this Section.
 - 5. Discrepancies: Based on requirements indicated in Contract Documents in effect at time of door hardware selection, furnish types, finishes, and quantities of door hardware, including fasteners, and Owner's maintenance tools required to comply with specified requirements and as needed to install and maintain hardware. Furnish or replace any items of door hardware resulting from shortages and incorrect items at no cost to the Owner or Contractor. Obtain signed receipts from Contractor for all delivered materials.
- C. Contractor's responsibilities shall be as follows:
 - 1. Submittals: Coordinate and process submittals for door hardware per Section 01300, 1.4 Submittal Procedures.
 - 2. Construction Schedule: Cooperate with door hardware supplier in establishing scheduled dates for submittals and delivery of templates and door hardware. Incorporate in construction schedule the times and dates related to furnishing hardware by door hardware supplier.
 - 3. Coordination: Coordinate door hardware with other Work. Furnish hardware supplier or manufacturer with shop drawings of other work where required or requested. Verify completeness and suitability of hardware with supplier.
 - 4. Product Handling: Provide secure lock-up for hardware delivered to the site. Inventory hardware jointly with representative of hardware supplier and issue signed receipts for all delivered materials.

5. Installation Information: The general types and approximate quantities of hardware required for this Project are indicated in the Hardware Sets at the end of this Section in order to establish Contractor's costs for installation and other work not included in section.
6. No adjustments in Contract sum will be made for costs other than those covered by subsequent increases or decreases in quantity of one or more hardware types that do not exceed 5 percent.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification sections.
- B. Product data including manufacturers' technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
- C. Final hardware schedule coordinated with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 1. Final Hardware Schedule Content: Based on hardware indicated, organize schedule into "hardware sets" indicating complete designations of every item required for each door or opening. Include the following information:
 - a. Type, style, function, size, and finish of each hardware item.
 - b. Name and manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of each hardware set using Architect's Hardware Set designations as shown on door and frame schedule.
 - e. Explanation of all abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for hardware.
 - g. Door and frame sizes and materials.
 - h. Keying information.
 2. Submittal Sequence: Submit final schedule at earliest possible date particularly where acceptance of hardware schedule must precede fabrication of other work that is critical in the Project construction schedule. Include with schedule the product data, samples, shop drawings of other work affected by door hardware, and other information essential to the coordinated review of schedule.
 3. Submittal Sequence: Submit initial draft of final schedule along with essential product data in order to facilitate the fabrication of other work that is critical in the Project construction schedule. Submit final schedule after samples, product data, coordination with shop drawings of other work, delivery schedules, and similar information has been completed and accepted.

1.5 QUALITY ASSURANCE

- A. Single Source Responsibility: Obtain each type of hardware (latch and locksets, hinges, closers, etc.) from a single manufacturer.
- B. Supplier Qualifications: A recognized architectural door hardware supplier, with warehousing facilities in the Project's vicinity, that has a record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that employs an experienced architectural hardware consultant (AHC) who is available to Owner, Architect, and Contractor, at reasonable times during the course of the Work, for consultation.
 - 1. Require supplier to meet with Owner to finalize keying requirements and to obtain final instructions in writing.

1.6 PRODUCT HANDLING

- A. Tag each item or package separately with identification related to final hardware schedule, and include basic installation instructions with each item or package.
- B. Packaging of door hardware is responsibility of supplier. As material is received by hardware supplier from various manufacturers, sort and repackage in containers clearly marked with appropriate hardware set number to match set numbers of approved hardware schedule. Two or more identical sets may be packed in same container.
- C. Inventory door hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.
- D. Deliver individually packaged door hardware items promptly to place of installation (shop or Project site).
- E. Provide secure lock-up for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable so that completion of the Work will not be delayed by hardware losses both before and after installation.

1.7 MAINTENANCE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with specification requirements, provide products by one of the following:
 - 1. Butts Hinges:
 - a. Hanger Hinge Co. – BB Series

- b. *McKinney Products Co. – TA Series
 - c. Stanley Hardware, Div. Stanley Works. – FBB Series
2. Key Control System:
- a. Key Control Systems, Inc.
 - b. Telkee Inc.
3. Cylinders:
- a. Best Lock Corporation
4. Locks and Latches:
- a. Best Lock Corporation – 35H Series – 15J Design
 - b. * Sargent Manufacturing Company – 8200 Series – LW1L Design
5. Bolts:
- a. Builders Brass Works Corp.
 - b. Glynn-Johnson Corp.
 - c. Rockwood Manufacturing Company.
 - d. H. B. Ives, A Harrow Company.
 - e. *Triangle Brass Manufacturing Company (Trimco).
6. Overhead Closers:
- a. LCN, Div. Ingersoll-Rand Door Hardware Group. – 4040 & 1460-72 Series
 - b. *Sargent Manufacturing Company. – 351 & 1430 Series
7. Door Control Devices:
- a. Brookline Industries, Div. Yale Security Inc.
 - b. Glynn-Johnson Corp.
 - c. H. B. Ives, A Harrow Company.
 - d. *Triangle Brass Manufacturing Company (Trimco).
8. Door Trim Units:
- a. Brookline Industries, Div. Yale Security Inc.
 - b. Builders Brass Works Corp.
 - c. Rockwood Manufacturing Company.

- d. H. B. Ives, A Harrow Company.
 - e. *Triangle Brass Manufacturing Company (Trimco).
9. Door Stripping, Seals, Thresholds, Automatic Drop Seals, Sound Stripping & Astragals:
- a. *National Guard Products, Inc.
 - b. Pemko Manufacturing Co., Inc.
 - c. Reese Enterprises, Inc.
 - d. Zero International, Inc.

2.2 SCHEDULE HARDWARE

- A. Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of finish hardware are indicated in the "Hardware Schedule" at the end of this Section. Products are identified by using hardware designation numbers of the following:
- 1. Manufacturer's Product Designations: The product designation and name of one manufacturer are listed for each hardware type required for the purpose of establishing minimum requirements. Provide either the product designated or, where more than one manufacturer is specified under the Article "Manufacturers" in Part 2 for each hardware type, the comparable product of one of the other manufacturers that complies with requirements.
 - 2. ANSI/BHMA designations used elsewhere in this Section or in schedules to describe hardware items or to define quality or function are derived from the following standards. Provide products complying with these standards and requirements specified elsewhere in this Section.
 - a. Butts and Hinges: ANSI/BHMA A156.1.
 - b. Bored and Pre-assembled Locks and Latches: ANSI/BHMA A156.2.
 - c. Exit Devices: ANSI/BHMA A156.3.
 - d. Door Controls - Closers: ANSI/BHMA A156.4.
 - e. Auxiliary Locks and Associated Products: ANSI/BHMA A156.5.
 - f. Architectural Door Trim: ANSI/BHMA A156.6.
 - g. Template Hinge Dimensions: ANSI/BHMA A156.7.
 - h. Door Controls - Overhead Holders: ANSI/BHMA A156.8.
 - i. Interconnected Locks and Latches: ANSI/BHMA A156.12.
 - j. Closer Holder Release Devices: ANSI/BHMA A156.15.
 - k. Auxiliary Hardware: ANSI/BHMA A156.16.

- I. Materials and Finishes: ANSI/BHMA A156.18.

2.3 MATERIALS AND FABRICATION

- A. Manufacturer's Name Plate: Do not use manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise acceptable to Architect.
 - 1. Manufacturer's identification will be permitted on rim of lock cylinders only.
- B. Base Metals: Produce hardware units of basic metal and forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units by applicable ANSI/BHMA A156 series standards for each type of hardware item and with ANSI/BHMA A156.18 for finish designations indicated. Do not furnish "optional" materials or forming methods for those indicated, except as otherwise specified.
- C. Base Metals: Produce hardware units of basic metal and forming method indicated using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units for finish designations indicated.
- D. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated.
- E. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.
- F. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of reinforcing the work adequately to fasten the hardware securely. Where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use sex screw fasteners.

2.4 HINGES, BUTTS, AND PIVOTS

- A. Templates: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.
- B. Screws: Provide Phillips flat-head screws complying with the following requirements:
 - 1. For metal doors and frames install machine screws into drilled and tapped holes.
 - 2. For fire-rated wood doors install #12 x 1-1/4-inch, threaded-to-the-head steel wood screws.
 - 3. Finish screw heads to match surface of hinges or pivots.

- C. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
 - 1. Out-Swing Exterior Doors: Non-removable pins.
 - 2. Interior Doors: Non-rising pins.
- D. Number of Hinges: Provide not less than 3 hinges per door leaf for doors 90 inches or less in height and one additional hinge for each 30 inches of additional height.

2.5 LOCK CYLINDERS AND KEYING

- A. Existing System: Masterkey the locks to the Owner's existing Best keying system.
- B. Equip locks with cylinders for 7 pin interchangeable-core pin tumbler inserts. Furnish only temporary inserts for the construction period, and remove these when directed.
 - 1. Permanent cylinder cores furnished under this Section, installed by the Owner.
- C. Owner will provide the type required (master, grandmaster or great-grandmaster), either new or integrated with existing system.
- D. Metals: Construct lock cylinder parts from brass or bronze, stainless steel, or nickel silver.
- E. Comply with Owner's instructions for masterkeying and, except as otherwise indicated, provide individual change key for each lock that is not designated to be keyed alike with a group of related locks.
 - 1. Permanently inscribe each key with number of lock that identifies cylinder manufacturer's key symbol, and notation, "DO NOT DUPLICATE."
- F. Key Material: Provide keys of nickel silver only.
- G. Key Quantity: Furnish 3 change keys for each lock, 5 master keys for each master system, and 5 grandmaster keys for each grandmaster system.
 - 1. Furnish one extra blank for each lock.
 - 2. Deliver keys to key control system manufacturer.
 - 3. Deliver keys to Owner.
 - 4. Furnish signed transmittal to Architect showing receipt of keys by Owner.

2.6 KEY CONTROL SYSTEM

- A. Provide a key control system including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150 percent of the number of locks required for the Project.
 - 1. Provide complete cross index system set up by key control manufacturer, and place keys on markers and hooks in the cabinet as determined by the final key schedule.
 - 2. Provide hinged-panel type cabinet for wall mounting.

3. Provide multiple-drawer type cabinet.

2.7 LOCKS, LATCHES, AND BOLTS

- A. Strikes: Provide manufacturer's standard wrought box strike for each latch or lock bolt, with curved lip extended to protect frame, finished to match hardware set, unless otherwise indicated.
 1. Provide curved lip, non-handed, strikes for locks with antifriction latchbolts as recommended by manufacturer.
 2. Provide extra long strike lips for locks used on frames with applied wood casing trim.
 3. Provide recess type top strikes for bolts locking into head frames, unless otherwise indicated.
 4. Provide dust-proof strikes for foot bolts, except where special threshold construction provides non-recessed strike for bolt.
 5. Provide roller type strikes where recommended by manufacturer of the latch and lock units.
- B. Lock Throw: Provide 3/4-inch minimum throw of latch on pairs of doors. Comply with UL requirements for throw of bolts and latch bolts on rated fire openings.
 1. Provide one-piece 3/4-inch minimum throw of latch for mortise locks. Provide 1-inch minimum throw for all dead bolts.
- C. Flush Bolt Heads: Minimum of 1/2-inch-diameter rods of brass, bronze, or stainless steel with minimum 12-inch-long rod for doors up to 7'-0" in height. Provide longer rods as necessary for doors exceeding 7'-0" in height.
- D. Exit Device Dogging: Except on fire-rated doors where closers are provided on doors equipped with exit devices, equip the units with keyed dogging device to keep the latch bolt retracted, when engaged..

2.8 PUSH/PULL UNITS

- A. Exposed Fasteners: Provide manufacturer's standard exposed fasteners for installation, thru-bolted for matched pairs but not for single units.

2.9 CLOSERS AND DOOR CONTROL DEVICES

- A. Size of Units: Except as otherwise specifically indicated, comply with the manufacturer's recommendations for size of door control unit depending on size of door, exposure to weather, and anticipated frequency of use.
 1. Where parallel arms are indicated for closers, provide closer unit one size larger than recommended for use with standard arms.
 2. Provide parallel arms for all overhead closers, except as otherwise indicated.
- B. Access-Free Manual Closers: Where manual closers are indicated for doors required to be

accessible to the physically handicapped, provide adjustable units complying with ANSI A117.1 provisions for door opening force and delayed action closing.

- C. Flush Floor Plates: Provide finished metal flush floor plates for floor closers except where thresholds are indicated and cover plate is specified to be an integral part of threshold. Finish floor plate to match hardware sets, unless otherwise indicated.
- D. Provide Grey resilient parts for exposed bumpers.

2.10 DOOR TRIM UNITS

- A. Fasteners: Provide manufacturer's standard exposed fasteners for door trim units consisting of either machine screws or self-tapping screws.
- B. Fabricate edge trim of stainless steel to fit door thickness in standard lengths or to match height of protection plates.
- C. Fabricate protection plates not more than 1-1/2 inches less than door width on hinge side and not more than 1/2 inch less than door width on pull side by height indicated.
- D. Metal Plates: Stainless steel, 0.050 inch (U.S. 18 gage).

2.11 WEATHERSTRIPPING AND SEALS

- A. General: Provide continuous weatherstripping on exterior doors. Provide non-corrosive fasteners for exterior applications and elsewhere as indicated.
- B. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strip is easily replaceable and readily available from stocks maintained by manufacturer.
- C. Weatherstripping at Jambs and Heads: Provide bumper-type resilient insert and metal retainer strips, surface applied unless shown as mortised or semi-mortised, and of following metal, finish, and resilient bumper material:
 - 1. Extruded aluminum with natural anodized finish, 0.062-inch minimum thickness of main walls and flanges.
 - 2. Flexibly vinyl hollow bulb or loop insert.
- D. Weatherstripping at Door Bottoms: Provide threshold consisting of contact-type resilient insert and metal housing of design and size shown and of following metal, finish, and resilient seal strip:
 - 1. Extruded aluminum with natural anodized finish, 0.062-inch minimum thickness of main walls and flanges.
 - 2. Flexible vinyl wiper or sweep seal strip.

2.12 THRESHOLDS

- A. Exterior items: US32D (630) Satin Stainless Steel
Interior items: US26D (626 & 652) Satin Chrome Plated
Door Closers: Satin Stainless Steel or Satin Chrome Plated.

- B. Provide finishes that match those established by BHMA.
- C. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.
- D. Provide protective lacquer coating on all exposed hardware finishes of brass, bronze, and aluminum, except as otherwise indicated.
- E. The designations used in schedules and elsewhere to indicate hardware finishes are those listed in ANSI/BHMA A156.18, "Materials and Finishes," including coordination with the traditional U.S. finishes shown by certain manufacturers for their products.
 - 1. Rust-Resistant Finish: For iron and steel base metal required for ALL work, provide 0.2-mil-thick copper coating on base metal before applying brass, bronze, nickel, or chromium plated finishes.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Mount hardware units at heights indicated in following applicable publications, except as specifically indicated or required to comply with governing regulations and except as otherwise directed by Architect
 - 1. "Recommended Locations for Builders Hardware for Standard Steel Doors and Frames" by the Door and Hardware Institute.
 - 2. NWWDA Industry Standard I.S.1.7, "Hardware Locations for Wood Flush Doors."
- B. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation or application of surface protection with finishing work specified in the Division 9 Sections. Do not install surface-mounted items until finishes have been completed on the substrates involved.
- C. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- D. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
- E. Set thresholds for exterior doors in full bed of butyl-rubber or polyisobutylene mastic sealant complying with requirements specified in Division 7 Section "Joint Sealers."
- F. Weatherstripping and Seals: Comply with manufacturer's instructions and recommendations to the extent installation requirements are not otherwise indicated.

3.2 ADJUSTING, CLEANING, AND DEMONSTRATING

- A. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.
 - 1. Where door hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.
- B. Clean adjacent surfaces soiled by hardware installation.
- C. Instruct Owner's personnel in the proper adjustment and maintenance of door hardware and hardware finishes.
- D. Six-Month Adjustment: Approximately six months after the date of Substantial Completion, the Installer, accompanied by representatives of the manufacturers of latchsets and locksets and of door control devices, and of other major hardware suppliers, shall return to the Project to perform the following work:
 - 1. Examine and re-adjust each item of door hardware as necessary to restore function of doors and hardware to comply with specified requirements.
 - 2. Consult with and instruct Owner's personnel in recommended additions to the maintenance procedures.
 - 3. Replace hardware items that have deteriorated or failed due to faulty design, materials, or installation of hardware units.
 - 4. Prepare a written report of current and predictable problems (of substantial nature) in the performance of the hardware.

3.3 HARDWARE SCHEDULE

- A. At Each Exterior Door:
 - 1. (3) 4.5" Ball Bearing Hinges – US 32D
 - 2. 36" ADA Compliant Aluminum Threshold
 - 3. 36" Aluminum Rain Guard Sweep with Vinyl Inset
 - 4. Interchangeable Core Entrance Lever Set – Grade 1 – US26D
 - 5. CR441 Closer – Aluminum
 - 6. Interchangeable Core (To be Keyed by Owner)

B. At Each Pair of Interior Doors:

1. (6) 4.5" Ball Bearing Hinges – US 32D
2. Interchangeable Core Entrance Lever Set – Grade 1 – US26D
3. (2) Flush Bolts
4. Z-Astragal on Fixed Panel
5. Interchangeable Core (To be Keyed by Owner)

END OF SECTION 08 71 00

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DIVISION 09-
FINISHES

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**SECTION 09 91 23
PAINTING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.
- B. Do Not Paint or Finish the Following Items:
 - 1. Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
 - 2. Items indicated to receive other finishes.
 - 3. Items indicated to remain unfinished.
 - 4. Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
 - 5. Floors, unless specifically indicated.
 - 6. Glass
 - 7. Concealed pipes, ducts, and conduits.

1.2 SUBMITTALS

- A. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g., "alkyd enamel").
 - 2. Cross- reference to specified paint system(s) product is to be used in; include description of each system.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Provide paints and finishes from the same manufacturer to the greatest extent possible.

2.2 PAINTS AND FINISHES – GENERAL

- A. Paints and Finishes: Ready-mixed.
 - 1. Provide paints and finishes of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Supply each paint material in quantity required to complete entire project's work from a single production run.
 - 3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.
- B. Colors: As indicated on drawings.
 - 1. Selection to be made by Architect after award of contract.

2.3 PAINTS AND FINISHES – GENERAL

A. EXTERIOR:

	PPG PAINTS	Sherman Williams
Galvanized Steel Primer:	Pitt Tech Plus EP DTM Primer 90	Procryl Universal Primer B66W310
Inhibitive Metal Primer:	Pitt Tech Plus EP DTM Primer 90	Procryl Universal Primer B66W310
Bonding Primer:	XIM-UMA Bonding Primer	Pro-Industrial DTM Bonding Primer
WB Alkyd Urethane	Aquacron 870 Acrylic Urethane	Pro-Industrial WB Acrylic Urethane
Traffic Marking Paint	Zone Marking Alkyd	Pro-Mar Traffic Paint B29

B. INTERIOR:

	PPG PAINTS	Sherman Williams
Inhibitive Metal Primer:	Pitt Tech Plus EP DTM Primer 90	Procryl Universal Primer B66W310
Bonding Primer:	XIM-UMA Bonding Primer	Pro-Industrial DTM Bonding Primer
WB Alkyd Urethane	Aquacron 870 Acrylic Urethane	Pro-Industrial WB Acrylic Urethane
Quick Drying Enamel Undercoat	Seal Grip Alkyd Primer 17-941NF	Easy Sand Alkyd Primer B49W8040
Latex Satin or Semi-Gloss	Prominence Interior	Durations Interior
Premium Acrylic Enamel	Premium Acrylic	Premium Acrylic
Acrylic Alkyd Enamel	Speedhide WB Alkyd 6-1510X1	Pro-Mar 200 Acrylic Alkyd
Concrete Sealer	(3) coats of H&C Clarishield Solvent-Based Natural Look with added pigment for color	

PART 3 EXECUTION

3.1 PREPERATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.2 APPLICATION

- A. Apply products in accordance with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual".
- B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before the next coat is applied.

END OF SECTION 09 91 23

DIVISION 10-
SPECIALTIES

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**SECTION 10 52 20
FIRE EXTINGUISHERS**

PART 1 GENERAL

1.1 SUMMARY

- A. This section includes:
 - 1. Portable fire extinguishers

1.2 SUBMITTALS

- A. Product Data, Samples of finishes, Operating and Maintenance Data.

1.3 QUALITY ASSURANCE

- A. Provide only fire extinguishers which are listed and labeled by Underwriters Laboratories Inc.

PART 2 PRODUCTS

2.1 FIRE EXTINGUISHERS

- A. Manufacturers: Products of the following manufacturers, provided they comply with requirements of contract documents, will be among those considered acceptable:
- B. Fire extinguishers:
 - 1. Buckeye Fire Equipment Co.
 - 2. Walter Kidde, The Fire Extinguisher Co.
 - 3. J.L. Industries, Inc.
- C. Fire Extinguishers:
 - 1. Rating: 44A:60B:C
 - 2. Type: Multipurpose dry chemical (ammonium phosphate).
 - Stored pressure type.
 - 3. Wall mounted.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install cabinets at locations indicated. Install so that the top of the extinguisher handle is 48 inches above finish floor, per A.D.A. Guidelines.

END OF SECTION 10 52 20

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UL EXPANSION OF NOVEL
MACAQUE BREEDING RUNS 2 (BUILDING 4)

PROJECT NUMBER 24138-A

DECEMBER 2025

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SECTION 22 00 00 – PLUMBING GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. Furnish all labor and material necessary to provide and install the complete plumbing portion of this Contract as called for herein and on accompanying drawings. Parts of the plumbing division may be bid separately or in combination, at the Contractor's option; however, it shall be the responsibility of the General Contractor to assure himself that all items covered in the Plumbing Division have been included if he chooses to accept separate bids.
- B. It is the intent of this specification that all materials with temperatures below ambient conditions or conveying any fluid/gas at temperatures below 70 deg. F be insulated to completely eliminate the potential for condensation. Unless specified elsewhere in these specifications, for materials that do not require and requiring occasional access, use 2" thick closed cell rubberized insulation with re-sealable fabric joints (hook and loop type).
- C. Contractor shall refer to the Architectural and Structural drawings and install equipment, piping, etc. to meet building and space requirements. No equipment shall be bid on or submitted for approval if it will not fit in the space provided.
- D. It is the intention of these specifications that all plumbing systems shall be furnished complete with all necessary valves, controls, insulation, piping devices, equipment, etc. necessary to provide a satisfactory installation that is complete and in good working order.
- E. Contractor shall visit the site and acquaint himself thoroughly with all existing facilities and conditions which would affect his portion of the work. Failure to do so shall not relieve the Contractor from the responsibility of installing his work to meet the conditions.
- F. This Contractor shall protect the entire system and all parts thereof from injury throughout the project and up to acceptance of the work. Failure to do so shall be sufficient cause for the Architect to reject any piece of equipment.
- G. Provide as work of this Division (unless clearly and specifically indicated as a requirement of the Division 26 contractor on the Division 26 drawings) the following:
 - 1. 120V power to all fixtures, control panels, unit controllers, field devices, etc. as required.
 - 2. Wiring of any remote start/stop switches controlling Division 22 equipment.

1.3 GROUNDS AND CHASES

- A. This Contractor shall see that all required chases, grounds, holes and accessories necessary for the installation of his work are properly built in as the work progresses; otherwise, he shall bear the cost of providing them.

1.4 CUTTING AND PATCHING

- A. Initial cutting and patching shall be the responsibility of the General Contractor, with the various trades being responsible for laying out and marking any and all holes required for the reception of his work. No structural beams or joists shall be cut or thimble without first receiving the approval of the Architect. After initial surfacing has been done, any further cutting, patching and painting shall be done at this Contractor's expense.

1.5 FILL AND CHARGES FOR EQUIPMENT

- A. Fill and charge with materials or chemicals all those devices or equipment as required to comply with the manufacturer's guarantee or as required for proper operation of the equipment.

1.6 BIDDING REQUIREMENTS AND RESPONSIBILITIES

- A. Prime bidder is responsible for all work, of all trades and sub-contractors bidding this project. It is the prime bidder's responsibility, prior to submitting a bid to ensure that sub-contractors coordinate all aspects of the work between trades, sub-contractors, etc. to the fullest extent possible.
- B. Prime bidder shall ensure that all sub-contractors, suppliers, equipment vendors, etc., obtain all necessary and pertinent contract document information pertaining to their work prior to the submission of a bid. Contractor shall realize that different sub-contractors may furnish equipment, accessories, devices, etc. necessary for a complete and working installation that require provision of services by another sub-contractor or trade.
- C. Bidders of all or any portions of this section or division are required to review all contract documents including but not limited to Architectural drawings, Structural drawings, Mechanical drawings, Plumbing drawings, Electrical drawings, etc. to coordinate requirements and responsibilities with and through prime bidder.
- D. Bidders of all or any portions of this section or division, by furnishing a bid on a portion of the prime contract are indicating that they have received all contract documents and coordinated services provided under their portion of the work with the prime bidder; they are indicating that they have expressed any pertinent questions (which would result from a detailed, thorough review of the entire set of contract documents) to the prime bidder in accordance with Division 00 & 01 requirements, prior to bidding.
- E. All timely, pertinent, questions provided in writing prior to bids, in accordance with Division 00 & 01 requirements, will be clarified, defined, or otherwise explained in a written addendum and/or addendums prior to bids, in accordance in Division 00 & 01 requirements.
- F. It is not the intention of these contract documents to leave any issue relating to coordination between trades or sub-contractors vaguely defined. The intention is to define all issues, coordination matters, equipment requirements, sizes, routing, etc. to the satisfaction of the prime bidder, prior to receipt of bids.
- G. Bidders of all or any portions of this section or division, by virtue of the submission of a bid to the prime bidder, are indicating that they have reviewed the entire set of contract documents with due diligence and regard for the Owner's desire for a comprehensive and complete bid proposal; that they have expressed all concerns or questions requiring clarification on matters of coordination between trades and/or sub-contractors; that they have expressed any such concerns or questions in writing in accordance with Division 00 & 01 requirements.

- H. Prime bidders, by submission of a comprehensive bid on the project are indicating that the subcontractors selected in their bid have complied with all Division 00 & 01 requirements, that they have indicated in writing, prior to bidding, all questions or concerns requiring clarification and/or explanation and have documented any and all specific exclusions involving work that would generally be considered to be work of their trade. The prime bidder shall coordinate all work so that anything excluded by the bidder of all or any portions of this section or division, have been addressed prior to bids in one of the following manners:
1. The work has been confirmed, by the prime bidder, to be work of another trade or subcontractor (whose proposal is also being accepted).
 2. Clarification of the matter has been made through the prime design professional via written addendum and is clearly and mutually understood by the prime bidder and the party raising the issue/question, or seeking clarification.
 3. The work has been accepted as the responsibility of the prime contractor directly.

1.7 MATERIAL AND EQUIPMENT

- A. The term "provide" when used in the Contract Documents shall mean "furnish and install" and includes all items necessary for the proper execution and completion of the Work.
- B. Specific reference in the Specifications to any article, device, product, material, fixture, form or type of construction by name, make or catalog number, shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition; and the Contractor, in such cases, may at his option use any article, device, product, material, fixture, form or type of construction which in the judgment of the Architect expressed in writing is equal to that specified.
- C. Coordinate and properly relate all Work of this Division to building structure and work of all other trades.
- D. Visit premises and become thoroughly familiar with existing conditions; verify all dimensions in field. Advise Architect of any discrepancies prior to Bid Date in accordance with Division 00.
- E. Do not rough-in for any item or equipment furnished by others or noted "Not in Contract" (NIC), without first receiving rough-in information from physically examining the existing equipment, receiving specific cut sheet information from the Owner's representative, other trades and/or Architect. Rough-in services for "NIC" equipment as required, as the work progresses.
- F. Provide storage and protection for all equipment and materials in accordance with requirements of Division 00 & 01. Replace any equipment and materials damaged by improper handling, storage, or protection, at no additional cost to Owner.
- G. Keep premises clean in accordance with requirements of Division 00 & 01.

1.8 SUBSTITUTIONS

- A. Substitutions are only allowed by approval of the Architect prior to Bid Date as stipulated in Division 00 & 01.
- B. Design of systems is based on specific equipment. If the use of other manufacturer's equipment, even though approved by Architect, involves additional cost due to space requirements, foundation requirements, increased mechanical or electrical services, the cost of such extra work shall be borne by Contractor. Even though a manufacturer's name appears in the Contract Documents as having acceptable equipment, their equipment with

different model numbers shall be classified as being a substitute to the equipment originally designed for and named in the Contract Documents. Substitute equipment, materials, etc., will not be allowed to deviate from Contract Document requirements. Furnish all options specified or reasonably implied from the contract documents. Specifically identify any variance in regard to submittal versus specified performance on the cover sheet of each submittal.

1.9 POST-BID VALUE ENGINEERING (V/E):

- A. While it may be in the project Owner's interest to consider the first cost money saving that may be generated via alternatives and options generated via participation in Value Engineering, Division 22 contractor shall realize that substantive offers of Value Engineering (V/E), if accepted by the Owner, constitute a design-build agreement (offer and acceptance) with the owner, and drastically change the design concept of the project, as developed by the Professional of Record identified on the Contract Documents.
- B. Should contractor offer, and the owner accept value engineering options that alter aspects of the system design, equipment, performance and/or performance verification or monitoring of respective systems, Division 22 contractor shall provide duly licensed professional engineering consultants working on behalf of the Division 22 contractor (including sub-contractors and equipment vendors/manufacturers) to review, approve and take professional responsibility for performance and suitability of V/E hybrid systems, materials or operational changes related to respective V/E items. The Division 22 contractor's licensed professional engineering consultants and the Division 22 contractor assume any and all responsibility for the design and suitability in terms of performance, of hybrid systems installed, as Division 22 contractor's Professional of Record, absolving the original project Professional of Record (identified on the original Contract Documents, released for the original project Bid/Negotiation) from responsibility for the V/E hybrid systems portion of the work.
- C. Division 22 contractor, via the offer and acceptance of value engineering items on the project agrees to provide professional engineering design services and take full and complete responsibility for the hybrid design. Further, the Division 22 contractor's (V/E Items) professional of record (either employees, or independent consultants to the Division 22 contractor) through the offer and acceptance of V/E items, agree to indemnify and hold harmless the project owner, the owner's original A/E team (Professional of Record on behalf of the owner for the original Contract Documents) their heirs and assigns in regard to the V/E changes and their impact on the Division 22 systems altered, affected or modified, in whole or in part. The Professional of Record shown on the original Contract Documents in regard to the systems altered, adjusted, revised, modified or otherwise affected by the value engineering items implemented, shall be absolved of design responsibility as a result of implementation of V/E items, and their original use of Engineering Seals used for original Contract Documents, shall not apply.

1.10 DRAWINGS AND SPECIFICATIONS

- A. The specific intent of these Contract Documents is to provide the various systems, equipment, etc. to the Owner complete and in a thoroughly calibrated functional condition.
- B. The Drawings shall not be construed as shop drawings. In the event of a possible interference with piping or equipment of another trade, items requiring set grade and elevations shall have precedence over other items should any major interference develop, immediately notify the Architect.
- C. In laying out Work, refer to mechanical, electrical, structural, and architectural drawings at all times in order to avoid interference and undue delays in the progress of the Work.

1.11 CODES AND REGULATIONS

- A. Work shall be in full accord with the most stringent interpretation of the State Sanitary Code, local ordinances, building codes, and other applicable national, local, and state regulations.
- B. Equipment shall conform to requirements and recommendations of the National bureau of Fire Underwriters and National Fire Protection Association (NFPA).
- C. Items provided under this Division shall comply with the American National Standards Institute (ANSI) "Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People," ANSI A 117.1
- D. In the possible event of conflict between codes or regulations and Contract Documents, the most stringent interpretation of either shall govern (provided it does not exceed the requirements of other codes). In the event of an irreconcilable difference between codes or regulations notify the Architect/Engineer immediately.
- E. In addition to the codes heretofore mentioned, all work and equipment shall conform to the applicable portions of the following specifications, codes and/or regulations:
 - 1. National Electrical Code (NEC)
 - 2. National Fire Protection Association (NFPA)
 - 3. American Society of Mechanical Engineers (ASME)
 - 4. American Gas Association (AGA)
 - 5. Underwriters Laboratories (UL)
 - 6. International Plumbing Code (IPC) with Louisiana Amendments
 - 7. NIH DRM
- F. All materials, equipment and accessories installed under this Contract shall conform to all rules, codes, etc. as recommended by National Associations governing the manufacturer, rating and testing of such materials, equipment and accessories. All materials shall be new and of the best quality and first class in every respect. Whenever directed by the Architect, the Contractor shall submit a sample for approval before proceeding.
- G. Where laws or local regulations provide that certain accessories such as gauges, thermometers, relief valves and parts be installed on equipment, it shall be understood that such equipment be furnished complete with the necessary accessories, whether or not called for in these Specifications.
- H. All unfired and fired pressure vessels shall be built in accordance with the A.S.M.E. Code and so stamped. Furnish shop certificates for each vessel. Contractor shall provide and pay for first operating certificate as per State Fire Marshal Regulations.

1.12 FEES, PERMITS, AND TAXES

- A. Obtain and pay for permits required for the Work of this Division. Pay fees in connection therewith, including necessary inspection fees.
- B. Pay any and taxes levied for Work of this Division, including municipal and/or state sales tax where applicable.
- C. All permits, fees, certificates, etc. for the installation, inspections, plan review, service connections locations, and/or construction of the work which are required by any authority and/or agencies having jurisdiction, shall be obtained and paid for by the Contractor.

- D. The Contractor shall make all tests required by the Architect, Engineer or other governing authorities at no additional cost to the Owner.
- E. The Contractor shall notify the Architect and local governing authorities before any tests are made, and the tests are not to be drawn off a line covered or insulated until examined and approved by the authorities. In event defects are found, these shall be corrected and the work shall be retested.
- F. Prior to requesting final inspection by the Architect, the Contractor shall have a complete coordination and adjustment meeting of all of his sub-contractors directly responsible for the operation of any portion of the system. At the time of this meeting, each and every sequence of operation shall be checked to assure proper operation. Notify the Architect in writing ten (10) days prior to this meeting, instructing him of the time, date and whom you are requesting to be present.
- G. This project shall not be accepted until the above provisions are met to the satisfaction of the Architect.

1.13 MANUFACTURER'S DIRECTIONS

- A. Install and operate equipment and material in strict accord with manufacturer's installation and operating instructions. The manufacturer's instructions shall become part of the Contract Documents and shall supplement Drawings and Specifications.

1.14 SUBMITTAL DATA

- A. Submit shop drawings, project data, and samples in accordance with requirements of Division 00 & 01.
- B. Shop drawings shall consist of published ratings or capacity data, detailed construction drawings for fabricated items, wiring and control diagrams, performance curves, installation instructions, manufacturer's installation drawings, and other pertinent data. Submit drawings showing revisions to equipment layouts due to use of alternate or substitute equipment.
- C. Where approved manufacturers and suppliers of equipment, materials, etc. are unable to fully comply with Contract Document requirements, specifically call such deviations to attention of Architect on submittals. Type deviations on a separate sheet; underlined statements or notations on standard brochures, equipment fly sheets, etc. will not be accepted.
- D. Approval of submittals shall not relieve Contractor from furnishing required quantities and verifying dimensions. In addition, approval shall not waive original intent of Contract Documents.
- E. Failure to obtain written approval of equipment shall be considered sufficient grounds for rejection of said equipment regardless of the stage of completion of the project.

1.15 REVIEW OF MATERIALS:

- A. Whenever manufacturers or trade names are mentioned in these Plans or Specifications, the words "or approved equivalent" shall be assumed to follow whether or not so stated. Manufacturers or trade names are used to establish a standard of quality only, and should not be construed to infer a preference. Equivalent products which meet the Architect's approval will be accepted; however, these products must be submitted to the Architect a minimum of ten (10) days prior to the Bid Date.

- B. Submission shall include the manufacturer's name, model number, rating table and construction features.
- C. Upon receipt and checking of this submittal, the Architect will issue an addendum listing items which are approved as equivalent to those specified. The contractor shall base his bid solely on those items specified or included in the "prior approval addendum", as no other item will be acceptable.
- D. Prior approval of a particular piece of equipment does not mean automatic final acceptance and will not relieve the Contractor of the responsibility of assuring himself that this equipment is in complete accord with the Plans and Specifications and that it will fit into the space provided. Shop drawings must be submitted on all items of equipment for approval as hereinafter specified.
- E. Before proceeding with work and/or within thirty (30) days after the award of the General Contract for this work, the Contractor shall furnish to the Architect complete shop and working drawings of such apparatus, equipment, controls, insulation, etc. to be provided in this project. These drawings shall give dimensions, weights, mounting data, performance curves and other pertinent information.
- F. The Architect's approval of shop drawings shall not relieve the Contractor from the responsibility of incorrectly figured dimensions or any other errors which may be contained in these drawings. Any omission from the shop drawings or specifications, even through approved by the Architect, shall not relieve the Contractor from furnishing and erecting same.
- G. Shop drawings shall be submitted in accordance with Section 013300. These submittals shall be supplied as part of this Contractor's contract. Any drawings not approved shall be resubmitted until they are approved. Submit all shop drawings at the same time. No separate items will be accepted.

1.16 PROJECT RECORD DOCUMENTS

- A. Keep Project Record Documents in accordance with requirements of Division 00 & 01.
- B. During construction period, keep accurate records of installations made under this Division, paying particular attention to major interior and exterior underground and concealed piping, ductwork, etc.
- C. The Contractor shall obtain at his cost, two sets of blue-line prints of the original bid documents by the Architect. One set shall be kept on the site with all information as referenced below, and shall update same as the work progresses. The other set will be utilized to record all field changes to a permanent record copy for the Owner.
- D. If the Contractor elects to vary from the Contract Documents and secures prior approval from the Architect for any phase of the work, he shall record in a neat and readable manner, all such variances on the blue-line print in red. The original blue-lines shall be returned to the Architect for documentation.
- E. Provide electronic (PDF) copies of all documentation included in Final Report.
- F. All deviations from sizes, locations, and from all other features of the installations shown in the Contract Documents shall be recorded.
- G. In addition, it shall be possible using these drawings to correctly and easily locate, identify and establish sizes of all piping, directions and the like, as well as other features of the work which will be concealed underground and/or in the finished building.

- H. Locations of underground work shall be established by dimensions to columns, lines or walls, locating all turns, etc., and by properly referenced centerline or invert elevations and rates of fall.
- I. For work concealed in the building, sufficient information shall be given so it can be located with reasonable accuracy and ease. In some cases, this may be by dimension. In others, it may be sufficient to illustrate the work on the drawings in relation to the spaces in the building near which it was actually installed. The Architect's/Engineer's decision in this matter will be final.
- J. The following requirements apply to all "As-Built" drawings:
 - 1. They shall be maintained at the Contractor's expense.
 - 2. All such drawings shall be done carefully and neatly, and in a form approved by the Architect/Engineer.
 - 3. Additional drawings shall be provided as necessary for clarifications.
 - 4. These drawings shall be kept up-to-date during the entire course of the work and shall be available upon request for examination by the Architect/Engineer; and when necessary, to establish clearances for other parts of the work.
 - 5. "As-built" drawings shall be returned to the Architect upon completion of the work and are subject to approval of the Architect/Engineer.

1.17 EXCAVATING AND BACKFILLING

- A. Provide excavating and backfilling necessary for Work of this Division. Comply with provisions of Division 02, Site Work, if applicable.
- B. Trenches shall be inspected by Code Authorities and/or Owner's Representative before and after piping is laid. Give Owner's Representative 24-hour notice for each inspection. If any trenches are filled without Owner's Representative inspection and as subsequently found to be deficient, the trenches shall be uncovered, inspected, and then re-filled, if requested by Owner's Representative.
- C. Provide minimum 18 inches of cover or in compliance with local published frost line data (if greater than 18 inches) to finish grades or paving at water piping.
- D. For piping, provide bell holes at trench bottom to assure uniform bearing. Accurately grade trench bottoms by instrument before laying any pipe.
- E. Protect and maintain trenches in dry condition until piping has been inspected and approved. Immediately after approval, backfill trenches in tamped layers.
- F. Compact fill to satisfaction of Architect and/or Owner's Representative.

1.18 CUTTING AND PATCHING

- A. Comply with requirements of Division 00 & 01 regarding cutting and patching. Locate and timely install sleeves as required to minimize cutting and patching.
- B. Cutting, fitting, repairing, patching, and finishing of Work shall be done by craftsmen skilled in their respective trades. Where cutting is required, cut in such a manner as not to weaken structure, partitions, or floors. Holes required to be cut must be cut or drilled without breaking out around the holes. Where patching is necessary in finished areas of the building, the Architect will determine the extent of such patching and refinishing.

- F. Contractor shall provide electronic (PDF) format copies of all Operation and Maintenance Instruction on disk.

1.22 GUARANTEE

- A. The Contractor shall guarantee all materials, equipment and workmanship for a period of one (1) year from the date of final acceptance of the project. This guarantee shall include furnishing of all labor and material necessary to make any repairs, adjustments or replacement of any equipment, parts, etc. necessary to restore the project to first class condition. This guarantee shall exclude only the changing or cleaning of filters. Warranties exceeding one (1) year are hereinafter specified with individual pieces of equipment.
- B. If the Contractor's office is in excess of a fifty (50) mile radius of the project, he shall appoint a local qualified contractor to perform any emergency repairs or adjustments required during the guarantee period. The name of the contractor appointed to provide emergency services shall be submitted to the Architect for his approval.

1.23 LOCAL CONDITIONS

- A. The location and elevation of all utility services is based on available surveys and utility maps and are believed to be reasonably accurate; however, these shall serve as a general guide only, and the Contractor shall visit the site and verify the location and elevation of all services to his satisfaction in order to determine the amount of work required for the execution of the Contract.
- B. The Contractor shall contact the various utility companies, determine the extent of their requirements and he shall include in his bid all lawful fees and payments required by these companies for complete connection and services to the building, including meters, connection charges, street patching, extensions from meters to main, etc.
- C. In case major changes are required, this fact, together with the reasons therefore, shall be submitted to the Architect, in writing, not less than seven (7) days before the date of bidding. Failure to comply with this requirement will make the Contractor liable for any changes, additions, and expenses necessary for the successful completion of the project.

1.24 MINOR DEVIATIONS

- A. Plans and detail sketches are submitted to limit, explain and define conditions, specified requirements, pipe sizes, etc. Structural or other conditions may require certain modifications from the manner of installation shown, and such deviations are permissible and shall be made as required. However, specified sizes and requirements necessary for satisfactory operation shall remain unchanged. It may be necessary to shift ducts or pipes, or to change the shape of ducts, and these changes shall be made as required. All such changes shall be referred to the Architect for approval before proceeding. Extra charges shall not be allowed for these changes.
- B. Only typical details are shown on the Plans. In cases where the Contractor is not certain about the installation of his work, he shall ask for details. Lack of details will not be an excuse for improper installation.
- C. In general, the drawings are diagrammatic, and the Contractor shall install his work in a manner so that interferences between the various trades are avoided. In cases where interferences do occur, the Architect is to state which item was first installed.

1.25 VALVE TAGS

- A. Secure metal tags to all valves. Labeling on all valve tags shall include type of system the valve controls and the area of building, zone, or equipment number affected by valve operation. Tag shall be 2" minimum diameter brass, engraved with code number, service and size. A framed list of the valves, giving manufacturer's name, model number, type and location shall be mounted in the main basement equipment room.

PART 2 - PRODUCTS (Not applicable)

PART 3 - EXECUTION (Not applicable)

END OF SECTION 22 00 00



SECTION 22 05 00 – COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. This Section includes the furnishing and installation of common work results for plumbing which includes the following related components:
 - 1. Strainers
 - 2. Water hammer arresters
 - 3. Valves
 - 4. Hose bibbs and sill faucets
 - 5. Pressure-temperature relief valves
 - 6. Reduced Pressure Zone Assembly Backflow Preventer

1.3 SUMMARY

- A. This Section specifies the water distribution piping system, including potable cold, hot, and recirculated hot water piping, fittings, and specialties within the building.

1.4 DEFINITIONS

- A. **Water Distribution Piping:** A pipe within the building or on the premises which conveys water from the water service pipe or meter to the points of usage.
- B. **Water Service Piping:** The pipe from the water main or other source of potable water supply to the water distributing system of the building served.

1.5 SUBMITTALS

- A. Refer to Division 01 and Basic Mechanical Requirements for administrative and procedural requirements for submittals.
- B. **Product Data:** Submit manufacturer's product data for the following products that apply to this project scope:
 - 1. Strainers
 - 2. Water hammer arresters
 - 3. Valves
 - 4. Hose bibbs and sill faucets
 - 5. Pressure-temperature relief valves
 - 6. Reduce Pressure Zone Assembly Backflow Preventer
- C. **Coordination Drawings:** Prepare and submit coordination drawings for Water Distribution Piping in accordance with Division 23 - Basic Mechanical Requirements.

- D. Maintenance Data: Submit maintenance and operating data. Include this data in maintenance manual in accordance with requirements of Division 01 and Division 23 - Basic Mechanical Requirements for the following products that apply to this project scope:
 - 1. Strainers
 - 2. Valves
 - 3. Hose bibbs and sill faucets
 - 4. Pressure-temperature relief valves

- E. Quality Control Submittals:
 - 1. Submit welders' certificates specified in Quality Assurance below.
 - 2. Submit certification of compliance with ASME and UL fabrication requirements specified in below.
 - 3. Submit reports specified in Part 3 of this Section.

1.6 QUALITY ASSURANCE

- A. Codes and Standards
 - 1. Plumbing Code Compliance: Comply with applicable portions of Edition 2021 of the International Plumbing Code.
 - 2. ASME Compliance: Fabricate and stamp pressure-temperature relief valves to comply with ASME Boiler and Pressure Vessel Code.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store pipe in a manner to prevent sagging and bending.

1.8 SEQUENCING AND SCHEDULING

- A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate the installation of pipe sleeves for foundation wall penetrations.

1.9 MAINTENANCE

- A. Spare Parts:
 - 1. Furnish to Owner, with receipt, one valve key for each key operated hydrant, bibb, or faucet installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer uniformity: Conform with the requirements specified in Basic Mechanical Requirements, under "Product Options" for the following water distribution piping products.

2.2 VALVES

- A. Gate, ball, butterfly, check, and drain valves are specified in Section 220519 "Plumbing Piping".

- B. Balance Cocks:
1. Threaded Ends 2" and Smaller: Class 125, bronze body, bronze plug, screw driver operated, straight or angle pattern.
 2. Soldered Ends 2" and Smaller: Class 125, bronze body, bronze plug, screw driver operated, straight or angle pattern.
- C. Reduce Pressure Zone Assembly Backflow Preventer
1. Shall be manufactured by Watts, Zurn, Caleffi or prior approved equal.
 2. A Reduced Pressure Zone Assembly shall be installed at each potential health hazard location to prevent backflow due to back-siphonage and/or backpressure. The assembly shall consist of an internal pressure differential relief valve located in a zone between two positive seating check modules with captured springs and silicone seat discs. Seats and seat discs shall be replaceable in both check modules and the relief valve. There shall be no threads or screws in the waterway exposed to line fluids. Service of all internal components shall be through a single access cover secured with stainless steel bolts. Body and shutoffs shall be constructed using Lead Free cast copper silicon alloy materials. Lead Free reduced pressure zone assembly shall comply with state codes and standards, where applicable, requiring reduced lead content. The assembly shall also include two resilient seated isolation valves, four resilient seated test cocks, and an air gap drain fitting. The valve body shall utilize a coating system with built-in electrochemical corrosion inhibitor and microbial inhibitor. The assembly shall meet the requirements of USC; ASSE Std. 1013; AWWA Std. C511; CSA B64.4. Shall be a Watts Series LF009 and shall include a sensor on the relief valve for flood detection on sizes ½" to 3".
 3. Assemblies of sizes ½" to 3" include a flood sensor to detect excessive water discharges from the relief valve. The sensor is installed on the assembly exterior and does not alter assembly functions or certifications. The sensor relays a signal that triggers notification to facility personnel who can take corrective action, thus avoiding the possibility of ruinous flooding and costly damage.
 4. Features:
 - a. Single access cover and modular check construction for ease of maintenance
 - b. Top entry to all internals for immediate accessibility.
 - c. Captured springs for safe maintenance.
 - d. Internal relief valve for reduced installation clearances.
 - e. Replaceable seats for economical repair
 - f. Coating technology to resist internal corrosion.
 - g. Lead Free cast copper silicon alloy body construction (¼" – 2").
 - h. Fused epoxy coated cast iron body (2-½" – 3").
 - i. Ball valve test cocks — screwdriver slotted (¼" – 2").
 - j. Large body passages provides low pressure drop.
 - k. Compact, space saving design.
 - l. No special tools required for servicing.
 - m. Sensor on the relief valve for flood detection (½" – 3")
 - n. Flood alerts feature activated with add-on sensor connection kit, shall be compatible with BMS.
- D. Flood Protection Backflow System (Automatic Flood Sensor)
1. Shall be manufactured by Watts, Zurn, Caleffi or prior approved equal.

2. Watts Flood Protection Backflow System with Sentry Plus Alert is a configured water flow control system that is assembled from proven, reliable components to meet exacting project application requirements. Connected Flood Protection Shutdown ACV coupled with an industry-leading Backflow Preventer helps protect against catastrophic property damage that can occur due to Relief Valve discharge and/or a blocked or overwhelmed floor drain. These drop-in valve stations are factory pre-assembled and tested, ensuring quality and flow performance for critical building demands. The Series PVS-7000 features integral SentryPlus Alert™ technology to provide multi-channel alerts to notify you in real time if there is an issue so you can take appropriate action.
3. The Flood Protection Shutdown Valve shall be a normally open Diaphragm Valve installed upstream of the Reduced Pressure Zone (RPZ) Backflow Assembly, and automatically close if the RPZ relief valve begins to discharge. A Time Delay supplied in the Control Box shall prevent the valve from closing on intermittent discharges from the RPZ relief valve. Once closed the ACV must be manually reset. The Relay Box on ACV connects to SentryPlus Alert™ Control Box. This communication is via cellular network using Watts Syncta Cloud IoT platform. Control box is a remote mounted, 120VAC powered unit. Cellular Gateway is a remote mounted unit and can be mounted up to 100ft away from the Control Box. Extra set of Remote Trip Indication terminals on the Control Box allow users to get remote alarms at through the Building Management System (BMS). The entire Valve station assembly shall be provided by the same manufacturer and be covered by a single warranty policy.

2.3 PIPING SPECIALTIES

- A. Water Hammer Arresters: Bellows type, with stainless steel casing and bellows, pressure rated for 250 psi, tested and certified in accordance with PDI Standard WH-201.
- B. Basket Strainers: Cast-iron body, 125 psi flanges, bolted type or yoke type cover; with removable non-corrosive perforated strainer basket having 1/8" perforations and lift-out handle.
- C. Flexible connectors: Stainless steel bellows with a woven flexible bronze wire reinforcing protective jacket; rated for 150 psig water working pressure, 250 deg F operating temperature and suitable for up to maximum 3/4" misalignment. Connectors shall be a minimum of 12" long and have threaded or flanged ends; sweat ends are not acceptable.
- D. Hose Bibbs: Bronze body, renewable composition disc, tee handle, 3/4" NPT inlet, 3/4" hose outlet.
- E. Recessed Non-Freeze Wall Hydrants: Cast-bronze box, with chrome plated face, tee handle key, vacuum breaker, hinged locking cover, 3/4" inlet, and hose outlet. Bronze casing shall be length to suit wall thickness.
- F. Floor Level Non-Freeze Hydrants: Cast-bronze hydrant, with rough bronze box, tee handle key, drain hole, vacuum breaker, hinged locking cover, 3/4" inlet, and hose outlet. Bronze casing shall be length to suit depth of bury.
- G. Relief Valves:
 1. Provide proper size for relief valve, in accordance with ASME Boiler and Pressure Vessel Codes, for indicated capacity of the appliance for which installed.

2. Combined Pressure- Temperature Relief Valves: Bronze body, test lever, thermostat, complying with ANSI Z21.22 listing requirements for temperature discharge capacity. Provide temperature relief at 210 deg. F, and pressure relief at 150 psi.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify all dimensions by field measurements. Verify that all water distribution piping may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.
- B. Examine rough-in requirements for plumbing fixtures and other equipment having water connections to verify actual locations of piping connections prior to installation.
- C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 JOINING PIPES AND FITTINGS

- A. Copper Tubing: Solder joints in accordance with the procedures specified in ANSI B9.1, using lead free piping, solder, and flux. Lead free, when used with respect to solder and flux, refer to solder and flux containing not more than 0.2 percent lead. When used with respect to pipe and fittings, lead free refers to pipe and fittings containing not more than 6.0 percent lead.

3.3 PIPING INSTALLATION

- A. Refer to the separate Division 230020 section: "Basic Mechanical Requirements", for general piping installation instructions.
- B. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.
- C. Install gravity drainage piping with minimum 1/32" per foot (1/4 percent) downward slope towards drain point unless specified otherwise, herein.

3.4 INSTALLATION OF VALVES

- A. Installation requirements for general duty valves are specified in a separate Section of Division 23.
- B. Sectional Valves: Install sectional valves on each branch and riser, close to main. For sectional valves 2" and smaller, use ball valves; for sectional valves.
- C. Shutoff Valves: Install shutoff valves on inlet of each plumbing equipment item, and on inlet of each plumbing fixture, and elsewhere as indicated. For shutoff valves 2" and smaller, use ball valves; for shutoff valves 2-1/2" and larger, use butterfly valves.
- D. Drain Valves: Install drain valves on each plumbing equipment item, located to completely drain equipment for service or repair. Install drain valves at the base of each riser, at low points of horizontal runs, and elsewhere as required to completely drain distribution piping system. For drain valves 2" and smaller, use gate or ball valves; for drain valves 2-1/2" and larger, use gate or butterfly valves.

- E. Check Valves: Install swing check valves on discharge side of each pump, and elsewhere as indicated.
- F. Balance Cocks: Install in each hot water recirculating loop, discharge side of each pump, and elsewhere as indicated.

3.5 INSTALLATION OF PIPING SPECIALTIES

- A. Install pressure regulating valves with inlet and outlet shutoff valves, and balance cock bypass. Install pressure gage on valve outlet.

3.6 EQUIPMENT CONNECTIONS

- A. Piping Runouts to Fixtures: Provide hot and cold-water piping runouts to fixtures of sizes indicated on plans. Connect cold water to hot and cold-water faucet connections where hot water is not provided.
- B. Mechanical Equipment Connections: Connect hot and cold-water piping system to mechanical equipment. Provide shutoff valve and union for each connection, provide drain valve on drain connection. For connections 2-1/2" and larger, use flanges instead of unions.

3.7 FIELD QUALITY CONTROL

A. Inspections:

1. Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the Architect.
2. During the progress of the installation, notify the Architect, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the Architect.
3. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
4. Final Inspection: Arrange for a final inspection by the Architect to observe the tests specified below and to ensure compliance with the requirements of the plumbing code.
5. Reinspections: Whenever the Architect finds that the piping system will not pass the test or inspection, make the required corrections, and arrange for reinspection by the Architect.
6. Reports: Prepare inspection reports, signed by the Architect.

B. Piping System Test:

1. Test for leaks and defects all water distribution piping systems. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
2. Leave uncovered and unconcealed all water distribution piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.
3. Cap and subject the piping system to a static water pressure of 50 psi above the operating pressure without exceeding the pressure rating of the piping system materials. Isolate the test source and allow to stand for a period of 4 hours. Leaks and loss in test pressure constitute defects which must be repaired.
4. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
5. Prepare reports for all tests and required corrective action.

3.8 ADJUSTING AND CLEANING

A. Cleaning and Disinfecting:

1. Purge all new water distribution piping systems and parts of existing systems, which have been altered, extended, or repaired prior to use.
2. Reports:
 - a. Prepare reports for all purging and disinfecting activities.

3.9 STERILIZATION

- #### A. Sterilize water lines in strict accordance with State Board of Health requirements. After flushing out, obtain approval of water sample analysis from State Board of Health and submit to Architect.

END OF SECTION 22 05 00



SECTION 22 05 19 – PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. This Section includes the following basic mechanical materials and methods to complement other Divisions and Sections.
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Pipe Specialties.
 - 3. Sleeves.
 - 4. Valves and Unions.
 - 5. Shock Absorbers.
 - 6. Escutcheons.
 - 7. Flashing.
 - 8. Access Panels.
 - 9. System Accessories.
- B. Pipe and pipe fitting materials are specified in individual piping system Sections.

1.3 ELECTRICAL WORK

- A. All electrical equipment shall have the U.L. Label and shall meet the standards of the National Electrical Code and NEMA.

PART 2 - PRODUCTS

2.1 PIPE:

- A. Sanitary Sewer Waste Lines Above Slab (PVC):
 - 1. Piping above slab, unless otherwise shown or specified, shall be constructed of solid wall Schedule 40 PVC "DWV" plastic pipe and fittings conforming to ASTM D265 and ASTM D1785 with solvent welded joints.
- B. Sanitary Sewer Waste Lines Below Slab (PVC):
 - 1. Piping below slab, unless otherwise shown or specified, shall be constructed of solid wall Schedule 40 PVC "DWV" plastic pipe and fittings conforming to ASTM D265 and ASTM D1785 with solvent welded joints.
- C. Sanitary Sewer Vent Lines Above Slab (PVC):
 - 1. These shall be constructed of solid wall Schedule 40 PVC "DWV" plastic pipe fittings conforming to ASTM D2665 and ASTM D1785 with solvent welded joints.

2. Sanitary sewer pipe penetrating concrete slabs shall be wrapped with Virginia Chemical K-501, Benjamin Manufacturing Model 6200, or equal foam insulation tape.

D. Domestic Cold and Hot Water Lines:

1. All such lines shall be Government Type "L", hard copper water tubing of standard weight and thickness as made by Mueller, Chase, Anaconda or equivalent, unless indicated otherwise. Use 95-5 lead-free solder on all piping above slab. Use Silfos 1000° lead-free solder on all piping beneath the slab.
2. In certain areas, type "L" soft copper without joints below slab shall be used only where indicated on the Plans. Piping shall be completely insulated per Section 220700.
3. Domestic cold-water lines penetrating concrete slabs shall be wrapped with "Protect-O-Sleeve" vinyl flexible tube as manufactured by Robert H. Harris Co., or equivalent. Sleeve shall have a minimum thickness of .025" (0.635 mm).
4. Domestic hot water lines shall be insulated at all penetrations through slab per insulation (see Section 220700).
5. Domestic cold-water piping within 5'-0" of building may be Schedule 40 PVC plastic pipe with solvent welded joints or slip joint fittings with EPDM seals. Provide thrust blocks all at changes in direction. Installation shall be in accordance with manufacturer's recommendations.

E. Water Heater Relief Lines:

1. These shall be Government Type "L" hard copper.

F. Trap Primer Lines:

1. All such lines shall be Type "L" soft copper, without joints.

2.2 PIPE SPECIALTIES

- A. Dielectric unions shall be used between copper and iron pipe.

2.3 PIPE WARNING TAPE AND TRACER WIRE

- A. Provide warning tape for buried piping as per the following:

1. During the backfilling process, all PVC and Ductile Iron mains, service lines and system appurtenances shall have a continuous warning tape placed immediately above them and throughout their length at a depth of eighteen (18) inches above the utility line surface.
2. The tape shall be six (6) inches wide. Tape material shall be formulated from 100 percent virgin polyolefin resins. Resins shall be pigmental for chemical stability and resistance to sulfide staining (color fastness).
3. Tape shall be constructed by the mechanical (non-adhesive) lamination of two plies of three layers blown film in such a manner as to produce a bi-axially oriented structure. The tape shall be able to provide a 700 percent elongation prior to rupture as per ASTM-D882.
4. The tape shall meet or exceed the standards provided in the Materials Specification List, included in these Standards. The warning tape shall be manufactured with a permanent APWA line color pigment at a maximum of every thirty (30) inches along its length, be imprinted with a continuous warning message as follows:
 - a. "CAUTION: (State Type) LINE BURIED BELOW"

5. At tees, tape ends, etc., the warning tape shall be tied together (spliced) with knot to create a continuous warning tape throughout the length of the pipeline and associated branch lines, appurtenances, etc.

B. Provide tracer wire for buried piping as per the following:

1. In addition to the installation of warning tape, copper tracing wire is to be installed with all PVC mains. This includes all mains, and individual hydrants. The tracing wire shall be taped, using electrical tape, on top of the pipe at ten (10) foot centers, for the total length of the pipe.
2. The tracing wire shall be 12 AWG (Average wire gauge), solid core, copper wire (solid core meaning one (1) single continuous strand of copper wire). In addition, the wire insulating coating (jacket) shall be blue in color and shall have 45 mils of polyethylene insulation thickness and high molecular weight. In addition, the tracing wire shall be HMW-PE and rated for UL 600V construction. The wire shall be suitable for wet or dry applications.
3. The wire size (gauge) shall be continuously affixed (printed on) the entire length of all tracing wire coating and shall be easily read.
4. Where a splice is required, or when a three (3)-way splice is necessary, the wires shall be joined together with an appropriate size (blue) wire nut which shall then be placed inside a 3M brand Direct Bury Splice kit (DBR), or approved equal, of appropriate size. No bare wire shall be left exposed anywhere. All wires shall be spliced to all other wires for a continuous tracing wire system.
5. On all hydrants and above ground appurtenances, the tracing wire shall be run up and protected. This wire end shall not be bare but shall have the coating jacket intact. Location and frequency of test boxes shall be as directed by P.M., or designee. Test boxes shall be required where hydrants are not used or where hydrant spacing exceeds 500 feet.
6. No electrical connections of the tracing wire to any metal pipes or metal service lines will be allowed and care shall be taken to ensure that the tracing wire is not damaged during installation.
7. The tracing wire will be tested for continuous signal (continuity test) and shorts to ground across all main and service lines before asphalt is installed, and prior to sub grade preparation. Tracing wire must be able to conduct a continuous signal before pipe is accepted.

2.4 PIPE HANGERS AND SUPPORTS

- A. This Contractor shall furnish and install all foundations and supports required for his equipment unless indicated otherwise on the Drawings.
- B. This Contractor shall furnish and install all escutcheons, inserts, thimbles, hangers, etc. required for the proper support and installation of his equipment and piping and he shall cooperate with other trades in locating and placing these items.

2.5 PROVIDE SLEEVES FOR ALL PIPES PASSING THROUGH WALLS, FLOORS, BEAMS, ETC.

- A. Sleeves passing through structural members or concrete footings shall be of cast iron or Schedule 40 steel pipe. Sleeves passing through nonstructural walls or floors shall be of 26-gauge galvanized iron. Joints between sleeves and pipes passing through floors shall be made weather tight with plastic materials. Where pipes pass through water proofing membrane, flashing sleeves shall be installed.
- B. Provide Grinnell, Fee & Mason, or equivalent malleable iron split ring hangers with rod supports throughout. Strap hangers or wire will not be accepted.

- C. Maximum spacing of hangers for cast iron pipes shall be 5 ft.; for other than soil, use 10 ft.
- D. Provide galvanized iron shields between hangers and pipe covering.
- E. Provide Grinnell, Fee & Mason, Crane or equivalent heavy steel riser clamps on vertical risers at floors to support pipes.
- F. Provide producer specialty, Jones Manufacturing or equal chrome plated brass escutcheons wherever pipes pass through floors, walls, or ceilings in exposed or finished areas.
- G. All piping projecting from chases shall be rigidly supported in the wall or chase. Loosely supported fixtures or accessories will not be accepted.

2.6 VALVES AND UNIONS

- A. Furnish and install all valves, unions, stops, connections, etc. shown on plans and necessary to make a complete system in working order. Provide valves on inlet and outlet of all equipment and fixtures and on branch lines to fixtures or groups of fixtures.
- B. Ball Valves, 3" and smaller, rated for 150 PSI saturated steam pressure, 600 PSI WOG pressure; shall be 2-piece construction, bronze body conforming to ASTM B-62, conventional port, chrome-plated brass ball, replaceable TFE seats and seals, blow-out proof stem, and vinyl-covered steel handle. Provide solder ends for domestic hot and cold-water service of NIBCO Design S-580-70, Milwaukee BA-150-S or equal, threaded ends of heating hot water and low pressure steam of NIBCO Design T-580-70, Milwaukee BA-100-S or equal. At Contractor's option, Victaulic Style 722 or 721 ball valves may be used.
- C. All valves, unions, etc. where pipe is chrome plated shall have similar finish. All exposed supplies to plumbing fixtures shall be chrome plated.
- D. Domestic water valves (below grade): M & H AWWA Series C-509 resilient gate valve with low torque operation, positive shut-off, O- Ring seals, full epoxy coating and square valve stem end. Provide two (2) adjustable "TEE" handle valve wrenches to be turned over to the owner after construction is complete.
- E. Wafer Check Valves: Class 2500, cast-iron body; with replaceable bronze seat, and non-slam design lapped and balanced twin bronze flappers and stainless-steel trim and torsion spring. Provide valves designed to open and close at approximately one-foot differential pressure.
- F. Select Valves with the following ends or types of pipe/tube connections:
 1. Copper Tube Size 2 Inch and Smaller: Solder ends, except provide threaded ends for heating hot water.
 2. Steel Pipe Sizes, 2 Inch and Smaller: Threaded or grooved end.
 3. Steel Pipe Sizes, 2-1/2 Inch and Larger: Grooved end or flanged.

2.7 SHOCK ABSORBERS

- A. All water service to fixtures or groups of fixtures shall have concealed lead free ASSE 1010 compliant water hammer arrestors on both hot and cold-water branches. Locate shock absorbers close to fixture or at end of header.
- B. Shock arrestors shall be installed for sterilizer water supplies.

2.8 ESCUTCHEONS

- A. Provide escutcheons for all exposed lines passing through floors, walls, and ceilings. They shall be chrome plated brass and shall be of such flange size as to cover necessary penetrating openings.

2.9 FLASHING

- A. Flash all vent penetrations through roof. Extend flashing approximately 10 inches in all directions at base and turn ends down into top of pipe. Off-set vents where necessary to provide 4 feet minimum clearance from other flashing such as outside walls, curbs, etc. Note: All vents shall be 25 feet from fresh air intakes.

2.10 ACCESS PANELS

- A. Furnish and install access panels where valves, dampers, control boxes, etc. are concealed in walls, ceilings, floors, or otherwise inaccessible or where specifically called for on plans. Panels shall be Milcor Style DW, or Bar-Co. Model 500, J-L Industries Model WB, or equal sized as required and furnished with prime coat finish.

2.11 SYSTEM ACCESSORIES

- A. Automatic Drain Valves for Compressed Air Piping shall be corrosion-resistant metal body and internal parts, rated for 200 psig minimum working pressure, capable of automatic discharge of collected condensate. Plug End shall be flow-sensor bleeder, check-valve type, with serrated outlet for hose.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING:

- A. All pipe shall be true and straight, without sags or traps.
- B. The Contractor shall exercise care in cleaning joints after making cuts on pipe to prevent pipe particles from entering the system.
- C. All pipe fittings shall be same as piping specified unless indicated otherwise.
- D. Arrange, install piping approximately as indicated, straight, plumb and as direct as possible; form right angles, or parallel lines with building walls. The most practical appearance of piping runs is required. Keep pipes close to walls, partitions, ceilings; off-set only where necessary to follow walls as directed.
- E. Before installing piping, check plumbing drawings with architectural, mechanical, structural, electrical drawings; make accurate layout of plumbing and HVAC piping. Where interferences may appear and departures from indicated arrangements are required, consult with other trades involved; come to agreement as to changed locations and elevations of piping; obtain approval of proposed changes. Note runs of other contractor's piping and large conduits and cooperate to achieve neat appearance.
- F. Unless otherwise indicated, conceal all piping in building construction in finished areas. Install such piping in time so as not to cause delay to work of other trades and to allow ample time for tests and approval; do not cover before approval is obtained.

- G. Locate groups of pipes parallel to each other and building lines; space them at distance to permit access for servicing, valves, and to create most practical appearance when racked with conduits, refrigerant, etc., provided by other contractors.
- H. Keep fixture branches concealed to points above floor close to fixtures; expose only as much as necessary for final connection. Rigidly support pipes projecting from walls, chases, etc. in wall or chase to make firm, well-braced installation. Loosely supported pipe or accessory is not acceptable.
- I. Install horizontal piping to coordinate with other trades and install without sags or humps.
- J. Grade inside sewer piping at uniform slope of 1/4 inch per foot, minimum; where this is impossible, maintain slope as directed but in no case less than 1/8 inch per foot. Waste lines 3 inches and smaller must grade at minimum 1/4 inch per foot. See Drawings for fall on exterior sewer lines.
- K. Grade other piping as specified under heading or service where used, or as directed.
- L. Keep piping free from scale and dirt, protect open pipe ends wherever work is suspended during construction. To prevent foreign bodies entering and lodging in pipe, use temporary plugs or other approved material.
- M. Where changes in pipe sizes occur, do not bush down; use only reducing fittings. For drainage piping changes in direction, use long sweep bends where possible; otherwise, short sweep 1/4 bends or combination Y and 1/8 bends; also, Ys in combination with other bends.
- N. Provide shut off valves at all supply connections to all equipment. Supplier of equipment shall provide rough-in drawings and this contractor shall fully connect all items, supply necessary piping and fittings as required, unless otherwise noted individually.
- O. Buried thermoplastic piping systems shall be installed in accordance with ASTM D2321.
- P. Do not locate valves with stems below horizontal.
- Q. Locate valves for easy access and operations. Where concealed, notify General Contractor of exact location in order that he may leave openings for access panels. Provide access panels.
- R. Provide unions, screwed or flanged, where indicated, and in following locations even if not indicated.
- S. In connection to equipment requiring disconnection for repairs or replacement. Locate between shut-off and equipment.
- T. Approved expansion joints or flexible couplings shall be provided as necessary.
- U. Care shall be taken in making up pipe and fittings such that the pipe does not extend into fitting sufficiently to reduce the waterway.
- V. Standard, one-piece reducing fittings of approved design shall be used wherever a change in size is made. Changes in pipe sizes shall not be made by means of reducing flanges.

- W. Bushings may be used only where standard, one-piece reducing fittings are not available and shall be subject to the following:
1. Bushings shall be of the face or flush type.
 2. Bushings shall not be used in elbow fittings.
 3. Bushings shall not be used when the reduction in size of the outlet is less than 1/2".
 4. Bushings shall not be used in more than one outlet of any tee or two outlets of any cross fitting.

3.2 INSTALLATION OF VALVES

- A. Use ball and butterfly valves for shut-off duty.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.
- D. Install three-valve bypass around each pressure reducing valve using throttling-type valves.
- E. Install valves in horizontal piping with stem at or above the center of the pipe.
- F. Install valves in a position to allow full stem movement.
- G. All valves, unions, etc. where pipe is chrome plated shall have similar finish. All exposed supplies to plumbing fixtures shall be chrome plated.
- H. All valves, on insulated piping shall be complete with extended lever handle stem.

3.3 PIPE MARKERS

- A. Provide pipe markers and directional arrows on all piping in mechanical equipment rooms, or which is exposed in building, and on both sides of all valves located above ceiling. Markers shall be as manufactured by W.H. Bradley Co., or the equivalent. All letters shall be color-coded and sized as recommended by OSHA. Samples of the type of letters to be used shall be submitted with shop drawings.

- B. The following pipe and valves shall be identified:

		Piping	Valves
1.	Domestic Cold Water	X	X
2.	Natural Gas	X	X

- C. Pipe markers with arrows shall indicate lines content and shall be located 20 feet on center and at each change of direction of line. Identification bands shall be color coded to match pipe markers and shall be provided 10 feet on center. Pipe identification markers shall be taped at each end and shall be taped around the entire circumference of pipe.
- D. Refer to specification section 22 05 96 Plumbing identification for specific labeling requirements.

3.4 TEST

- A. Make such tests of work as specified or required by Architect or by State and Municipal Bureaus having jurisdiction, and under their supervision. Perform tests in presence of Architect's representative. Notify Architect two days prior to testing.
- B. Provide apparatus, temporary piping connections, or other requirements necessary for tests. Take precautions to prevent damage to building or contents by tests. Contractor is required to repair and make good at his expense damage so caused.
- C. For Drain, Waste, and Vent piping, use hydrostatic test to 10 feet of head. Do not use compressed air or gas.
- D. Correct leaks, defects, or deficiencies discovered as result of tests. Repeat tests until test requirements are fully complied with. Caulking of pipe joints to remedy leaks is not permitted, except on lead and oakum joints.

3.5 STERILIZATION

- A. Sterilization all water lines in strict accordance with State Board of Health requirements. After flushing out, obtain approval of water sample analysis from State Board of Health and submit approval report to Architect.

END OF SECTION 22 05 19



SECTION 22 05 53 – PLUMBING IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. Section Includes:
 - 1. Valve Tags.
 - 2. Pipe labels.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1-1/2 inches high.

2.2 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

- B. Pipe Label Color Schedule shall comply with OSHA and ANSI A13.1 Standards (Verify exact color prior to installation):
1. Domestic Cold Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 2. Domestic Hot Water Piping:
 - a. Background Color: Blue.
 - b. Letter Color: White.
 3. Natural Gas Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.

END OF SECTION 22 05 53



SECTION 22 07 00 – PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. Pipe insulation shall not begin until all work has been tested and found to be tight. All insulation adhesives, sealers, tapes and mastic shall meet the latest NFPA requirements and shall meet 25/50/50 flame spread and smoke developed ratings.
- B. All insulation shall be installed in strict accordance with the manufacturer's recommendations.
- C. All pipe insulation where recommended by the manufacturer shall be banded with aluminum bands, three to a section and with one band on each side of each fitting, valve, etc.
- D. Insulation shall be continuous through walls and ceilings.
- E. All valves, strainers, etc. shall be insulated to maintain the same thermal resistance rating as its adjacent piping and the covering shall extend all the way up to the equipment.
- F. Use high density insulation inserts at hangers on all piping 1-1/2" and above to prevent crushing of insulation.

PART 2 - PRODUCTS

2.1 THERMAL INSULATION

- A. After all work has been tested and approved, insulate as follows:
 - 1. Insulation shall be installed in accordance with the manufacturer's recommendations and instructions.

2.2 DOMESTIC WATER PIPING

- A. Cover all domestic cold and hot water lines and hot water return lines above slab with 1" thick, high density fiberglass insulation with Universal Fire-Retardant Jacket, Owens/Corning "25 ASJ/SSL", Knauf ASJ-SSL, or equal. All laps are to be sealed and stapled in place. Fittings are to be mitered segments of insulation held in place with white vapor barrier tape for concealed areas and Zeston 25/50 PVC, Knauf 25/50 rated PVC, pre-molded insulated fitting covers in exposed areas.
- B. Domestic cold and hot water lines 2 -1/2" and above shall be insulated with 1-1/2" thick fiberglass with jacket.
- C. All water lines exposed, including mechanical rooms, shall be covered with 0.030 PVC jacket with solvent welded seams and joints.

- D. All water lines on the outside of the building exposed to the weather shall be covered with 0.016" smooth aluminum jacket and elbows.
- E. Domestic cold and hot water lines run below slab within building shall be insulated with 3/4" thick closed cell tube insulation. Apply two (2) coats of mastic on insulation.

2.3 WASTE LINE P-TRAPS

- A. P-traps receiving HVAC condensate (exposed to weather or above ceilings) shall be insulated with 2.33" thick 3/4 # density fiberglass ductwrap insulation with aluminum foil vapor barrier. Insulation shall be sealed at all seams and joints.

2.4 P-TRAP & SUPPLY LINES

- A. Unless specified otherwise on drawings, insulate p-trap, tailpiece and water supplies on lavatories/sinks with white, Truebro Model 102 Handi Lav-Guard, Pro-Wrap A.D.A. lavatory insulation kit, or approved equivalent insulating system to meet A.D.A. Requirements. Provide accessories for offset tailpiece as required.

PART 3 - EXECUTION

3.1 INSULATION THROUGH HANGERS AND SLEEVES

- A. The insulation shall be continuous through pipe hangers and pipe sleeves. At hangers where the pipe is supported by insulation, provide a galvanized iron protection shield. Provide pipes 2-inch i.p.s. and larger in insulation inserts at points of hanger supports. The inserts shall be of calcium silicate, cellular glass, prestressed molded glass fiber of minimum 13-pound density, or other approval material of the same thickness as adjacent insulation and not less than 13-pound density. The inserts shall have sufficient compression strength to adequately support the pipe without compressing the inserts to a thickness less than the adjacent insulation. Inserts shall be 180 degrees and not less than the length of the protection shield. Vapor barrier facing of the insert shall be the same as the facing on the adjacent insulation. Where copper clad hangers are used on domestic copper pipe, insulation may cover pipe and hanger. Provide 18-gauge metal saddles between all hangers and insulation.

END OF SECTION 22 07 00



SECTION 22 11 23 – NATURAL GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Manual gas shutoff valves.
 - 5. Pressure regulators.
 - 6. Dielectric fittings.

1.3 SCOPE OF WORK

- A. Prior to bid, contact the local utility company to determine the extent of their requirements and include all costs associated with the complete installation of the gas service line, gas meter assembly, gas meter and gas service regulator. Contractor shall be responsible for fees and permits required for the gas service.
- B. Contract shall include routing gas main from the local utility main to the building and throughout project as indicated on Drawings.
- C. Provide gas pressure regulator downstream of the meter assembly to provide adequate gas pressure to equipment furnished in project. Coordinate gas supply pressure and equipment supply pressure requirements with the utility company and equipment manufacturer.
- D. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
 - 1. International Fuel Gas Code.
 - 2. NFPA 54.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Gas Regulators shall be AGA rated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Architect, Owner and Engineer no fewer than seven days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Architect's permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 - 2. Service Regulators: 100 psig minimum unless otherwise indicated.
 - 3. Minimum Operating Pressure of Service Meter: 5 psig.
- B. Natural-Gas System Pressure within Buildings: 0.5 psig or less [More than 0.5 psig but not more than 2 psig] [More than 2 psig but not more than 5 psig] [More than 5 psig].

2.2 PIPES, TUBES, AND FITTINGS

- A. See Part 3 – Piping Schedule articles to determine where pipes, tubes, fittings and joining materials are applied in various services.
- B. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless-steel underground.

5. Mechanical Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - i. Baker Hughes Company.
 - ii. Smith-Blair, Inc.
 - b. Stainless-steel flanges and tube with epoxy finish.
 - c. Buna-nitrile seals.
 - d. Stainless-steel bolts, washers, and nuts.
 - e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.
- C. PE Pipe: ASTM D2513, SDR 11.
1. PE Fittings: ASTM D2683, socket-fusion type or ASTM D3261, butt-fusion type with dimensions matching PE pipe.
 2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11; and steel pipe complying with ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
 3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet.
 - b. Casing: Steel pipe complying with ASTM A53/A53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
 - c. Aboveground Portion: PE transition fitting.
 - d. Outlet shall be threaded or flanged or suitable for welded connection.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
 4. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - i. Lyall, R. W. & Company, Inc.
 - ii. Mueller Co.
 - iii. Perfection Corporation.
 - b. PE body with molded-in, stainless-steel support ring.
 - c. Buna-nitrile seals.
 - d. Acetal collets.
 - e. Electro-zinc-plated steel stiffener.
 5. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - i. Lyall, R. W. & Company, Inc.
 - ii. Mueller Co.
 - iii. Perfection Corporation.
 - b. Fiber-reinforced plastic body.
 - c. PE body tube.
 - d. Buna-nitrile seals.
 - e. Acetal collets.
 - f. Stainless-steel bolts, nuts, and washers.

6. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - i. Baker Hughes Company.
 - ii. Smith-Blair, Inc.
 - b. Stainless-steel flanges and tube with epoxy finish.
 - c. Buna-nitrile seals.
 - d. Stainless-steel bolts, washers, and nuts.
 - e. Factory-installed anode for steel-body couplings installed underground.

2.3 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.4 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 GAS VALVES

A. General Requirements for Metallic Valves, **(NPS 2 and Smaller)**: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
5. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

- B. General Requirements for Metallic Valves, **(NPS 2-1/2 and Larger)**: Comply with ASME B16.38.
1. CWP Rating: 125 psig.
 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 3. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- C. Service / Main Line Valves: Cast-Iron, Lubricated Plug Valves: MSS SP-78.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Flowserve Corporation.
 - c. Homestead Valve.
 - d. Milliken Valve Company.
 - e. Mueller Co.
 - f. R & M Energy Systems; Robbins & Myers.
 - g. Nordstrom.
 - h. Resun.
 2. Body: Cast iron, complying with ASTM A126, Class B.
 3. Plug: Bronze or nickel-plated cast iron.
 4. Seat: Coated with thermoplastic.
 5. Stem Seal: Compatible with natural gas.
 6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 7. Operator: Square head or lug type with tamperproof feature where indicated.
 8. Pressure Class: 125 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- D. Equipment / Shut-off Valves: Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Nibco.
 - b. Apollo Flow Controls; Conbraco Industries, Inc.
 - c. Milwaukee.
 - d. BrassCraft Manufacturing Co.; a Masco company.
 - e. Lyall, R. W. & Company, Inc.
 - f. Perfection Corporation.
 - g. A.Y. McDonald Mfg. Co
 2. Body: Bronze, complying with ASTM B584.
 3. Ball: Chrome-plated bronze.
 4. Stem: Bronze; blowout proof.
 5. Seats: Reinforced TFE; blowout proof.
 6. Packing: Threaded-body packnut design with adjustable-stem packing.
 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 8. CWP Rating: 600 psig.
 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

- E. Automatic Emergency Shut-off Valves.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ASCO Red Hat Series 8044
 - b. Honeywell.
 - 2. Listing: UL listed and Factory Mutual (FM) Approved for natural gas service.
 - 3. Valve shall be 2-way electrically tripped solenoid type, fail safe closed; manual reset; Type 1 solenoid enclosure; NBR seals and disc; stainless steel core tube and springs; copper coil.

2.6 PRESSURE REGULATORS

A. General Requirements:

- 1. Single stage and suitable for natural gas.
- 2. Steel jacket and corrosion-resistant components.
- 3. Elevation compensator.
- 4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Meter Company.
 - b. Dormont; a WATTS brand.
 - c. Fisher Control Valves & Instruments; a brand of Emerson Process Management.
 - d. Maxitrol Company.
- 2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
- 3. Springs: Zinc-plated steel; interchangeable.
- 4. Diaphragm Plate: Zinc-plated steel.
- 5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
- 6. Orifice: Aluminum; interchangeable.
- 7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
- 8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
- 9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
- 10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
- 11. Maximum Inlet Pressure: 2 psig.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dormont; a WATTS brand.
 - b. Eaton.
 - c. Harper Wyman Co.
 - d. Maxitrol Company.
 - e. SCP, Inc.
- 2. Body and Diaphragm Case: Die-cast aluminum.

3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 2 psig.

2.7 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions (NPS 1/2 to NPS 2):
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. HART Industrial Unions, LLC.
 - c. WATTS.
 - d. Wilkins.
 - e. Zurn Industries, LLC.
 2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges (NPS 2-1/2 to NPS 4):
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Matco-Norca.
 - c. WATTS.
 - d. Wilkins.
 2. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 125 psig minimum at 180 deg F.
 - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 2. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.

- c. Gasket: Neoprene or phenolic.
- d. Bolt Sleeves: Phenolic or polyethylene.
- e. Washers: Phenolic with steel backing washers.

2.8 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade.
 - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D2774.
- D. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
- E. Install fittings for changes in direction and branch connections.
- F. Install pressure gage upstream and downstream from each service regulator.

3.4 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.

- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. 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.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Verify final equipment locations for roughing-in.
- K. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- L. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- M. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- N. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- O. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
 - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.

- 3. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
- 4. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- Q. Connect branch piping from top or side of horizontal piping.
- R. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- S. Do not use natural-gas piping as grounding electrode.
- T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- U. Install pressure gage upstream and downstream from each line regulator.
- V. Install sleeves for piping penetrations of walls, ceilings, and floors.
- W. Install sleeve seals for piping penetrations of concrete walls and slabs.
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.5 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing connector.
- B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- C. Install cooking appliance shunt trip valve per valve manufacturer's instructions and in coordination with the kitchen equipment vendor and installer.

3.6 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.

4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 2. Bevel plain ends of steel pipe.
 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- F. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.
1. Plain-End Pipe and Fittings: Use butt fusion.
 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Install hangers for steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- B. Install hangers for corrugated stainless-steel tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping within 12 inches of each fitting.
- D. Support vertical runs of steel piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support vertical runs of corrugated stainless-steel tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.8 CONNECTIONS

- A. Connect to utility's gas main after the gas meter and the gas regulator.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

- A. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

- A. Paint exposed, Exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

- 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (gloss).
Color (Service Gas Regulator and Upstream): Grey
 - d. Color (Downstream of Service Gas Regulator): Yellow.

- B. Paint exposed, Interior metal piping, fittings and piping specialties, except components, with factory-applied paint or protective coating.

- 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex (gloss).
 - d. Color: Yellow.

- C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports and submit to the Architect and Engineer for review.

3.12 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping shall be the following:
 - 1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
- B. Aboveground natural-gas piping, (**NPS 2 and Smaller**) shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.

C. Aboveground natural-gas piping, **(NPS 2-1/2 and Larger)** shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints.

3.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, natural-gas piping **(NPS 2 and smaller)** shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. At Contractor's option, for branch piping **(NPS 1 or smaller)** Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
3. Exceptions:
 - a. All exposed piping located within areas utilized as a return air plenum shall have welded joints with Schedule 40 socket welded forged steel fittings conforming ASME B16.11.
 - b. All exposed piping serving laboratories from main natural gas riser to each emergency shut-off valve shall have welded joints with Schedule 40 socket welded forged steel fittings conforming to ASME B16.11.

B. Aboveground natural-gas piping, **(NPS 2-1/2 and Larger)** shall be the following:

1. Steel pipe with wrought-steel fittings and welded joints.

END OF SECTION 22 11 23



SECTION 22 11 24 - NATURAL GAS DISTRIBUTION

1.1 SERVICE:

- A. Contractor shall contact local utility company, determine the extent of their requirements and include in his price all costs required for the complete installation of gas service, meter and regulator.
- B. Contract shall include routing gas main from local utility main to the building and throughout project as indicated on Drawings.
- C. Contractor shall provide gas pressure regulator downstream of the meter to provide adequate gas pressure to equipment furnished in project. Coordinate gas supply pressure and equipment supply pressure requirements with utility co. and equipment manufacturers.

1.2 GENERAL:

- A. Gas piping shall be of materials as hereinbefore specified and installed in accordance with NFPA 54.
- B. Provide valved outlet and rigid pipe connection at each piece of equipment requiring gas service.
- C. All gas piping shall be run exposed. All gas piping not exposed shall be encased with Schedule 40 steel sleeves with open ends. ALL PIPING THROUGH WALLS SHALL BE SLEEVED.
- D. Automatic gas valve supplying gas equipment below kitchen hood shall be furnished by the Hood Chemical Extinguisher System Contractor and installed by the Plumbing Contractor.
- E. Gas supports on the roof and penetrations through the roof shall be furnished and installed as detailed on the drawings.
- F. The Mechanical Contractor shall lay out location of supports and openings and coordinate same with all respective trades.
- G. Pipe shall be anchored to roof supports with Fee & Mason #366 galvanized pipe anchor. (STRAPS NOT ACCEPTABLE.)

1.3 TESTING:

- A. All low-pressure gas piping shall be tested with a 10" mercury column for thirty (30) minutes.
- B. After the test has been completed and approved by the City Inspector and Architect, the Contractor shall complete the attached form on next page entitled "GAS INSTALLATION CERTIFICATE OF INSPECTIONS AND TESTS", and forward same to Architect.

CERTIFICATION
GAS INSTALLATION
CERTIFICATE OF INSPECTIONS AND TESTS

FILE NO _____

DATE: _____

NAME OF OCCUPANCY _____

STREET ADDRESS _____

PARISH _____ TOWN _____

IS THERE A SHUTOFF COCK OR VALVE AT METER? _____ CONDITION _____

ACCESSIBLE? _____

LENGTH OF SHUT-IN TEST (TIME) _____

RESULT OF TEST IN DETAIL _____

MODE OF TESTING UNDERGROUND LINES _____

MODE OF TESTING GENERAL INSTALLATION _____

CONDITIONS FOUND _____

OWNER'S NAME _____

ADDRESS _____ PHONE _____

OCCUPANT'S NAME _____

ADDRESS _____ PHONE _____

NAME OF PERSON MAKING TEST _____

ADDRESS _____ PHONE _____

REMARKS _____

MAINTENANCE SUPERINTENDENT NAME _____

ADDRESS _____ PHONE _____

END OF SECTION 22 11 24



SECTION 22 13 19 – PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. This Section includes plumbing specialties for water distribution systems; soil, waste, and vent systems; and storm drainage systems.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing piping systems with following minimum working pressure ratings, except where otherwise indicated:
 - 1. Water Distribution Systems, Below Ground: 250 psig.
 - 2. Water Distribution Systems, Above Ground: 250 psig.
 - 3. Soil, Waste, and Vent Systems: 10-foot head of water.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections, and Utility Company requirements.
- B. Submit product data including rated capacities of selected models and weights (shipping, installation, and operation). Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following plumbing specialty products that apply to this project scope:
 - 1. Drain valves.
 - 2. Trap seal primer valves.
 - 3. Cleanouts, cover plates, and access panels.
 - 4. Floor drains, open receptors, and trench drains.
 - 5. Sleeve penetration systems.
- C. Maintenance data for inclusion in Operating and Maintenance manuals as specified in Division 01.

1.5 QUALITY ASSURANCE

- A. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
- B. Electrical Component Standard: NFPA 70, "National Electrical Code."
- C. Listing and Labeling: Provide equipment that is listed and labeled.
- D. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.

- E. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.6 EXTRA MATERIALS

- A. Deliver extra materials to Owner. Furnish extra materials matching products installed as described below. Package them with protective covering for storage and identify with labels clearly describing contents.
- B. Operating Keys (Handles): Furnish 1 extra key for each key-operated hose bibb and hydrant installed.

PART 2 - PRODUCTS

2.1 MISCELLANEOUS PIPING SPECIALTIES

- A. Piping specialties such as escutcheons, dielectric fittings, sleeves, and sleeve seals are specified in Division 23 Section "Basic Mechanical Materials and Methods."
- B. Stop-and-Waste Drain Valves: Ball valve or MSS SP-80 gate valve, rated for 200 psig WOG minimum, ASTM B 62 bronze body, with 1/8-inch side drain outlet and cap.
- C. Trap Seal Primer Valves: ASSE 1018, water-supply-fed type, with the following characteristics:
 - 1. 30-75 psig minimum operating pressure.
 - 2. Bronze body with atmospheric-vented drain chamber.
 - 3. Inlet and Outlet Connections: 1/2 inch threaded, union, or solder joint.
 - 4. Gravity Drain Outlet Connection: 1/2 inch threaded or solder joint.
 - 5. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.
- D. Stack Flashing Fittings: Counterflashing-type, cast-iron fitting, with bottom recess for termination of roofing membrane, and with threaded or hub top for extension of vent pipe.

2.2 CLEANOUTS

- A. General: Size cleanouts as indicated on drawings, or where not indicated, same size as connected drainage piping.
- B. Cleanouts larger than 4 inches are not required except where indicated.
- C. Cleanouts: ASME A112.36.2M, cast-iron body with straight threads and gasket seal or taper threads for plug, flashing flange and clamping ring, and a brass closure plug. Cleanouts for installation in floors not having membrane waterproofing may be furnished without clamping ring.
- D. Cleanout top styles shall be coordinate with floor types.

2.3 SLEEVE PENETRATION SYSTEMS

- A. Description: UL 1479, through-penetration firestop assembly consisting of sleeve and stack fitting with firestopping plug.
 - 1. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on 1 end for installation in cast-in-place concrete slabs.

2. Stack Fitting: ASTM A 48, cast-iron, hubless-pattern, wye branch stack fitting with neoprene O ring at base and cast-iron plug in thermal-release harness in branch. Include PVC protective cap for plug.
 - a. Special Coating: Include corrosion-resistant interior coating on fittings for vent stacks.

2.4 FLASHING MATERIALS

- A. Elastic Membrane: Nonreinforced flexible, black elastic, sheet, 50 to 65 mils thick and complying with the following:
 1. Shore A Hardness: ASTM D 2240, 50 to 70.
 2. Tensile Strength: ASTM D 412, 1200 psi.
 3. Tear Resistance: ASTM D 624, Die C, 20 lb per linear inch.
 4. Ultimate Elongation: ASTM D 412, 250 percent.
 5. Low-Temperature Brittleness: ASTM D 746, minus 30 deg F.
 6. Resistance to Ozone Aging: ASTM D 1149, no cracks for 10 percent elongated sample for 100 hours in ozone at 104 deg F.
 7. Resistance to Heat Aging: ASTM D 573, maximum hardness increase of 15 points, elongation reduction of 40 percent, and tensile strength reduction of 30 percent, for 70 hours at 212 deg F.
 8. Fasteners: Metal compatible with material and substrate being fastened.

2.5 TRENCH DRAINS

- A. General: Lengths and width as indicated on drawings.
- B. Trench drain: Pre-sloped trench drain system, UV stabilized glass-filled polypropylene frame and UV stabilized talc-filled polypropylene channels. An integral 4" no hub bottom outlet shall be provided on center trench drain that makes up the entire length of the trench drain. System to include frame connectors, grate lock-downs, and construction covers.
- C. Standard length is 48". Other available lengths are 12", 24", and 36". Provide lengths as indicated on the drawings to make-up the overall length specified.
- D. System shall be framed-anchored to slab. Coordinate requirements prior to rough-in and concrete pour.
- E. A class C polypropylene grate shall be provided.
- F. The basis of design is Watts Model D-PP. Subject to compliance with requirements, provide trench drain system by one of the following: Watts, Zurn, Josam. All other manufacturer's shall submit for prior approval.

PART 3 - EXECUTION

3.1 PIPING SPECIALTY INSTALLATION

- A. Install strainers on supply side of each control valve, pressure-regulating valve, and solenoid valve, and where indicated.
- B. Install trap seal primer valves with valve outlet piping pitched down toward drain trap a minimum of 1/8 inch per foot (1:100) (1 percent) and connect to floor drain body, trap, or inlet fitting. Adjust valve for proper flow.
- C. Install expansion joints on vertical risers, stacks, and conductors.

- D. Install cleanouts in above-ground piping and building drain piping where indicated, and where not indicated, according to the following:
 - 1. Size same as drainage piping up to 4 inches size. Use 4 inches size for larger drainage piping except where larger size cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet for piping 3 inches and smaller and 80 feet for larger piping.
 - 4. Locate at base of each vertical soil or waste stack.
- E. Install cleanout deck plates (covers), of types indicated, with top flush with finished floor, for floor cleanouts for piping below floors.
- F. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.
- G. Install flashing flange and clamping device with each stack and cleanout passing through floors having waterproof membrane.
- H. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to the manufacturer's written instructions.
- I. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

3.2 CONNECTIONS

- A. Supply Runouts to Fixtures: Install hot- and cold-water supply piping runouts to fixtures of sizes indicated, but not smaller than required by equipment/fixture connection size and/or required by the plumbing code.
- B. Drainage Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated, for equipment/fixture connection size and/or required by the but not smaller than required by plumbing code.
- C. Locate drainage piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

3.3 FLASHING INSTALLATION

- A. Provide flashing manufactured in a single piece except where large pans, sumps, or other drainage shapes are required.
- B. Install 4 psf lead flashing or 16 oz. per sq. ft. copper, except when another weight or material is specified.
- C. Install 6 psf lead flashing or heavier where burning (welding) of lead sheets is required.
- D. Solder joints of metal sheet flashing utilized sheets where required.
- E. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with membrane waterproofing.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum sleeve length of 10 inches, and skirt or flange extending at least 8 inches around pipe.

2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- F. Set flashing on floors and roofs in solid coating of bituminous cement.
 - G. Secure flashing into sleeve and specialty clamping ring or device.
 - H. Install flashing for piping passing through roofs with counter flashing or commercially made flashing fittings, according to Division 07 Section "Sheetmetal Flashing and Trim."
 - I. Extend flashing up vent pipe passing through roofs and turn down into pipe or secure flashing into cast-iron sleeve having calking recess.
 - J. Fabricate and install metal sheet flashing and pans, sumps, and other drainage shapes consistent with Architectural details and materials identified. Install drain connection at all equipment requiring drain piping connection.

3.4 COMMISSIONING

- A. Preparation: Perform the following checks before start-up:
 1. Systems tests are complete.
 2. Damaged and defective specialties and accessories have been replaced or repaired.
 3. There is clear space for servicing of specialties.
- B. Before operating systems, perform these steps:
 1. Close drain valves, hydrants, and hose bibbs.
 2. Open valves to full open position.
 3. Remove and clean strainers.
 4. Verify drainage and vent piping are clear of obstructions. Flush with water until clear.
- C. Starting Procedures: Follow manufacturer's written procedures.

3.5 ADJUSTING

- A. Adjust operation and correct deficiencies discovered during commissioning.

3.6 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day or when work stops.

END OF SECTION 22 13 19



SECTION 22 14 00 – DRAINAGE AND VENT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. This Section specifies building sanitary drainage and vent piping systems, building condensate drainage system, building grease waste drainage and vent system, and storm drainage and vent piping systems, including drains and drainage specialties.

1.3 DEFINITIONS

- A. **Building Drain:** That part of the lowest piping of a drainage system which receives the discharge from soil, waste, and other drainage pipes inside the walls of the building and conveys it to the building sewer.
- B. **Building Sewer:** That part of the drainage system which extends from the end of the building drain and conveys its discharge to a public sewer, private sewer, individual sewage disposal system, or other point of disposal.
- C. **Drainage System:** Includes all the piping within a public or private premise which conveys sewage, rain water or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.
- D. **Vent System:** A pipe or pipes installed to provide a flow of air to or from a drainage system, or to provide a circulation of air within such system to protect trap seals from siphonage and back pressure.

1.4 SUBMITTALS

- A. Refer to Division 01 and Division 23, Basic Mechanical Requirements for administrative and procedural requirements for submittals.
- B. **Product Data:** Submit product data for the following products that apply to this project scope:
 - 1. Drainage piping specialties
 - 2. Floor drains.
- C. **Quality Control Submittals:**
 - 1. Submit reports specified in Part 3 of this Section.

1.5 QUALITY ASSURANCE

- A. **Codes and Standards:**

1. Plumbing Code Compliance: Comply with applicable portions of Edition 2021 of the International Plumbing Code.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate the installation of roof drains, flashing, and roof penetrations.
- B. Coordinate flashing materials installation of roofing, waterproofing, and adjoining substrate work.
- C. Coordinate the installation of drains in poured-in-place concrete slabs, to include proper drain elevations, installation of flashing, and slope of slab to drains.
- D. Coordinate with installation of sanitary and storm sewer systems as necessary to interface building drains with drainage piping systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer Uniformity: conform with the requirements specified in Division 23, Basic Mechanical Requirements, under "Product Options" for the following drainage and vent systems.

2.2 DRAINAGE PIPING SPECIALTIES

- A. Trap Primers: Bronze body valve with automatic vacuum breaker, with 1/2" connections matching piping system. Complying with ASSE 1018.
- B. Expansion Joints: Cast-iron body with adjustable bronze sleeve, bronze bolts with wing nuts.

2.3 FLOOR DRAINS

- A. Floor drain type designations, descriptions, and sizes are indicated on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify all dimensions by field measurements. Verify that all drainage and vent piping and specialties may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.
- B. Verify all existing grades, inverts, utilities, obstacles, and topographical conditions prior to installations.
- C. Examine rough-in requirements for plumbing fixtures and other equipment having drain connections to verify actual locations of piping connections prior to installation.
- D. Examine walls, floors, roof, and plumbing chases for suitable conditions where piping and specialties are to be installed.
- E. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION FOUNDATION FOR UNDERGROUND BUILDING DRAINS

- A. Grade trench bottoms to provide a smooth, firm and stable foundation, free from rock, throughout the length of the pipe.
- B. Remove unstable, soft, and unsuitable materials the surface upon which pipes are to be laid and backfill with clean sand and pea gravel to indicate invert elevation.
- C. Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand backfill. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads and to ensure continuous bearing of the pipe barrel on the foundation.

3.3 JOINING PIPES AND FITTINGS

- A. Copper Tubing: Solder joints in accordance with the procedures specified in ANSI B9.1.
- B. Cast-Iron Soil Pipe: Make lead and oakum calked joints, compression joints, and hubless joints in accordance with the recommendations in the CISPI Cast Iron Soil Pipe and Fittings Handbook, Chapter IV.

3.4 INSTALLATION

- A. Refer to the separate Division 23 section: Basic Piping Materials and Methods, for general piping installation instructions.
- B. Install supports and anchors in accordance with Division-23 Basic Mechanical Materials and Methods section "Supports and Anchors".
- C. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into account many design considerations. So far as practical, install piping as indicated.
- D. Make changes in direction for drainage and vent piping using appropriate 45-degree wyes, half-wyes, or long sweep quarter, sixth, eighth, or sixteenth bends. Sanitary tees or short quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn fittings where two fixtures are installed back-to-back and have a common drain. Straight tees, elbows, and crosses may be used on vent lines. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper size, standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.
- E. Install underground building drains to conform with the plumbing code, and in accordance with the Cast Iron Soil Pipe Institute Engineering Manual. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.
- F. Install building drain pitched down at minimum slope of 1/4" per foot (2 percent) for piping 3" and smaller, and 1/8" per foot (1 percent) for piping 4" and larger.
- G. Extend building drain to connect to sewer piping, of size and in location indicated for service entrance to building. Sewer piping is specified in a separate section of Division 02.

- H. Install sleeve and mechanical sleeve seal through foundation wall for watertight installation.
- I. Install 1" thick extruded polystyrene over underground building drain piping not under building. Width of insulation shall extend minimum of 12" beyond each side of pipe. Install directly over, and center on pipe center line.

3.5 INSTALLATION OF PIPING SPECIALTIES

- A. Install expansion joints on vertical risers as indicated, and as required by the plumbing code.
- B. Flashing Flanges: Install flashing flange and clamping device with each stack and clean-out passing through waterproof membranes.
- C. Vent Flashing Sleeves: Install on stacks passing through roof, secure over stack flashing in accordance with manufacturer's instructions.
- D. Frost-Proof Vent Caps: Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1" clearance between vent and pipe and roof substrate.

3.6 INSTALLATION OF FLOOR DRAINS

- A. Install floor drains in accordance with manufacturer's written instructions and in locations indicated.
- B. Install floor drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.
- C. Set drain elevation depressed below finished slab elevation as listed below to provide proper slope to drain:

DEPRESSION	RADIUS OF AREA DRAINED
1/2"	5'-0"
3/4"	10'-0"
1"	15'-0"
1-1/4"	20'-0"
1-1/2"	25'-0"

- D. Trap all drains connected to the sanitary sewer. Provide 6" deep seal p-traps, and trap primers.
- E. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.
- F. Position drains so that they are accessible and easy to maintain.

3.7 INSTALLATION OF TRAP PRIMERS

- A. Install trap primers with piping pitched towards drain trap, minimum of 1/8" per foot (1 percent). Adjust trap primer for proper flow.

3.8 CONNECTIONS

- A. Piping Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated.

- B. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

3.9 FIELD QUALITY CONTROL

A. Inspections:

1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the Architect.
2. During the progress of the installation, notify the Architect, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the Architect.
3. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
4. Final Inspection: Arrange for a final inspection by the Architect to observe the tests specified below and to ensure compliance with the requirements of the plumbing code.
5. Re-inspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for reinspected by the Architect.
6. Reports: Prepare inspection reports, signed by the Architect.

B. Piping System Test:

1. Test for leaks and defects all new drainage and vent piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
2. Leave uncovered and unconcealed all new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.

C. Drainage and Venting System Testing Procedures:

1. Rough Plumbing: Except for outside leaders and perforated or open jointed drain tile, test the piping of plumbing drainage and venting systems upon completion of the rough piping installation. Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period from 15 minutes before the inspection starts, through completion of the inspection. Inspect all joints for leaks.
2. Finished Plumbing: After the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proved gas and water-tight. Plug the stack openings on the roof and building drain where it leaves the building, and introduce air into the system equal to a pressure of 1" water column. Use a "U" tube or manometer inserted in the trap of a water closet to measure this pressure. Air pressure shall remain constant without the introduction of additional air throughout the period of inspection. Inspect all plumbing fixture connections for gas and water leaks.
3. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.
4. Prepare reports for all tests and required corrective action.

3.10 ADJUSTING AND CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Clean drain strainers, domes, and traps. Remove dirt and debris.

3.11 PROTECTION

- A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

END OF SECTION 22 14 00



SECTION 22 40 00 – PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. This Section includes plumbing fixtures and trim, fittings, and accessories, appliances, appurtenances, equipment, and supports associated with plumbing fixtures.
- B. Products unloaded, uncreated, set in place, installed and final connections made but not furnished under this Section include:
 - 1. Plumbing Fixtures described in Plumbing Fixture Schedule.
 - 2. Accessories, appliances, appurtenances, and equipment specified in other sections, requiring plumbing services or fixture-related devices such as ice makers for refrigerators, as indicated.

1.3 DEFINITIONS

- A. Accessible: Describes a plumbing fixture, building, facility, or portion thereof that can be approached, entered, and used by physically handicapped people.
- B. Accessory: Device that adds effectiveness, convenience, or improved appearance to a fixture but is not essential to its operation.
- C. Appliance: Device or machine designed and intended to perform a specific function.
- D. Appurtenance: Device or assembly designed to perform some useful function when attached to or used with a fixture.
- E. Equipment: Device used with plumbing fixtures or plumbing systems to perform a certain function for plumbing fixtures but that is not part of the fixture.
- F. Fitting: Fitting installed on or attached to a fixture to control the flow of water into or out of the fixture.
- G. Fixture: Installed receptor connected to the water distribution system that receives and makes available potable water and discharges the used liquid or liquid-borne wastes directly or indirectly into the drainage system. The term "Fixture" means the actual receptor, except when used in a general application where terms "Fixture" and "Plumbing Fixture" include associated trim, fittings, accessories, appliances, appurtenances, support, and equipment.
- H. Roughing-In: Installation of piping and support for the fixture prior to the actual installation of the fixture.

- I. Support: Device normally concealed in building construction, for supporting and securing plumbing fixtures to walls and structural members. Supports for urinals, lavatories, and sinks are made in types suitable for fixture construction and the mounting required. Categories of supports are:
 - 1. Chair Carrier: Support for wall-hung fixture, having steel pipe uprights that transfer weight to the floor.
 - 2. Chair Carrier, Heavy Duty: Support for wall-hung fixture, having rectangular steel uprights that transfer weight to the floor.
 - 3. Reinforcement: Wood blocking or steel plate built into wall construction, for securing fixture to wall.
- J. Trim: Hardware and miscellaneous parts, specific to a fixture and normally supplied with it required to complete fixture assembly and installation.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
- B. Product data for each type of plumbing fixture specified, including fixture and trim, fittings, accessories, appliances, appurtenances, equipment, supports, construction details, dimensions of components, and finishes.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with requirements of ANSI Standard A117.1, "Buildings and Facilities -- Providing Accessibility and Usability for Physically Handicapped People," and Public Law 90-480, "Architectural Barriers Act, 1968," with respect to plumbing fixtures for the physically handicapped.
- B. Regulatory Requirements: Comply with requirements of ATBCB (Architectural and Transportation Barriers Compliance Board) "Uniform Federal Accessibility Standards (UFAS) - 1985-494-187" with respect to plumbing fixtures for the physically handicapped.
- C. Listing and Labeling: Provide electrically (battery) operated fixtures specified in this Section that are listed and labeled.
 - 1. The terms "listed" and "labeled" shall be as defined in the National Electrical Code, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- D. Design Concept: The drawings indicate types of plumbing fixtures and are based on the specific descriptions, manufacturers, models, and numbers indicated. Plumbing fixtures having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions, operation, color or finish, or other characteristics are minor and do not change the design concept or intended performance as judged by the Architect. Burden of proof for equality of plumbing fixtures is on the proposer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver plumbing fixtures in manufacturer's protective packing, crating, and covering.
- B. Store plumbing fixtures on elevated platforms in a dry location.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work as described in plumbing fixture schedule on drawings.

2.2 PLUMBING FIXTURES, GENERAL

- A. Contractor shall install all plumbing fixtures shown on accompanying Drawings. Refer to both Plumbing and Architectural, and install all fixtures shown on either.
- B. Provide plumbing fixtures and trim, fittings, other components, and supports as specified in "Plumbing Fixture Schedule" identified on plans.
- C. All brass must be of the best quality. Lightweight goods will not be accepted.
- D. All brass pipe shall be seamless brass tubing and nipples shall be extra heavy.
- E. All fittings and trim shall be chromium plated heavy brass unless otherwise specified.
- F. "P" traps on sinks shall be cast brass with cleanouts.
- G. All exposed piping shall be chromium plated.
- H. Provide cut-off valves at each fixture in both hot and cold-water piping.
- I. For the purpose of establishing type and class of fixtures required, the following plate numbers have been taken from the Manufacturer's Catalog as indicated Fixture manufacturers and Model numbers with prior approval will be acceptable, however fixtures and accessories shall meet standards and features consistent with basis of design fixtures and accessories identified.
- J. Provide plumbing fixtures and trim, fittings, other components, and supports as specified in "Plumbing Fixture Schedule" identified on plans.

2.3 PLUMBING FIXTURE SUPPORTS

- A. Supports: ASME A112.6.1M, categories and types as required for wall-hanging fixtures specified, and wall reinforcement.
 - 1. Support categories are:
 - a. Carriers: Supports for wall-hanging fixtures supported from wall construction.
 - b. Reinforcement: 2 inches by 4 inches wood blocking between studs or 1/4 inch by 6 inches steel plates attached to studs, in wall construction, to secure floor-mounted and special fixtures to wall.
 - c. Support Types: Provide support of type having features required to match fixture.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for potable cold water and hot water supplies and soil, waste, and vent piping systems to verify actual locations of piping connections prior to installing fixtures.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 APPLICATION

- A. Install plumbing fixtures and specified components, in accordance with designations and locations indicated on Drawings.
- B. Install supports for plumbing fixtures in accordance with categories indicated, and of type required:
 - 1. Chair carriers for the following fixtures:
 - a. Wall-hanging sinks.
 - 2. Heavy-duty chair carriers for the following fixtures:
 - a. Fixtures where specified.
 - 3. Reinforcement for the following fixtures:
 - a. Floor-mounted sinks required to be secured to wall.
 - b. Recessed, box-mounted electric water coolers.

3.3 INSTALLATION OF PLUMBING FIXTURES

- A. Install plumbing fixtures level and plumb, in accordance with fixture manufacturers' written installation instructions, roughing-in drawings, and referenced standards.
- B. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.
- C. Fasten wall-mounted fittings to reinforcement built into walls.
- D. Secure supplies behind wall or within wall pipe space, providing rigid installation.
- E. Install stop valve in an accessible location in each water supply to each fixture.
- F. Install trap on fixture outlet except for fixtures having integral trap.
- G. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork. Use deep pattern escutcheons where required to conceal protruding pipe fittings.
- H. Seal fixtures to walls, floors, and counters using a sanitary-type, one-part, mildew-resistant, silicone sealant in accordance with sealing requirements specified in Division 07. Match sealant color to fixture color.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other sections of Division 22. The Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
 - 1. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other sections of Division 22.

2. Install piping connections indicated between appliances and equipment specified in other sections, direct connected to plumbing piping systems.

3.5 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.

3.6 ADJUSTING AND CLEANING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust disposers, hot water dispensers, and controls. Replace damaged and malfunctioning units and controls.
- C. Adjust water pressure at faucets having controls, to provide proper flow and stream.
- D. Replace washers of leaking and dripping faucets and stops.
- E. Clean fixtures, fittings, and spout and drain strainers with manufacturers' recommended cleaning methods and materials.

1. Review the data in Operating and Maintenance Manuals. Refer to Division 01.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of fixtures for temporary facilities, except when approved in writing by the Owner.

END OF SECTION 22 40 00



SECTION 23 00 10 - MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. Furnish all labor and material necessary to provide and install the complete mechanical portion of this Contract as called for herein and on accompanying drawings. Parts of the mechanical division may be bid separately or in combination, at the Contractor's option; however, it shall be the responsibility of the Contractor to assure himself that all items covered in the mechanical Division have been included if he chooses to accept separate bids.
- B. It is the intent of this specification that all materials with temperatures below ambient conditions or conveying any fluid/gas at temperatures below 70 deg. F be insulated to completely eliminate the potential for condensation. Unless specified elsewhere in these specifications, for materials that do not require and requiring occasional access, use 2" thick closed cell rubberized insulation with re-sealable fabric joints (hook and loop type).
- C. Contractor shall refer to the Architectural and Structural drawings and install equipment, piping, etc. to meet building and space requirements. No equipment shall be bid on or submitted for approval if it will not fit in the space provided.
- D. It is the intention of these specifications that all mechanical systems shall be furnished complete with all necessary valves, controls, insulation, piping devices, equipment, etc. necessary to provide a satisfactory installation that is complete and in good working order.
- E. Contractor shall visit the site and acquaint himself thoroughly with all existing facilities and conditions which would affect his portion of the work. Failure to do so shall not relieve the Contractor from the responsibility of installing his work to meet the conditions.
- F. Contractor shall protect the entire system and all parts thereof from injury throughout the project and up to acceptance of the work. Failure to do so shall be sufficient cause for the Architect to reject any piece of equipment.
- G. Provide as work of this Division (unless clearly and specifically indicated as a requirement of the Division 26 contractor on the Division 26 drawings) the following:
 - 1. 120V power to all temperature control panels, unit controllers, field devices, etc. as required.
 - 2. Wiring of any remote start/stop switches, occupancy sensors, manual or automatic motor speed control devices, motorized damper actuators controlling Division 23 equipment.

1.3 BIDDING REQUIREMENTS AND RESPONSIBILITIES

- A. Prime bidder is responsible for all work, of all trades and sub-contractors bidding this project. It is the prime bidder's responsibility, prior to submitting a bid to ensure that sub-contractors coordinate all aspects of the work between trades, sub-contractors, etc. to the fullest extent possible.
- B. Prime bidder shall ensure that all sub-contractors, suppliers, equipment vendors, etc., obtain all necessary and pertinent contract document information pertaining to their work prior to the submission of a bid.
- C. Bidders of all or any portions of this section or division are required to review all contract documents including but not limited to Architectural drawings, Structural drawings, Mechanical drawings, Plumbing drawings, Electrical drawings, and Fire Alarm drawing section to coordinate requirements and responsibilities with and through prime bidder.
- D. Bidders of all or any portions of this section or division, by furnishing a bid on a portion of the prime contract are indicating that they have received all contract documents and coordinated services provided under their portion of the work with the prime bidder; they are indicating that they have expressed any pertinent questions (which would result from a detailed, thorough review of the entire set of contract documents) to the prime bidder in accordance with Division 01 requirements, prior to bidding.
- E. All timely, pertinent, questions provided in writing prior to bids, in accordance with Division 01 requirements, will be clarified, defined, or otherwise explained in written addendum and / or addendums prior to bids, in accordance in Division 01 requirements.
- F. It is not the intention of these contract documents to leave any issue relating to coordination between trades or sub-contractors vaguely defined. The intention is to define all issues, coordination matters, equipment requirements, sizes, routing, etc. to the satisfaction of the prime bidder, prior to receipt of bids.
- G. Bidders of all or any portions of this section or division, by virtue of the submission of a bid to the prime bidder, are indicating that they have reviewed the entire set of contract documents with due diligence and regard for the Owner's desire for a comprehensive and complete bid proposal; that they have expressed all concerns or questions requiring clarification on matters of coordination between trades and/or sub-contractors; that they have expressed any such concerns or questions in writing in accordance with Division 01 requirements.
- H. Prime bidders, by submission of a comprehensive bid on the project are indicating that the subcontractors selected in their bid have complied with all Division 01 requirements, that they have indicated in writing, prior to bidding, all questions or concerns requiring clarification and/or explanation and have documented any and all specific exclusions involving work that would generally be considered to be work of their trade. The prime bidder shall coordinate all work so that anything excluded by the bidder of all or any portions of this section or division, have been addressed prior to bids in one of the following manners:
 - 1. The work has been confirmed, by the prime bidder, to be work of another trade or subcontractor (whose proposal is also being accepted).
 - a. Clarification of the matter has been made through the prime design professional via written addendum and is clearly and mutually understood by the prime bidder and the party raising the issue/question, or seeking clarification.
 - b. The work has been accepted as the responsibility of the Contractor directly.

1.4 POST-BID VALUE ENGINEERING (V/E):

- A. Value Engineering (V/E) defined: For purposes of Division 23 Specifications, in accordance with all Division 01 Requirements and all Terms and Conditions of proposed contract between Owner and Contractor, Value Engineering (V/E) shall be defined as a "post bid" process, whereby the apparent low bidder (having submitted a proposal in strict accordance with Project Contract Documents, that exceeds the Owner's available funds for construction [AFC] for this specified project offers proposed changes ("Value Engineering") to the work. This proposed value engineering may alter or adjust aforementioned contract document requirements in exchange for financial and/or other consideration (in response to a specific request by the Owner/Owner's Representative).
- B. Value Engineering may not be considered, prior to scheduled receipt and review of Bid Proposals by the Owner and an official written request from the Owner/Owner's Representative expressing the Owner's desire to consider value engineering items.
- C. While it may be in the project Owner's interest to consider the first cost money saving that may be generated via alternatives and options generated via participation in Value Engineering, Division 23 contractor shall realize that substantive offers of Value Engineering (V/E), if accepted by the Owner, constitute a design-build agreement (offer and acceptance) with the owner, and drastically change the design concept of the project, as developed by the Professional of Record identified on the Contract Documents.
- D. Should Contractor offer, and the owner accept value engineering options that alter aspects of the system design, equipment, performance and/or performance verification or monitoring of respective systems, Contractor shall provide duly licensed professional engineering consultants working on behalf of the Contractor (including sub-contractors and equipment vendors/manufacturers) to review, approve and take professional responsibility for performance and suitability of V/E hybrid systems, materials or operational changes related to respective V/E items. The Contractor's licensed professional engineering consultants and the Contractor assume any and all responsibility for the design and suitability in terms of performance, of hybrid systems installed, as Contractor's Professional of Record, absolving the original project Professional of Record (identified on the original Contract Documents, released for the original project Bid/Negotiation) from responsibility for the V/E hybrid systems portion of the work.
- E. Division 23 Contractor, via the offer and acceptance of value engineering items on the project agrees to provide professional engineering design services and take full and complete responsibility for the hybrid design. Further, the Contractor's (V/E Items) professional of record (either employees, or independent consultants to the Contractor) through the offer and acceptance of V/E items, agree to indemnify and hold harmless the project owner, the owner's original A/E team (Professional of Record on behalf of the owner for the original Contract Documents) their heirs and assigns in regard to the V/E changes and their impact on the Division 23 systems altered, affected or modified, in whole or in part. The Professional of Record shown on the original Contract Documents in regard to the systems altered, adjusted, revised, modified or otherwise affected by the value engineering items implemented, shall be absolved of design responsibility as a result of implementation of V/E items, and their original use of Engineering Seals used for original Contract Documents, shall not apply.

1.5 MATERIAL AND EQUIPMENT

- A. The term "provide" when used in the Contract Documents shall mean "furnish and install" and includes all items necessary for the proper execution and completion of the Work.

- B. Specific reference in the Specifications to any article, device, product, material, fixture, form or type of construction by name, make or catalog number, shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition; and the Contractor, in such cases, may at his option use any article, device, product, material, fixture, form or type of construction which in the judgment of the Architect expressed in writing is equal to that specified.
- C. Coordinate and properly relate all Work of this Division to building structure and work of all other trades.
- D. Visit premises and become thoroughly familiar with existing conditions; verify all dimensions in field. Advise Architect of any discrepancies prior to Bid Date in accordance with Division 00.
- E. Do not rough-in for any item or equipment furnished by others or noted "Not in Contract" (NIC), without first receiving rough-in information or determining rough-in requirements from physically examining the existing equipment, receiving specific cut sheet information from the Owner's representative, other trades and/or Architect. Rough-in services for "NIC" equipment as required, as the work progresses.
- F. Provide storage and protection for all equipment and materials in accordance with requirements of Division 00 and Division 01. Replace any equipment and materials damaged by improper handling, storage, or protection, at no additional cost to Owner.
- G. Keep premises clean in accordance with requirements of Division 00 and Division 01.

1.6 SUBSTITUTIONS

- A. Substitutions are allowed under La. R.S. 38:2291 and La R.S. 38:2292. Any requests for prior approval (as provided for under La. R.S. 38:2295) including any re-submitted data, shall be received by the Architect/Engineer a minimum of ten (10) working days prior to bid date. The Contractor shall recognize that it may be necessary to submit certain requests for prior approval sooner than the final date listed in the Instructions to Bidders, depending upon the complexity and completeness of the submittal. If, in the opinion of the Architect/Engineer, there is neither sufficient time available nor adequate descriptive data attached to the submittal, the submittal will not be considered. Except as otherwise specified, materials and equipment shall be new and bear the approval label of the Underwriters Laboratories, Inc. for the type of installation required.
- B. Basis of design of systems is based on specific equipment for performance, size, shape, color, construction material, etc... If the use of other manufacturer's equipment, even though approved by Architect, involves additional cost due to space requirements, foundation requirements, increased mechanical or electrical services, the cost of such extra work shall be borne by the contractor. Even though a manufacturer's name appears in the Contract Documents as having acceptable equipment, his equipment shall be classified as being a substitute to the equipment originally designed for and named in the Contract Documents. Substitute equipment, materials, etc., will not be allowed to deviate from basis of design requirements.
- C. All requests for prior approval shall identify where proposed material matches or exceeds the performance of the equipment specified. In addition, such submittal shall also clearly identify all deficiencies compared to specified product. Submittal of general cut sheets will be returned rejected.

1.7 DRAWINGS AND SPECIFICATIONS

- A. The specific intent of these Contract Documents is to provide the various systems, equipment, etc. to the Owner complete and in a thoroughly calibrated and functional condition.
- B. The Drawings shall not be construed as shop drawings. In the event of a possible interference with piping or equipment of another trade, items requiring set grade and elevations shall have precedence over other items. Should any major interference develop, immediately notify the Architect.
- C. In laying out Work, refer to Contract Documents at all times in order to avoid interference and undue delays in the progress of the Work.
- D. Furnish all plumbing fixtures (with required accessories) shown on either the plumbing drawings or the architectural drawings. Review Architectural casework elevations and identify fixtures indicated. Provide fixtures indicated. Rough-in for all fixtures as work progress. Verify plumbing fixtures required from review of Mechanical and Architectural drawings, prior to fixture shop drawing submittal.

1.8 CODES AND REGULATIONS

- A. Work shall be in full accord with the most stringent interpretation of the State Sanitary Code, local ordinances, building codes, and other applicable national, local, and state regulations.
- B. Equipment shall conform to requirements and recommendations of the National Bureau of Fire Underwriters and National Fire Protection Association (NFPA).
- C. Items provided under this Division shall comply with the American National Standards Institute (ANSI) "Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People," ANSI A 117.1
- D. In the possible event of conflict between codes or regulations and Contract Documents, notify the Architect immediately. Codes and Standards represent minimum requirements. These specifications may exceed requirements in various codes and standards.

1.9 FEES, PERMITS, AND TAXES

- A. Obtain and pay for permits required for the Work of this Division. Pay fees in connection therewith, including necessary inspection fees.
- B. Pay any and all taxes levied for Work of this Division, including municipal and/or state sales tax where applicable.

1.10 MANUFACTURER'S DIRECTIONS

- A. Install and operate equipment and material in strict accord with manufacturer's installation and operating instructions. The manufacturer's instructions shall become part of the Contract Documents and shall supplement Drawings and Specifications.

1.11 SUBMITTAL DATA

- A. Submit shop drawings, project data, and samples in accordance with requirements of Division 01.

- B. Shop drawings shall consist of published ratings or capacity data, detailed construction drawings for fabricated items, wiring and control diagrams, performance curves, installation instructions, manufacturer's installation drawings, and other pertinent data. Submit drawings showing revisions to equipment layouts due to use of alternate or substitute equipment.
- C. Where approved manufacturers and suppliers of equipment, materials, etc. are unable to fully comply with Contract Document requirements, specifically call such deviations to attention of Architect on submittals. Type deviations on a separate sheet; underlined statements or notations on standard brochures, equipment fly sheets, etc. will not be accepted.
- D. Approval of submittals shall not relieve Contractor from furnishing required quantities and verifying dimensions. In addition, approval shall not waive original intent of Contract Documents.
- E. Failure to obtain written approval of equipment shall be considered sufficient grounds for rejection of said equipment regardless of the stage of completion of the project.

1.12 PROJECT RECORD DOCUMENTS

- A. Keep Project Record Documents in accordance with requirements of Division 00 and/or Division 01.
- B. During construction period, keep accurate records of installations made under this Division, paying particular attention to major interior and exterior underground and concealed piping, ductwork, etc.

1.13 CUTTING AND PATCHING

- A. Comply with requirements of Division 00 and Division 01 regarding cutting and patching. Locate and timely install sleeves as required to minimize cutting and patching.
- B. Cutting, fitting, repairing, patching, and finishing of Work shall be done by craftsmen skilled in their respective trades. Where cutting is required, cut in such a manner as not to weaken structure, partitions, or floors. Holes required to be cut must be cut or drilled without breaking out around the holes. Where patching is necessary in finished areas of the building, the Architect will determine the extent of such patching and refinishing.
- C. Repairing Roadways and Walks: Coordinate all roadway work with authorities having jurisdiction. Cut and/or bore under roadways for connection of utilities as required. Coordinate work through Contractor. Where this Contract cuts or breaks roadways, or walks to lay the piping, he shall repair or replace these sections to match existing, unless specifically identified as the responsibility of others.

1.14 PAINTING

- A. Painting shall be provided under Division 09, unless specified otherwise. Leave exposed piping, materials, and equipment clean and free of rust, grease, dirt, etc. before and after painting.
- B. Factory finished equipment, fixtures, and materials which are marred, chipped, scratched, or otherwise unacceptable shall be repaired or replaced under this Division to Architect satisfaction, at no additional cost to Owner.
- C. Coordinate all painting requirements with prime bidder prior to bids.

- D. Paint all exposed piping inside and outside of building. Label all piping after painting in accordance with Section 230553. Utilize industry standard paint colors for respective system unless directed otherwise by Architect. Review proposed color scheme with Division 23 Requirements prior to ordering materials.

1.15 GUARANTEE

- A. The Contractor shall guarantee all materials, equipment, and workmanship for a period of one (1) year from the date of final acceptance of the project. This guarantee shall include furnishing of all labor and material necessary to make any repairs, adjustments or replacement of any equipment, parts, etc. necessary to restore the project to first class condition. This guarantee shall exclude only the changing or cleaning of filters. Warranties exceeding one (1) year are hereinafter specified with individual pieces of equipment.
- B. If the Contractor's office is in excess of a fifty (50) mile radius of the project, he shall appoint a local qualified contractor to perform any emergency repairs or adjustments required during the guarantee period. The name of the contractor appointed to provide emergency services shall be submitted to the Architect for his approval.

PART 2 - PRODUCTS

2.1 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Furnish manufacturers operating and maintenance instructions, parts lists and sources of supply for replacements in accordance with Division 01.
- B. Provide the following operations and maintenance data:
 - 1. Complete sets of final and correct shop drawings, maintenance and replacement parts manuals, and operating instructions, for equipment supplied.
 - 2. Bind each set within a common binder. Index and organize with a table of contents, to permit quick and convenient reference.
 - 3. Provide a minimum of five (5) days of instruction in operation and maintenance of equipment to Owner's Representative maintenance force. Design a 2-week period, convenient to Owner's Representative, during which qualified personnel, including manufacturers' technicians and authorized factory trainers shall be available for Architect/Owner's Representative instruction.

2.2 RECORD DRAWINGS

- A. Provide "Record Drawings" in accordance with the Division 01, General Requirements, indicating in a neat and accurate manner a complete record of all revisions of the original design of the work.
 - 1. Include all changes and provide for an accurate record, on reproductions of the Contract drawings or on appropriate shop drawings, all deviations between the work shown and work installed.
- B. Submit for approval bound sets of the required drawings, manuals and operating instructions.

2.3 IDENTIFICATION MARKINGS

- A. General: Apply identification tags, markers, etc. after insulation and field painting are completed.

PART 3 - EXECUTION

3.1 COORDINATION AND LAYOUT

- A. Study Drawings and Specifications to ensure completeness of work required.
 - 1. Include supplementary items normal to manufacturers' requirements or standard accepted trade practices as necessary to complete work, though not specifically indicated or specified.
- B. Verify measurements and conditions in field before starting work.
- C. Examine materials to which work is to be applied and notify the Architect/Owner's Representative, in writing, of any conditions existing which are detrimental to proper and expeditious installation of work.
 - 1. Starting of work shall be construed as acceptance of conditions.
- D. Confer with other trades, install work to avoid interference with other trades, and possible necessary adjustments to conform to structural conditions and work of other trades.
- E. Coordinate and set inserts and locate openings in floors and walls in new construction.
 - 1. Locate pipes and ducts to avoid interference with other work shown on the drawings and as directed by the Architect/Owner's Representative.
 - 2. Keep all concealed pipes and ducts within the enclosing construction provided.
 - 3. Arrange exposed work neatly in parallel runs and parallel with walls or structure, with uniformly spaced hangers and supports, and within the spaces assigned for each kind of work.
- F. Make coordinated layouts showing concrete work required for housekeeping pads, equipment bases and inertia masses which are cast in place, including the location of anchors and dowels.
 - 1. Coordinate the scheduling and placing of the concrete to suit the mechanical work schedules.
 - 2. Concrete housekeeping pads are to cover the full area of each piece of equipment. Concrete bases are to be of dimension and heights to suit the equipment. The forming and placing of concrete shall be provided under this specification section.

3.2 MAINTENANCE OF EQUIPMENT AND SYSTEM PRIOR TO FINAL ACCEPTANCE

- A. Maintain all installed equipment and systems in accordance with the manufacturer's published instructions, until final acceptance by the Architect/Owner's Representative, and take such measures as necessary to ensure adequate protection of all equipment and materials during delivery, storage, installation, operating and shut-down conditions.
 - 1. This responsibility shall include all provisions required to meet the conditions incidental to the delays pending final test of systems and equipment.
 - 2. Maintain and periodically clean all equipment until final acceptance.
- B. After installation of systems has been completed, operate the system to determine the capability of the equipment and controls to conform to the requirements of the drawings and specifications prior to performance testing.

3.3 DAMAGED EQUIPMENT

- A. Any and all equipment, parts, components, etc., provided under this division which is damaged by the Contract, or which is received in damaged condition during shipping, transit, handling, or during installation shall be replaced. Dented, or damaged non-structural equipment jackets or surface casings such as but not limited to water heater jackets, boiler jackets, chiller insulation jackets, etc., shall either be repaired or replaced at the option of the Owner's Representative. If repaired, the finished product shall match original equipment exactly.
- B. Any equipment which develops surface rust, either through improper storage, handling or installation, shall be refinished by grinding the affected area down to bare (white) metal, then prepared with a rust preventive primer and finished with the original manufacturer's touch-up paint to match existing color.

3.4 EQUIPMENT INSTALLATION

- A. Locate and set equipment anchor bolts, dowels and aligning devices for all equipment requiring them. Coordinate requirements of concrete work with Contractor and other trades.
 - 1. Level the equipment and grout solid between the equipment and the surface below.
Grout to be premixed grout mixed in accordance with manufacturer's specifications.
- B. The field assembly, installation and alignment of equipment is to be done under field supervision provided by the manufacturer or with inspections, adjustments and approval by the manufacturer.
- C. Equipment startup.
 - 1. Contractor shall provide qualified start-up personnel, certified by equipment manufacturer, to inspect and approve equipment and to supervise the operating tests of the equipment. System commissioning shall be performed in accordance with ASHRAE standards.
- D. Equipment and system test operation.
 - 1. Note: Equipment and system test operation is separate and apart from additional requirements of training and demonstration. Refer to individual sections for requirements regarding training and demonstration. Notify the Owner's Representative in advance of beginning the equipment and system test operation. All equipment testing/demonstration shall be performed in the presence of the Architect/Owner's Representative. A minimum of seven (7) days notice is required before equipment and system testing.
 - 2. Each piece of equipment shall be operated in its system as long as required to provide proper functioning.
 - 3. Perform an operating test of each complete system for twenty-four hours continuous operation as a minimum, or as long as required to provide coordination and proper functioning of all related systems and controls.
 - 4. The operating criteria for each test shall be determined in advance with the Owner's Representative approval whenever seasonal conditions shall not produce a full design load on any equipment or system.
 - 5. Certify to the Owner's Representative that all equipment is functioning properly.
 - 6. Should the apparatus fail to meet the Contract requirements, adjust, repair or replace all defective or inoperative parts and again conduct the complete performance tests.

3.5 CLEANING AND ADJUSTING OF SYSTEMS

- A. Blow out, clean and flush each system of piping, ductwork and equipment to thoroughly clean the systems.
 - 1. Clean all materials and equipment, and leave in condition ready to operate and receive succeeding finishes where required.
 - 2. Adjust and align all equipment interconnected with couplings or belts.
 - a. Adjust valves of all types and operating equipment of all types to provide proper operation.
 - b. Remove and clean elements in all steam trap bodies.
 - c. Clean all strainers. Replace temporary construction screens with new permanent screens.
- B. Permanent equipment operated during construction shall not be abused or be used in service different from its design application.
 - 1. Temporary disposable filters shall be used during temporary operation.
 - 2. All expendable media, including belts used for temporary operation and similar expendable materials shall be replaced just prior to acceptance.
 - 3. Packing boxes of equipment operated during construction must be replaced just prior to system acceptance, using materials and methods specified by the supplying manufacturer.
- C. Equipment furnished with factory finishes where damaged shall be retouched and repainted to present a new appearance.
- D. Furnish and maintain protection for all of the work whether completed or in progress.
 - 1. Furnish and install coverings and enclosures as required.
- E. New and existing operating equipment and systems shall be clean and dust free inside and out.
 - 1. Concealed and unoccupied areas such as plenums, pipe and duct spaces and Equipment Rooms shall be free of rubbish and swept, vacuumed, or wiped clean at time of acceptance.

3.6 CONTRACTOR REQUESTED FIELD OBSERVATIONS

- A. During the course of, and at stages appropriate to the progress of construction, the Contractor may request field observations of the design professional. If the field observation is a request of and by the Contractor, the Contractor shall provide all necessary ladders, scaffolding, lifts, safety harnesses or other equipment in order for the Architect to safely and adequately perform the requested observations.
 - 1. Requests for observations shall be made a minimum of seven (7) days in advance of the requested date of observation.
 - 2. All equipment, ladders, lifts, safety nets, scaffolding, etc., shall be provided and in place for the use of the Architect.
 - 3. All equipment panel covers, electrical panels, or other equipment shall be opened by the Contractor for viewing by the Architect.
 - 4. The Contractor shall make available a mechanic or technician of that field in order to answer questions of the designer, make any and all adjustments and/or corrections and to assist the Architect.

3.7 TESTING AND BALANCING

- A. Refer to Specifications Section 230593.

3.8 PAINTING

- A. General painting is typically performed by the Division 09 Contractor. This Contract shall however, either perform specialized painting as called for below in the following conditions or he shall advise the Contractor of these requirements as follows:
 - 1. Thoroughly clean all surfaces, requiring prime painting, of rust, loose scale, oil and grease.
 - 2. Dry surfaces before painting.
 - 3. Do not paint controls, nameplates, labels or sprinklers.
- B. Paint all equipment unless otherwise specified not to be painted at the factory with one prime coat of rust prohibitive paint.
- C. Provide field painting as follows:
 - 1. All exposed iron work, including un-insulated ferrous piping and conduit system components, hangers, supports, equipment bases, and apparatus; prime coat with a red lead-free paint.
 - 2. Un-insulated duct work and casing exposed to view and exposed galvanized surfaces of conduit and piping and of equipment prime painted at the shop: Prime coat, zinc chromate for galvanized surfaces.
 - 3. Inside of all duct work where visible through registers and grilles: One coat of flat black paint.

3.9 CONNECTIONS TO EQUIPMENT

- A. Provide mechanical connections to equipment and fixtures requiring such connections which are supplied by Architect/Owner's Representative or under other divisions.
- B. Provide unions, nipples, adapters, valves, flexible connections, and other trim required for final connections for each such fixture or item of equipment, as required for complete operation, servicing, and maintenance.

3.10 WORKMANSHIP

- A. Perform all work in a practical, neat and workmanlike manner with mechanics skilled in work, and using the best practices of the trade involved.
- B. No work shall be concealed until it has been inspected and approved by the Architect/Owner's Representative.
- C. Workmanship or materials not meeting with requirements of the specifications and drawings and satisfaction of the Architect/Owner's Representative shall be rejected and immediately replaced in an acceptable manner, without additional cost to the Architect/Owner's Representative.

3.11 LUBRICATION

- A. All equipment furnished, installed, or connected under this division, shall be inspected for proper lubrication when connected and before operation of the equipment is begun, as recommended by the Manufacturer.

- B. The Contractor for the work of this division shall be held responsible for any damage to equipment that is operated without having been properly lubricated.

3.12 USE OF PREMISES AND CLEANING

- A. Remove and dispose of all waste materials and rubbish due to all construction operations under the Contract, except as otherwise noted, and keep the building free from rubbish and dirt caused by his and/or his Sub-Contractors' employees.
 - 1. During the entire progress of the work, rubbish removal shall be made frequently so as to prevent any potential safety or health hazard.
- B. Upon completion of the work, remove all protection, paint, putty, and other stains from all fixtures and glass and leave the premises thoroughly broom cleaned.

3.13 CUTTING, ALTERING AND PATCHING

- A. Provide all cutting, chasing, drilling, altering and rough patching required for the work of this division.
- B. Do all shoring, bracing, cutting, patching, piecing out, filling in, repairing and refinishing of all present work as made necessary by the alteration and the installation of new work.
- C. All holes and openings occurring in the existing floors after equipment, partitions, floors, steel work, conduits and pipes are removed or installed shall be closed up with materials similar to the adjacent work.
- D. The size and location of items requiring an opening, chase or other provisions to receive it shall be given by the trade requiring same in ample time to avoid undue cutting of any new work to be installed. These provisions shall not relieve the Contractor from keeping other trades informed as to the required opening, chases, etc., nor from responsibility for the correctness thereof, nor for cutting and repairing after the new work is in place.
- E. Include all cutting, repairing, and patching in connection with the work that may be required to make the several parts come together properly and fit it to receive or be received by the work of other trades, as shown on the drawings and/or specified, or reasonably implied by the drawings and specifications.
- F. All repairing, patching, piecing-out, filling-in, restoring and refinishing shall be neatly done by mechanics skilled in their trade to leave same in condition satisfactory to the Architect/Owner's Representative.
- G. Materials and their methods of application for patching shall comply with applicable requirements of the specifications.
 - 1. Materials and workmanship not covered by the specifications and items of work exposed to view adjoining existing work to remain shall conform to similar materials and workmanship existing in or adjacent to the spaces to be altered.
- H. Cutting, repairing, and patching shall include all items shown on the drawings, specified in the specifications or required by the installation of new work or the removal of existing work.
- I. Remove partitions, walls, suspended ceilings, etc., as necessary to perform the required alterations or new construction work.
 - 1. Avoid damage to construction and finishes that are to remain.

- J. Protect and be responsible for the existing building, facilities and improvements if any.
 - 1. Any disturbance or damage to the work, the existing building, and improvements, or any impairments of facilities resulting from the construction operations, shall be promptly rectified, with the disturbed, damaged, or impaired work, restored, repaired or replaced at no extra cost.
- K. All alterations which are not indicated on the drawings nor specified herein but necessary to make good existing work disturbed by reason of the work shall be restored to a condition satisfactory to the Architect/Owner's Representative.
- L. All holes in masonry floors and walls are to be core drilled.
- M. Disturbed concrete and /or cement floor areas shall be patched with approved type latex mortar.
 - 1. When cement mortar is used for patching, the surfaces shall be depressed a minimum depth of one inch (1").
- N. Reinstall all weather protection work in waterproof manner.
- O. Openings in roofs:
 - 1. Openings in roofs shall be kept properly plugged and caulked at all times, except when being worked on, to preclude the possibility of flooding due to storms or other causes. After completion of work, openings shall be permanently sealed.
- P. Temporary openings.
 - 1. All temporary openings cut in walls, floors or ceilings for pipe or duct work shall be closed off with transite or an equally non-combustible material except when mechanics are actually working at the particular opening.

3.14 USE OF PERMANENT SYSTEMS:

- A. Heating System:
 - 1. The Contractor may, at his option, utilize the permanent heating systems provided under this Contract to provide space heating prior to Project completion date. The fuel for such space heating and for required tests of heating equipment shall be provided by Contractor.
 - 2. The heating system shall be operated only by qualified personnel, and shall be operated with all auxiliaries, and in accordance with manufacturer's' instructions and good operating practice. If at any time the Owner's Representative determines that the equipment is being improperly operated or maintained, Contractor may be directed to disconnect its use.
 - 3. Heating systems shall be operated and controlled to prevent temperature in any room or space in any building from exceeding 90 deg. F.
 - 4. Systems may be activated without diffusers and registers in place, but filters with same efficiency as those specified shall be provided both in air handling equipment and at return air grille locations. Filter return air entering duct work, to prevent return air duct work from accumulating dust or otherwise becoming dirty.
 - 5. Contractor shall, prior to final acceptance of the Work, place heating systems and related equipment in a condition equal to new.

3.15 PENETRATIONS THROUGH FIRE SEPARATIONS

- A. Pack annular space between sleeve and pipe (insulation) and / or conduit in fire rated construction with fire retardant putty, sealant and / or caulk in accordance with listed assemblies utilized on the project. Material shall be non-asbestos based and installed in accordance with manufacturers instructions for fire rating required.
- B. Penetrations of multiple items and penetrations with annular space greater than 1/2" shall be provided with approved backing material in accordance with manufacturer's instructions.
- C. Fire retardant sealer and system shall meet ASTM E-84, ASTM E-814, and UL-1479.

END OF SECTION 23 00 10



SECTION 23 00 20 – BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. This Section specifies the basic requirements for mechanical installations and includes requirements common to more than one section of Division 23. It expands and supplements the requirements specified in sections of Division 01.

1.3 ACCESSIBILITY

- A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. Verify exact location and placement of all access panels with/through Architect prior to any equipment rough-in.
- B. Extend all grease fittings to an accessible location.
- C. Refer to the Division 08 Section: Access Doors.

1.4 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 23 for rough-in requirements.

1.5 MECHANICAL INSTALLATIONS

- A. Coordinate mechanical equipment and materials installation with other building components.
- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.
- D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
- E. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- F. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.

- G. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.
- H. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- I. Coordinate the installation of mechanical materials and equipment above ceilings with suspension system, light fixtures, and other installations.
- J. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

1.6 MECHANICAL COORDINATION DRAWINGS

- A. Prepare and submit a set of coordination drawings showing major elements, components, and systems of mechanical equipment and materials in relationship with other building components. Prepare drawings to an accurate scale of 1/4"=1'-0" or larger. Indicate the locations of all equipment and materials, including clearances for installing and maintaining insulation, servicing, and maintaining equipment, valve stem movement, and similar requirements. Indicate movement and positioning of large equipment into the building during construction.
- B. Prepare floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate and integrate all installations. Indicate locations where space is limited, and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
 - 1. Mechanical equipment room layouts
 - 2. Specific equipment installations, including:
 - a. Ductwork and diffusers
 - b. Heating equipment with accessories requirements.
 - 3. Work in pipe spaces, chases, trenches, and tunnels
 - 4. Exterior wall penetrations
 - 5. Ceiling plenums which contain piping, ductwork, or equipment in congested arrangement
 - 6. Installations in mechanical riser shafts, at typical sections and crucial offsets and junctures
 - 7. Division 23 Contractor shall furnish drawings, to Contractor, once approved by reviewing Architect, to fully coordinate with all trades and subcontractors required. Failure to fully coordinate via this process shall not relieve the contractor of his responsibility to coordinate structural supports, electrical service routing of mechanical systems and provisions for required access.

1.7 CUTTING PATCHING AND SEALING OF PENETRATIONS

- A. This Article specifies the cutting and patching of mechanical equipment, components, and materials to include removal and legal disposal of selected materials, components, and equipment.
- B. Refer to the Division 01 Section: CUTTING AND PATCHING for general requirements for cutting and patching.
- C. Refer to Division 26 Section for BASIC ELECTRICAL REQUIREMENTS for requirements for cutting and patching electrical equipment, components, and materials.

- D. Do not endanger or damage installed Work through procedures and processes of cutting and patching.
- E. Arrange for repairs required to restore other work, because of damage caused as a result of mechanical installations.
- F. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.
- G. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
 - 1. Uncover Work to provide for installation of ill-timed Work.
 - 2. Remove and replace defective Work.
 - 3. Remove and replace Work not conforming to requirements of the Contract Documents.
 - 4. Remove samples of installed Work as specified for testing.
 - 5. Install equipment and materials in existing structures.
 - 6. Upon written instructions from the Architect, uncover and restore Work to provide for Architect observation of concealed Work.
- H. Cut, remove, and legally dispose of selected mechanical equipment, components, and materials as indicated, including, but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items made obsolete by the new Work.
- I. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- J. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
- K. Locate identify, and protect mechanical and electrical services passing through remodeling or demolition area and serving other areas required to be maintained operational. When transit services must be interrupted, provide temporary services for the affected areas and notify the Owner prior to changeover.
- L. Seal all penetrations of building envelope air and water tight. For complete closure of openings, where necessary, provide 1/8" thick elastomeric barrier anchored to materials penetrating building envelope and adjacent envelope surfaces involved - seal connections with caulk and mechanical fasteners. Refer to Architectural Sections on joints and sealants. Seal all conduit systems communicating between conditioned and unconditioned spaces. Coordinate all work with and through prime bidder and other trades. Unless otherwise directed, caulk sealant shall be long lasting polyurethane based products, resistant to UV exposure, installed in accordance with manufactures instructions. Sealant joints shall withstand building pressures variance with respect to ambient of 0.25 inches water gauge, with no leakage in terms of air and or water vapor.

1.8 MECHANICAL SUBMITTALS

- A. Refer to the Conditions of the Contract (General and Supplementary) and Division 01 Section: Submittal Procedures for submittal definitions, requirements, and procedures.
- B. Submittal of bound shop drawings, product data, and samples will be accepted only when submitted by the Contractor. Data submitted from subcontractors and material suppliers directly to the Architect will not be processed.

PART 2 - PRODUCTS

2.1 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Refer to the Instructions to Bidders for requirements in selecting products and requesting substitutions.

2.2 PRODUCT LISTING

- A. Prepare listing of major mechanical equipment and materials for the project. A sample schedule is included at the end of this Section to complete this requirement.
- B. Provide all information requested.
- C. Submit this listing as a part of the submittal requirement specified in the Division 01.
- D. When two or more items of same material or equipment are required (plumbing fixtures, pumps, valves, air conditioning units, etc.) they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flanged and grooved types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in Work, except as otherwise indicated.
- E. Provide products which are compatible within systems and other connected items.

2.3 NAMEPLATE DATA

- A. Provide permanent operational data nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance, and similar essential data. Locate nameplates in an accessible location.

2.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
- B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.
- C. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

2.5 RECORD DOCUMENTS

- A. Refer to the Division 01 Section: Closeout Procedures for requirements. The following paragraphs supplement the requirements of Division 01.
- B. Mark Drawings to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with

items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.

- C. Mark Specifications to indicate approved substitutions, Change Orders, actual equipment and materials used.

2.6 OPERATION AND MAINTENANCE DATA

- A. Refer to the Division 01 Section for Project Closeout or Operation and Maintenance Data for procedures and requirements for preparation and submittal of maintenance manuals.
- B. In addition to the information required by Division 01 for Maintenance Data, include the following information:
 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
 2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.
 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 4. Servicing instructions and lubrication charts and schedules.
- C. Submit in accordance with Section 017800.
- D. Use multiple binders if a single binder would exceed 2-1/2 inches in thickness; arrange the data in the same sequence as the specification sections; delete or mark through extraneous data.
- E. Provide tab pages with metal or plastic reinforced holes to separate each major item or closely related group of items with typed item names on the tabs. Supply a table of contents at the beginning of each volume listing at items, the manufacturers and the name, address and phone number of the nearest authorized service representative.
- F. A copy of the completed manual shall be submitted to the Contracting Officer one week before the user instruction for perusal. This copy will be returned to the Contractor with the user, comments. These comments shall be incorporated in the final copies of the manual. The Contractor shall obtain a signed receipt for the manual.
- G. The O & M Manual outline shall be prepared in two parts along the lines suggested in the 2011 HVAC Applications, Chapter 39.
- H. All contents shall be project specific, typewritten.

2.7 WARRANTIES

- A. Refer to individual equipment specifications for warranty requirements.
- B. Compile and assemble the warranties specified in Division 23, into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.
- C. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

2.8 CLEANING

- A. Refer to the Division 01 Section for general requirements for final cleaning.
- B. Refer to Division 230593 Section: TESTING, ADJUSTING, AND BALANCING for requirements for cleaning filters, strainers, and mechanical systems prior to final acceptance.

PART 3 - EXECUTION

3.1 WARRANTIES

- A. Refer to the Division 01 Section for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.
- B. Compile and assemble the warranties specified in Division 23, into a separated set of vinyl covered, three ring binders, tabulated, and indexed for easy reference.
- C. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

3.3 CLEANING

- A. Refer to the Division 01 Section for general requirements for final cleaning.
- B. Refer to Division 23 Section: TESTING, ADJUSTING, AND BALANCING for requirements for cleaning filters, strainers, and mechanical systems prior to final acceptance.

END OF SECTION 23 00 20



SECTION 23 05 15 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. All Variable Frequency Drives (VFD's) specified under this section shall be provided by the same manufacturer.
- B. All VFD's installed in return air plenums shall be plenum rated.
- C. Extent of motor starter and/or variable frequency drive work is indicated by drawings, schedules, and specifications. All motors and mechanical equipment provided with motors supplied by the Division 23 Contractor shall be also provided with Motor Starters and/or Variable Frequency Drives. It is the responsibility of the Division 23 Contractor to ensure that all VFD's are sized and suitable for the intended purpose of the mechanical equipment provided.
- D. The Division 23 Contractor shall provide the Motor Starters and VFD's to the Division 26 Contractor for mounting, installation, and connection by the Division 26 Contractor. Disconnecting means unless integral to the Starter/VFD shall be provided by the Division 26 Contractor.

1.3 SECTION INCLUDES

- A. Variable Frequency Drives (VFDs): This section includes stand alone Variable Frequency Drives, Drives that are integral to equipment, and Variable Frequency Drives located within Motor Control Centers.
 - 1. All Variable Frequency Drives shall be of the same manufacturer. Variable Frequency Drives located in mechanical rooms as Free-Standing Units and Variable Frequency Drives located in Motor Control Centers shall be of the same manufacturer. Drives that are integral to the equipment being installed shall be of the same manufacturer as the equipment in which they are installed.
 - 2. Variable Frequency Drives shall be plenum rated where installed in mechanical rooms which are used as return air plenums.
 - 3. Variable Frequency Drives (VFD's), Variable Speed Controllers (VSD's), and Adjustable Speed Drives are also referred to as AC Drives and their nomenclature shall be used interchangeably.
 - 4. Drives are for use with NEMA "B" or NEMA "E", MG-1 design AC motors.
 - 5. Drives coordinated short circuit current shall be rated in accordance with UL 508C "Standard for Safety for Power Conversion Equipment". Drives which do not bear the short circuit current on the drive nameplate shall not be permitted.
 - 6. Drives shall also be tested in accordance with NEMA ICS 7.1 "Safety Standard for the Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems."

1.4 REFERENCES

- A. ANSI/NFPA 70 - National Electric Code
- B. IEC 60068, Part 2-3
- C. NEMA ICS
- D. UL 50, 98, 507, 508, 508C, 991
- E. OSHA 1910.95 - AC Drive Controller Acoustical Noise

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include the following:
 - 1. General Electric Company
 - 2. Allen Bradley
 - 3. Cuttler Hammer
 - 4. Square D Company
 - 5. Aesa Brown Boveri (ABB)
 - 6. Franklin Controls (Cerus)
 - 7. Danfoss
 - 8. Yaskawa

2.2 GENERAL

- A. Environmental Ratings:
 - 1. The "Service Voltage" for the Project is 208/3/60.
 - 2. The AC Drive shall meet IEC 60664-1 Annex A and NEMA ICS 1, UL, and CSA standards.
 - 3. For indoor installation, the AC Drive shall be designed to operate in an ambient temperature environment from 0 to 40 deg C (32 to 104 deg F).
 - 4. For outdoor installation, the AC Drive shall be designed to operate in an ambient temperature environment from -18 to 50 deg C (0 to 122 deg F).
 - 5. The storage temperature range shall be -25 to 60 deg C (-13 to 149 deg F)
 - 6. The maximum humidity shall be 90 % at 40 deg C (104 deg F) non-condensing.
 - 7. The AC Drive shall meet the IEC 60721-3-3M3 operational vibration specification.
 - 8. Drives shall be plenum rated where installed in return air plenums.
- B. Construction:
 - 1. For indoor installation the AC Drive power converter shall be enclosed in a Type 12K enclosure with top and bottom conduit knockouts with a circuit breaker disconnect, industrial rated operator controls, user terminal strip connections, and by-pass controls.
 - 2. For outdoor installation the AC Drive power converter shall be enclosed in a Type NEMA 3R enclosure with industrial rated operator controls, user terminal strip connections, and by-pass controls. NEMA 4X enclosures shall be provided near cooling towers and other corrosive environments.
 - 3. The enclosure shall provide dedicated user terminals for power and control device connection.

4. Provisions shall be included for locking the disconnect in the "OFF" position with a padlock.
 5. All enclosure heat sink fans shall be front accessible and shall not require the removal of the AC Drive converter.
- C. Harmonic Mitigation:
1. The electrical distribution system shall be designed to meet IEEE-519-1992 with the addition of line reactors. These line reactors shall be mounted inside the drive enclosure.
- D. **Furnish complete variable frequency drives including internal unit mounted disconnects meeting the requirements of NEC as specified herein for the fans and pumps designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. VFD unit shall be capable of being provided single source power by the Division 26 Contractor without the need of an externally mounted disconnecting means or fused disconnect switch.**
- E. All VFD's shall be rated for "constant torque" at temperatures stated in section 2.2, A and shall be capable of operating in location shown on contract documents.
1. Provide internal cooling fans sized and rated for the conditions stated above.
 2. The controller, bypass assembly, disconnect switch and controls shall be by the same manufacturer, factory installed, and shall be self-contained in a single convection cooled cabinet.
 3. All terminal blocks provided for field wiring shall be pre-wired at the factory.
- F. The VFD shall utilize Pulse Width Modulated (PWM) design with latest generation IGBT's.
1. Unit shall be UL listed and rated.
 2. Unit shall have output current rating of 110% of motor FLA for one (1) minute.
 3. Unit shall take incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors.
 4. The motor current shall closely approximate a sine wave.
 5. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to negate the need for motor derating.
 6. Provide short circuit and ground fault protection.
 7. Provide non-volatile memory.
 8. Provide and be capable of single-phase input operation with 50% VFD derating.
 9. Minimum efficiency shall be 97% at full load, full speed.
 10. Unit shall be capable of operation on an AC line containing line notching and up to 10% THD and capable of operation with motor disconnected from output.
 11. VFD to be compatible with NEMA Design "B" motors.
 12. VFD shall report to the Building Automation System (BAS) via a direct N2 connection.
- G. An advanced sine wave approximation and voltage vector control shall be used to allow operation at rated motor shaft output at nominal speed with no derating. This voltage vector control shall minimize harmonics to the motor to increase motor efficiency and life.
- H. Reference Signal:
1. In the event of loss of the reference signal. The VFD shall alarm and go to one of the following user programmable conditions:

- a. Stop
 - b. Maintain last reference
 - c. Go to pre-set speed
 - d. Go to maximum speed

- I. The VFD shall include a full-wave diode bridge or SCR rectifier and maintain a fundamental power factor near unity regardless of speed or load. If SCR's are utilized, they shall be gated fully on once precharge is complete.

- J. The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL-508 certified for the building and assembly of option panels. Local representative panel shop assembly for option panels is not acceptable. The appropriate UL stickers shall be applied to both the drive and option label, in the case where these are not contained in one panel.

- K. The VFD shall have a DC link reactor to minimize power line harmonics. VFDs without a DC link reactor shall provide a 3% impedance line reactor.

- L. The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output currently continuously, 110% of rated current for 60 seconds and 150% of rated current for up to 0.3 seconds while starting.

- M. The VFD shall be able to provide full torque at any selected speed up to base speed to allow driving direct drive fans without derating.
 - 1. The VFD shall be provided with a selectable soft start, linear, or S-curve start function.
 - 2. Provide selectable ramp to stop, coast, brake, and S-curve stop function.

- N. An automatic energy optimization selection feature shall be provided standard in the drive. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings.

- O. An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor and decouple the motor from the load to run the test.

2.3 PROTECTIVE FEATURES

- A. Class 10 I square root electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor application.

- B. Phase-to-phase and phase to neutral short circuit protection. Drive shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.

- C. Protection against input transients, loss of AC line phase, short circuit, ground fault, over voltage, under voltage, drive over temperature and motor over temperature. The VFD shall display faults in plain English. Codes are not acceptable.

- D. Protect VFD from sustained or intermittent power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output with an input voltage as low as 285 volts for 480-volt units.

- E. The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.

- F. Drive shall maintain logic control and shall not fault for 2 seconds after a power loss.
- G. Drive shall have semi-conductor rated input fuses to protect power components.
- H. To prevent breakdown of the motor winding insulation, the dV/dt must be below 1500 V/msec per IEC recommendations. The supplier shall include with the quotation the V/dt values of the drive.
- I. Drive shall include a "signal loss detection" circuit to sense the loss of the control signal, and shall be programmable to react as desired in such instance.
- J. Drive shall catch a rotating motor operating forward or reverse up to full speed.
- K. VFD shall be rated for a minimum 60,000 amp interrupting capacity (AIC).
- L. Drive shall include UL 508C programmable electronic motor overload.
- M. Drive shall continue to operate without faulting until input voltage exceeds 604 volts on 480-volt drives.

2.4 INTERFACE FEATURES

- A. Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the drive and determine the speed reference.
- B. Provide a 24 V DC output signal to indicate that the drive is in Auto/Remote mode.
- C. Digital manual speed control. Potentiometers are not acceptable.
- D. Lockable, alphanumeric backlit display keypad that can be remotely mounted up to 10 feet away using standard 9-pin cable.
- E. All keypads shall be identical and interchangeable.
- F. Drive shall be capable of being operated with the keypad removed.
- G. All drives shall utilize the same control keypad.
- H. To setup multiple drives, it shall be possible to upload all setup parameters to the drive's keypad, place that keypad on all other drives in turn and download the setup to each drive.
- I. Display shall be programmable to display in English.
- J. The display shall have minimum of four lines, with 20 small characters or eight large characters on each line.
- K. Three (3) lines of the display shall allow free programming so that the exact unit controlled by the drive can be identified.
- L. A red "FAULT" light, a yellow "WARNING" light and a green "POWER-ON" light shall be provided. These indications shall be visible both on the keypad and on the drive when the keypad is removed.
- M. A quick setup menu with the most common HVAC parameters shall be provided on the drive eliminating the need for macros.

- N. The drive shall be fitted with an RS 485 serial communications port with capability for remote monitoring signals.
- O. Two set-point control interface (PID control) shall be standard in the unit. Drive shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.
- P. Floating point control interface shall be provided to increase/decrease speed in response to switch closures.
- Q. Sleep mode shall be provided to automatically stop the drive when speed drops below set "sleep" level for a specified time. Drive automatically restarts when speed command exceeds set "wake" level.
- R. Run permissive circuit shall be provided to accept a "system ready" signal to assure that the drive does not start until dampers or other auxiliary equipment are in the proper state for drive operation.
- S. An elapsed time meter and kWh meter shall be provided.
- T. The following displays shall be accessible from the control panel in actual units:
 1. Reference Signal Value in actual units
 2. Output Frequency in Hz or percent
 3. Output Amps
 4. Motor HP
 5. Motor KW
 6. KWH
 7. Output Voltage
 8. No Load Warning
 9. DC Bus Voltage
 10. Drive Temperature in degrees
 11. Motor Speed in engineering units per application (in percent speed, GPM, CFM). Drive will read out the selected engineering unit either in a linear, square or cubed relationship to output frequency as appropriate to the unit chosen.
- U. Up to four-meter displays can be shown at once on the display. This allows the actual value of the follower signal to be shown simultaneously with the drive's response to that signal for ease in commissioning.
- V. Drive will sense the loss of load and signal a no load/broken belt warning or fault.
- W. The VFD shall have temperature controlled internal cooling fans for quiet operation and minimized losses. Fan shall be sized for ambient conditions in which drive is installed. Drives that overheat in Mechanical spaces (ambient temperatures at 120 deg. F or below) for the installed load, shall be removed and replaced with suitable new unit, at no cost to Owner.
- X. The VFD shall store in memory the last four (4) faults (minimum) and record all operational data.
- Y. Seven (7) programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
- Z. Two (2) programmable relay outputs, one form C 240 V AC, one Form A 50 V AC, shall be provided for remote indication of drive status.

- AA. Two programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include 0-10V dc, 0-20 mA and 4-30mA.
- BB. Two programmable analog outputs shall be provided for indication of drive status. These outputs shall be programmable for output speed, voltage, frequency, amps and input kW.

2.5 ADJUSTMENTS

- A. VFD shall have an adjustable carrier frequency.
- B. Seven (7) preset speeds shall be provided.
- C. Two (2) acceleration and two (2) deceleration ramps shall be provided. Acceleration and deceleration time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves may be automatically contoured to prevent tripping.
- D. Four current limit settings shall be provided.
- E. If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: under voltage, over voltage, current limit, inverter overload and motor overload.
- F. The number of restart attempts shall be selectable from 0 through 20 and the time between attempts shall be adjustable from 0 through 600 seconds.
- G. An automatic "on delay" may be selected from 0 to 120 seconds.

2.6 BYPASS

- A. Provide a manual bypass consisting of a door interlocked main fused disconnect padlockable in the "Off" position, a built-in motor starter and a four position DRIVE/OFF/LINE/TEST switch controlling three contactors. In the drive position, the motor is operated at an adjustable speed from the drive. In the "Off" position, the motor and drive are disconnected. In the LINE position, the motor is operated at full speed from the A/C power line and power is disconnected from the drive so that service can be performed. In the TEST position, the motor is operated at full speed from the AC line power. This allows the drive to be given an operational test while continuing to run the motor at full speed in bypass. Supplemental, normally closed, dry contact shall be furnished with the drive and interlocked with the drives safety trip circuitry to stop the motor whether in DRIVE or BYPASS mode in case of an external safety fault.

2.7 SERVICE CONDITIONS

- A. Unit shall be suited to operate in environmental temperatures up to 122 deg. F (50 deg. C), and up to 90% relative humidity (non-condensing) expected for environment in which installed. Provide high-capacity cooling fans and enclosures rated for ambient conditions.
- B. Input AC line voltage variation, -10 to +10% of nominal with full output. Input frequency - +/- 5% 50/60 Hz. 3-phase, 3-wire, phase sequence insensitive.
- C. Service Factor: 1.0

- D. No side clearance shall be required for cooling of any NEMA 1 units, or of any NEMA 12 units of less than 75 HP at 460 volts. All power and control wiring shall be done from the bottom of the drive, unless otherwise noted or coordinated differently from that stated by Contractor.

2.8 QUALITY ASSURANCE

- A. To ensure quality and minimize failures at the job site, the complete VFD shall be tested by the manufacturer. The VFD shall operate a dynamometer at full load and the load and speed shall be cycled during the test.
- B. All features shall be functionally tested at the factory for proper operation.

2.9 SUBMITTALS

- A. Submit manufacturer's performance data including dimensional drawings, power circuit diagrams, installation and maintenance manuals, warranty description, VFD's FLA rating, certification agency file numbers and catalog information.
- B. The specification lists the minimum VFD performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.
- C. Submit a Harmonic Distortion Analysis for the jobsite location.
- D. The drives shall conform to the "Made in USA" requirement.
- E. Indicate all field wiring and factory wiring clearly in submittal. All field wiring other than work shown to be part of Division 26 work on electrical drawings shall be by Division 23 Contractor furnishing drives.

PART 3 - EXECUTION

3.1 START-UP SERVICE

- A. Installation of drives shall be in compliance and in accordance with manufacturer's instructions, drawings, and recommendations.
- B. The manufacturer shall provide start-up, testing, and commissioning of the variable frequency drive(s); to certify and inspect the installation of the drive; and to verify all circuits by a factory certified service/technical representative who is experienced in start-up and repair services. The technical representative shall be the same personnel that will provide the factory service and warranty repairs at the customer's site. Sales personnel and other agents who are not factory certified technicians for VFD field repair shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system.

3.2 WARRANTY

- A. The VFD shall be warranted by the Contractor for a period of three (3) years (36 months) from date of substantial completion of the project and not from date of shipment or installation. The contractor shall include in his bid, all manufacturer's "extended warranty" costs associated with this requirement. The Warranty shall include all parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the VFD manufacturer.

1. Refer to Specification Section 230020 - "Basic Mechanical Requirements" for additional requirements of warranties and guarantees.

B. Documentation:

1. The AC Drive manufacturer shall provide a comprehensive 8 ½" x 11" bound instruction/installation manual that includes wiring diagrams, layout diagrams, and outline dimensions. The manual shall be in a 3-hole binder and punched for insertion into a shop manual supplied by the installing Contractor.

3.3 EXAMINATION

- A. Contractor and factory start-up technician shall verify that job site conditions for installation meet factory recommended and code-required conditions for VFD installation prior to shop drawing submittal. These conditions shall be re-verified prior to start-up, including clearance spacing, temperature, contamination, dust, and moisture of the environment. Separate conduit installation of the motor wiring, power wiring and control wiring, and installation per the manufacturer's recommendations shall be verified. Factory certified service technician, by virtue of completing the "start-up" of the drive, is certifying that actual environmental/code required conditions have been found to be satisfactory or have been corrected to manufacturer's satisfaction (if originally found unsatisfactory). A start-up sheet signed by the factory certified service technician shall be bound into the final Operation and Maintenance Manuals turned over to the Owner' Representative.
- B. The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.

3.4 TRAINING & DEMONSTRATION

- A. Demonstration Services: Arrange and pay for a factory-authorized service representative to train Owner's maintenance personnel on the following:
1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.
 2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 01, Section "Closeout Submittals" and Division 23, Section 230020 - "Basic Mechanical Requirements."
 3. Provide Service Manuals for each variable frequency drive specified.
- B. Provide four (4) hours of factory authorized training.
1. Schedule training with Owner's Representative with at least seven (7) days notice.
 2. Refer to Section 230010 – "Mechanical General Provisions" for videotaping requirements.

END OF SECTION 23 05 15



SECTION 23 05 29 – HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. This Section includes hangers and supports for mechanical systems piping and equipment.

1.3 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product data for each type of hanger and support.
- C. Submit pipe hanger and support schedule showing manufacturer's Figure No., size, location, and features for each required pipe hanger and support.
- D. Welder certificates signed by Contractor certifying that welders comply with requirements specified under the "Quality Assurance" Article.
- E. Shop drawings for each type of hanger and support, indicating dimensions, weights, required clearances, and methods of component assembly.

1.4 QUALITY ASSURANCE

- A. Qualify welding processes and welding operators according to AWS D1.1 "Structural Welding Code--Steel."
 - 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- B. Qualify welding processes and welding operators according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
- C. Listing and Labeling: Provide hangers and supports that are listed for their intended use.
 - 1. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Hangers, Supports, and Components: Factory-fabricated according to MSS SP-58.

1. Components include galvanized coatings where installed for piping and equipment that will not have a field-applied finish.
 2. Pipe attachments include nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Thermal-Hanger Shield Inserts: 100-psi average compressive strength, waterproofed calcium silicate, encased with sheet metal shield. Insert and shield cover entire circumference of pipe and are of length indicated by manufacturer for pipe size and thickness of insulation.
- C. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners for fire protection systems include UL listing and FM approval.
- D. Provide chrome plated brass escutcheons: Steel, 30 gauge, CTS type, shallow box style with chrome plated finish.

2.2 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36, steel plates, shapes, and bars, black and galvanized.
- B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex-head, track bolts and nuts.
- C. Washers: ASTM F 844, steel, plain, flat washers.
- D. Grout: ASTM C 1107, Grade B, non-shrink, nonmetallic.
1. Characteristics include post-hardening, volume-adjusting, dry, hydraulic-cement-type grout that is non-staining, noncorrosive, nongaseous and is recommended for both interior and exterior applications.
 2. Design Mix: 5000-psi, 28-day compressive strength.
 3. Water: Potable.
 4. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger requirements are specified in the Section specifying the equipment and systems.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping specification Sections.

3.2 HANGER AND SUPPORT INSTALLATION

- A. General: Comply with MSS SP-69 and SP-89. Install hangers, supports, clamps, and attachments to properly support piping from building structure.
- B. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible.
- C. Install supports with maximum spacings complying with MSS SP-69.

- D. Where pipes of various sizes are supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
- E. Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Install reinforcing bars through openings at top of inserts.
- F. Install concrete inserts in new construction prior to placing concrete.
- G. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install according to fastener manufacturer's written instructions. Do not use in lightweight concrete slabs or in concrete slabs less than 4 inches thick.
- H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- I. Heavy-Duty Steel Trapezes: Field-fabricate from ASTM A 36 steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- J. Support fire protection systems piping independent of other piping.
- K. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- L. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.
- N. Insulated Piping: Comply with the following installation requirements.
 - 1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.
 - 2. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
 - 3. Shields: Install MSS Type 40, protective shields on cold piping with vapor barrier. Shields span an arc of 180 degrees and have dimensions in inches not less than the following:

<u>THICKNESS</u> <u>NPS (Inches)</u>	<u>LENGTH</u> <u>(Inches)</u>	
1/4 to 3-1/2	12	0.048
4	12	0.060
5 and 6	18	0.060
8 to 14	24	0.075
16 to 24	24	0.105
 - 4. Pipes 8 Inches and Larger: Include pressure treated wood inserts.

5. Insert Material: Length at least as long as the protective shield.
6. Thermal-Hanger Shields: Install with insulation of same thickness as piping.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make a smooth bearing surface.
- C. Provide housekeeping pads where indicated on plans.

3.4 DUCT SUPPORTS AND HANGERS

- A. Refer to specification section 23 31 13 for duct support requirements.

3.5 METAL FABRICATION

- A. Cut, drill, and fit miscellaneous metal fabrications for pipe and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for manual shielded metal-arc welding, appearance and quality of welds, methods used in correcting welding work, and the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. Finish welds at exposed connections so that no roughness shows after finishing, and so that contours of welded surfaces match adjacent contours.

3.6 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.7 ESCUTCHEONS, SLEEVES AND RISER CLAMPS

- A. Contractor shall furnish and install all escutcheons, inserts, thimbles, hangers, etc. required for the proper support and installation of his equipment and piping and he shall cooperate with other trades in locating and placing these items.
- B. Contractor shall furnish and install all piping sleeves required. Sleeves passing through structural members or concrete footings shall be of cast iron or Schedule 40 steel pipe. Sleeves passing through nonstructural walls or floors shall be of 26-gauge galvanized iron. Joints between sleeves and pipes passing through floors shall be made weather tight with plastic materials. Where pipes pass through water proofing membrane, flashing sleeves shall be installed. Sleeves of structural members shall be as detailed on structural plans.
- C. Provide malleable iron split ring hangers with rod supports as specified. Strap hangers or wire will not be accepted. Spacing of hangers shall be as required above by MSS Standards. Maximum spacing shall no case exceed the following: For cast iron pipes 5ft.; for other than soil pipes 10 ft.

- D. Provide galvanized iron shields between hangers and pipe covering.
- E. Provide heavy steel riser clamps on vertical risers at floors to support pipes.
- F. Provide chrome plated brass escutcheons wherever pipes pass through floors, walls or ceilings in exposed or finished areas.
- G. All piping projecting from chases shall be rigidly supported in the wall or chase. Loosely supported piping, fixtures or accessories will not be accepted.

3.8 PAINTING

- A. Touching Up: Clean field welds and abraded areas of shop paint and paint exposed areas immediately after erection of hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal is specified in Division 09 Section "Paints and Coatings."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 23 05 29



SECTION 23 05 53 – MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Duct labels.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: White.
 - 3. Background Color: Black.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Black.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws .
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
 2. Lettering Size: At least 1-1/2 inches high.

2.3 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Aluminum.
2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

END OF SECTION 23 05 53



SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. This Section specifies the requirements and procedures total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications and recording and reporting the results.
- B. Test, adjust, and balance the following mechanical systems:
 - 1. Supply air systems, all pressure range
 - 2. Exhaust Air
 - 3. Packaged Heaters
 - 4. Fans
 - 5. Verify temperature control system operation.
- C. Provide assistance to Division 23 and Division 26 Contractor and project Architect in system commissioning process. Identify all system variances of greater than 10% and make required measurements, adjustments, etc. to bring systems into compliance to satisfaction of project Architect.
- D. Testing, adjusting and balancing shall be done by a 3rd party TAB contractor that is a member of either AABC or NEBB.
- E. THE TEST AND BALANCE CONTRACTOR SHALL BE RESPONSIBLE FOR CHECKING OUT AND REPORTING EACH SEQUENCE OF HEATING, COOLING AND CONTROL INTERLOCK OPERATION FOR THE EQUIPMENT REFERENCED ABOVE.

1.3 DEFINITIONS

- A. Systems testing, adjusting, and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes:
 - 1. The balance of air distribution.
 - 2. Adjustment of total system to provide design quantities.
 - 3. Electrical measurement.
 - 4. Verification of performance of all equipment and automatic controls.
- B. Test: To determine quantitative performance of equipment.
- C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).
- D. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.

- E. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.
- F. Report forms: Test data sheets arranged for collecting test data in logical order for submission and review. These data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.
- G. Terminal: The point where the controlled fluid enters or leaves the distribution system. These are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.
- H. Main: Duct or pipe containing the system's major or entire fluid flow.
- I. Submain: Duct or pipe containing part of the systems' capacity and serving two or more branch mains.
- J. Branch main: Duct or pipe serving two or more terminals.
- K. Branch: Duct or pipe serving a single terminal.

1.4 SUBMITTALS

- A. Agency Data:
 - 1. Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below.
- B. Engineer and Technicians Data:
 - 1. Submit proof that the Test and Balance Engineer assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.
- C. Procedures and Agenda: Submit a synopsis of the testing, adjusting, and balancing procedures and agenda proposed to be used for this project.
- D. Maintenance Data: Submit maintenance and operating data that include how to test, adjust, and balance the building systems. Include this information in maintenance data specified in Division 01 and Section 230020.
- E. Sample Forms: Submit sample forms, if other than those standard forms prepared by the AABC or NEBB are proposed.
- F. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below:
 - 1. Draft reports: Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on the approved forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports

in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.

2. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports.
 3. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs:
 4. General Information and Summary
 - a. Air Systems
 - b. Temperature Control Systems
 - c. Special Systems
 5. Report Contents: Provide the following minimum information, forms and data:
 - a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, Contractor, Owner, Architect, Engineer, and Project. Include addresses and contact names and telephone numbers. Also include a certification sheet containing the seal and name address, telephone number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentations used for the procedures along with the proof of calibration.
 - b. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC and NEBB, for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.
 6. Provide electronic (PDF) copies of all documentation included in the Final Report.
- G. Calibration Reports: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.
- H. At the front of the Report, the TAB Contractor shall provide a summary sheet identifying system operational variances problems, etc. recommended corrective measures that in the opinion of the TAB Contractor should be enacted by the Mechanical Contractor prior to retesting. Submit to project Architect as work progresses with resolution documented for inclusion in final report.

1.5 QUALITY ASSURANCE

- A. Test and Balance Engineer's Qualifications: A Professional Engineer (independent consultant), registered in the State in which the services are to be performed, and having testing, adjusting, and balancing experience on projects with testing and balancing requirements similar to those required for this project.
- B. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a conference with the Architect and representatives of installers of the mechanical systems. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

1.6 PROJECT CONDITIONS

- A. Systems Operation: Systems shall be fully operational prior to beginning procedures.

1.7 SEQUENCING AND SCHEDULING

- A. Test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 5 deg F wet bulb temperature of maximum summer design condition, and within 10 deg F dry bulb temperature of minimum winter design condition. Take final temperature readings during seasonal operation.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

- A. Before operating the system, perform these steps:
 1. Obtain design drawings and specifications and become thoroughly acquainted with the design intent.
 2. Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return, and exhaust) and temperature control diagrams.
 3. Compare design to installed equipment and field installations.
 4. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.
 5. Check filters for cleanliness.
 6. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.
 7. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.
 8. Determine best locations in main and branch ductwork for most accurate duct traverses.
 9. Place outlet dampers in the full open position.
 10. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.
 11. Lubricate all motors and bearings.
 12. Check fan belt tension.
 13. Check fan rotation.

3.2 MEASUREMENTS

- A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.
- B. Provide instruments meeting the specifications of the referenced standards.
- C. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.
- D. Apply instrument as recommended by the manufacturer.
- E. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.

- F. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.
- G. Take all reading with the eye at the level of the indicated value to prevent parallax.
- H. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.
- I. Take measurements in the system where best suited to the task.

3.3 PERFORMING TESTING, ADJUSTING, AND BALANCING

- A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.
- B. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
- C. Patch insulation, ductwork, and housings, using materials identical to those removed.
- D. Seal ducts and piping, and test for and repair leaks.
- E. Seal insulation to re-establish integrity of the vapor barrier.
- F. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
- G. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.4 RECORD AND REPORT DATA

- A. Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by the referenced standards, and as approved on the sample report forms.
- B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.
- C. Prepare a summary sheet of noted variances in excess of $\pm 10\%$ of design value. Include all such variances, recommended resolutions and ultimate result in Appendix "A" to TAB Final Report.

3.5 DEMONSTRATION

- A. Training:
 - 1. Train the Owner's maintenance personnel on troubleshooting procedures and testing, adjusting, and balancing procedures. Review with the Owner's personnel, the information contained in the Operating and Maintenance Data specified in Division 01 and 230020.
 - 2. Schedule training with Owner through the Architect with at least 7 days prior notice.

END OF SECTION 23 05 93



SECTION 23 07 13 – MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. Extent of mechanical insulation required by this section is indicated on drawings and schedules, and by requirements of this section.
- B. This Section includes:
 - 1. Exterior Ductwork.
- C. Maintain the integrity of vapor jackets on all duct insulation, equipment insulation and protect during construction to prevent puncture or other damage.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections:
 - 1. Product data for each type of mechanical insulation identifying k-value, thickness, and accessories.
 - 2. Manufacturer's installation recommendations.
 - 3. Material certificates, signed by the manufacturer, certifying that materials as a minimum, comply with specified requirements where laboratory test reports cannot be obtained.
 - 4. Material test reports prepared by a qualified independent testing laboratory. Certify insulation meets specified requirements.

1.4 QUALITY ASSURANCE

- A. Fire Performance Characteristics: Conform to the following characteristics for insulation including facings, cements, and adhesives, when tested according to ASTM E 84, by UL or other testing or inspecting organization acceptable to the authority having jurisdiction. Label insulation with appropriate markings of testing laboratory.
 - 1. Interior Insulation: Flame spread rating of 25 or less and a smoke developed rating of 50 or less.
 - 2. Exterior Insulation: Flame spread rating of 75 or less and a smoke developed rating of 150 or less.

1.5 SEQUENCING AND SCHEDULING

- A. Schedule piping and duct insulation application only after the testing of piping and duct systems is complete and accepted.

- B. Schedule insulation application after installation and testing of heat trace tape is complete and accepted.
- C. Schedule insulation of walls and ceiling to correspond with installation of hangers, supports and equipment.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All insulation shall be installed in strict accordance with the manufacturer's recommendations.
- B. Insulation shall be continuous through walls and ceilings.

2.2 THERMAL INSULATION

- A. After all work has been tested and approved, insulate as follows:
 - 1. INSULATION SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS AND INSTRUCTIONS.

2.3 HVAC EXTERIOR DUCTWORK INSULATION:

- A. 2" rigid insulation wrapped completely around ductwork. Insulation shall have a minimum R-8 insulation value.
- B. Apply two (2) layers each of mastic and glass fab (applied in alternate layers).
- C. Refer to mechanical Details for additional requirements.
- D. Paint gripped with final paint color by Architect.

END OF SECTION 23 07 13



SECTION 23 09 00 – BUILDING AUTOMATION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. The Temperature controls shall be installed by Select Building Controls one (1) of the following. Contact the following for pricing to be included in the total cost of project.
 - 1. Barton Dupre (337-447-0481) (barton_dupre@w-industries.com)
 - 2. Jody Bourque (337-581-4329) (jody.bourque@powers-hvac.com)
- B. This Section includes control equipment and installation for HVAC systems and components, including control components for heating and ventilation systems not supplied with factory-furnished controls.
- C. The control system shall be an extension of the existing JACE BACnet Building Automation System, and all controllers and software shall match existing or be the latest version of existing. The existing system is a Siemens JACE with the Niagara framework.
- D. See "Sequences of Operation" for requirements that relate to this Section.
- E. The Temperature controls components, equipment, etc. installed as part of this project shall be integrated to be tied back into the existing frontend located on the campus.

1.2 Drawings and Specification Sections of the Contract, including General and Supplementary Conditions, apply to this Section.

- A. Division 01 – General and Special Requirements
- B. Division 01 – Submittal Requirements
- C. Division 01 – Materials and Equipment
- D. Division 23 – Common Work Results for HVAC
- E. Division 23 – Testing, Adjusting, and Balancing for HVAC
- F. Division 26 – General Electrical Provisions for Electrical Work
- G. Division 26 – Common Work Results for Electrical
- H. Division 26 – Low Voltage Electrical Power Conductors and Cables
- I. Division 26 – Hangers and Supports for Electrical Systems
- J. Division 26 – Raceway and Boxes for Electrical Systems
- K. Division 26 – Identification for Electrical Systems
- L. Division 26 – Wiring Devices

1.3 ABBREVIATIONS

- A. AAC: Advanced Application Controller

- B. ALN: Automation Level Network
- C. ASC: Application Specific Controller
- D. ASHRAE: American Society of Heating Refrigerating and Air-Conditioning Engineers
- E. BAS: Building Automation System
- F. BC: Building Controller
- G. BIBB: BACnet Interoperability Building Blocks
- H. BIM: Building Information Modeling
- I. CFM: Cubic Feet per Minute.
- J. DCV: Demand Controlled Ventilation
- K. DDC: Direct digital controls
- L. EIA: Electronics Industries Alliance
- M. EMI: Electro-Magnetic Interference
- N. EP: Electric-to-Pneumatic
- O. FLN: Floor Level Network
- P. HMI: Human Machine Interface
- Q. HVAC: Heating, Ventilating and Air Conditioning.
- R. IEEE: Institute of Electrical and Electronic Engineers
- S. I/O: Input/Output
- T. IP: Internet Protocol
- U. IT: Information Technology
- V. LAN: Local area network.
- W. LCD: Liquid Crystal Display
- X. LED: Light Emitting Diode
- Y. MER: Mechanical Equipment Room.
- Z. MLN: Management Level Network
- AA. MS/TP: Master-slave/token-passing.
- BB. NEMA: National Electric Manufacturers' Association
- CC. NFPA: National Fire Protection Association

- DD. OEM: Operator Equipment Manufacturer
- EE. PC: Personal Computer
- FF. PICS: Protocol Implementation Conformance Statement
- GG. PID: Proportional Integral Derivative.
- HH. POT: Portable Operators Terminal.
- II. RAM: Random Access Memory
- JJ. RFI: Radio Frequency Interference
- KK. RTD: Resistance Temperature Device
- LL. TAB: Testing and Balancing
- MM. TCP: Transfer Control Protocol
- NN. UDP: User Datagram Protocol
- OO. UL: Underwriters Laboratories
- PP. UPS: Uninterruptable Power Supply
- QQ. VFD: Variable Frequency Drive.
- RR. WAN: Wide Area Network.

1.4 DEFINITIONS

- A. BACnet: An industry standard data communication protocol for Building Automation and Control Networks. Refer to the latest version of AHSRAE standard 135.
- B. Scope Terminology
 - 1. Provide = Furnish equipment, engineer, program and install
 - 2. Furnish = Furnish equipment, engineer, and program
 - 3. Mount = securely fasten or pipe
 - 4. Install = mount and wire
 - 5. Wire = wire only

1.5 WORK INCLUDED

- A. The BAS Contractor shall provide a complete and operational system that will perform the sequences of operation as described herein.
- B. Furnish a complete distributed direct digital control system in accordance with this specification section. This includes all system controllers, logic controllers, and all input/output devices. Items of work included are as follows:
 - 1. Provide a submittal that meets the requirements below for approval.
 - 2. Coordinate installation schedule with the mechanical contractor and general contractor.
 - 3. Provide installation of all panels and devices unless otherwise stated.

4. Provide power for panels and control devices unless otherwise stated.
 5. Provide all low voltage control wiring for the DDC system.
 6. Provide miscellaneous control wiring for HVAC and related systems regardless of voltage.
 7. Provide engineering and technician labor to program and commission software for each system and operator interface. Submit commissioning reports for approval.
 8. Provide testing, demonstration and training as specified below.
- C. The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, flow diagrams, bill of materials, component designation, or identification number and sequence of operation all bearing the name of the manufacturer.

1.6 SUBMITTALS

- A. Provide submittals for fast-track items that need to be approved and released to meet the schedule of the project. Provide submittals for the following items separately upon request:
1. Damper schedule and product data
 2. Mounting and wiring diagrams for factory-installed control components
 3. Thermostat locations
- B. Provide a complete submittal with all controls system information for approval before construction starts. Include the following:
1. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 2. Wiring Diagrams: Power, signal, and control wiring. Detail the wiring of the control devices and the panels. Show point-to-point wiring from field devices to the control panel. Show point-to-point wiring of hardwired interlocks. Show a ladder diagram or schematic of wiring internal to the panels, including numbered terminals. Clearly designate wiring that is done at a factory, at a panel shop or in the field.
 3. Details of control panel faces, including sizes, controls, instruments, and labeling.
 4. Written description of the Sequence of Operations.
 5. Network riser diagram showing wiring types, network protocols, locations of floor penetrations and number of control panels. Label control panels with network addresses and BACnet device instance numbers. Show all routers, switches, hubs and repeaters.
 6. Point list for each system controller including both inputs and outputs (I/O), point numbers, controlled device associated with each I/O point, and location of I/O device.
 7. Starter and variable frequency drive wiring details of all automatically controlled motors.
 8. Reduced size floor plan drawings showing locations of control panels, thermostats and any devices mounted in occupied space.
 9. Product Data: Include manufacturer's technical literature for each control device indicated, labeled with setting or adjustable range of control. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated. Submit a write-up of the application software that will be used on the operator workstation including revision level, functionality and software applications required to meet the specifications.
 10. Submit BACnet Protocol Implementation Conformance Statements (PICS) for all direct digital controllers, software and other system components that will communicate on the BAS utilizing BACnet.

- C. Submit a description of the application software that will be used on the operator workstation including revision level, functionality and software applications required to meet the specifications.
- D. After the BAS system is approved for construction, submit sample operator workstation graphics for typical systems for approval. Print and submit the graphics that the operator will use to view the systems, change setpoints, modify parameters and issue manual commands. Programming shall not commence until typical graphics are approved.

1.7 PROJECT RECORD DOCUMENTS

- A. Project Record Documents: Submit three (3) copies of record (as-built) documents upon completion of installation. Submittal shall consist of:
 - 1. Project Record Drawings. As-built versions of the submittal shop drawings provided as AutoCAD compatible files in electronic format and as 11x17 inch prints.
 - 2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements in the Control System Demonstration and Acceptance section of this specification.
 - 3. Operation and Maintenance (O & M) Manual.
 - a. As-built versions of the submittal product data.
 - b. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
 - c. Operator's Manual with procedures for operating control systems, logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
 - d. Programming manual or set of manuals with description of programming language and of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 - e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
 - f. Documentation of all programs created using custom programming language, including setpoints, tuning parameters, and object database.
 - g. Graphic files, programs, and database on electronic media.
 - h. List of recommended spare parts with part numbers and suppliers.
 - i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware, including computer equipment and sensors.
 - j. Complete original original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
 - k. Licenses, guarantees, and warranty documents for equipment and systems.
- B. Operating manual to serve as training and reference manual for all aspects of day-to-day operation of the system. As a minimum include the following:
 - 1. Sequence of operation for automatic and manual operating modes for all building systems. The sequences shall cross-reference the system point names.
 - 2. Description of manual override operation of all control points in system.
 - 3. BAS system manufacturers complete operating manuals.

- C. Provide maintenance manual to serve as training and reference manual for all aspects of day-to-day maintenance and major system repairs. As a minimum include the following:
1. Complete as-built installation drawings for each building system.
 2. Overall system electrical power supply schematic indicating source of electrical power for each system component. Indicate all battery backup provisions.
 3. Photographs and/or drawings showing installation details and locations of equipment.
 4. Routine preventive maintenance procedures, corrective diagnostics troubleshooting procedures, and calibration procedures.
 5. Parts list with manufacturer's catalog numbers and ordering information.
 6. Lists of ordinary and special tools, operating materials supplies and test equipment recommended for operation and servicing.
 7. Manufacturer's operation, set-up, maintenance and catalog literature for each piece of equipment.
 8. Maintenance and repair instructions.
 9. Recommended spare parts.
- D. Provide Programming Manual to serve as training and reference manual for all aspects of system programming. As a minimum include the following:
1. Complete programming manuals, and reference guides.
 2. Details of any custom software packages and compilers supplied with system.
 3. Information and access required for independent programming of system.

1.8 QUALITY ASSURANCE

A. Codes

1. Perform all wiring in accordance with Division 26, NEC, local codes and Owner's requirements.
2. 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.
3. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."
4. Comply with ASHRAE 135-2010 BACnet: A Data Communication Protocol for Building Automation and Control Networks.
5. Comply with ASHRAE 90.1- Energy Standard for Buildings Except Low-Rise Residential Buildings.
6. All equipment shall be UL listed and approved and shall meet with all applicable NFPA standards, including UL 916 - PAZX Energy Management Systems,
 - a. Provide written approvals and certifications after installation has been completed.
7. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
8. The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

B. Qualifications

1. Installing contractor shall be in the business of installing and servicing DDC controls for mechanical systems, temperature and ventilation control, environmental control, lighting control, access and , and energy management.
 2. Installer Qualifications: An experienced installer who is the authorized representative of the automatic control system manufacturer for both installation and maintenance of controls required for this Project.
 3. Engineering, drafting, programming, and graphics generation shall be performed by the local branch engineers and technicians directly employed by the Building Automation System Contractor.
 4. Supervision, checkout and commissioning of the system shall be by the local branch engineers and technicians directly employed by the Building Automation System Contractor. They shall perform commissioning and complete testing of the BAS system.
- C. The BAS contractor shall maintain a service organization consisting of factory trained service personnel and provide a list of ten (10) projects, similar in size and scope to this project, completed within the last five years.
- D. Final determination of compliance with these specifications shall rest solely with the Engineers and Owner who will require proof of prior satisfactory performance.
- E. For any BAS system and equipment submitted for approval, the BAS contractor shall state what, if any, specific points of system operation differ from these specifications.
- F. All portions of the system must be designed, furnished, installed, commissioned, and serviced by manufacturer approved, factory trained employees.
- G. The system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability for any existing control system component including but not limited to building controllers, advanced application controllers, application specific, personal operator workstations and portable operator's terminals, to be connected and directly communicate with any new BAS system equipment without bridges, routers, or protocol converters.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.
- B. Deliver, store, protect, and handle products to site under provisions of the contract Documents. Coordinate all site deliveries with Construction project Manager.
- C. Protect products from construction operations, dust, and debris, by storing materials inside, protected from weather in a conditioned space.

1.10 COORDINATION

- A. Coordinate IP drops, network connections, user interfaces, firewall, etc with Owner's IT representative.
- B. Coordinate location of thermostats, humidistats, panels, and other exposed control components with plans and room details before installation.
- C. Coordinate equipment with Division 28 "Fire Alarm" to achieve compatibility with equipment that interfaces with that system.

- D. Coordinate power for control units and operator workstation with electrical contractor.
- E. Coordinate equipment with provider of starters and drives to achieve compatibility with motor starter control coils and VFD control wiring.
- F. Coordinate scheduling with the mechanical contractor and general contractor. Submit a schedule for approval based upon the installation schedule of the mechanical equipment.
- G. Coordinate installation of taps, valves, airflow stations, etc. with the mechanical contractor.
- H. Products Furnished but Not Installed Under This Section
 - 1. Sheetmetal accessories
 - a. Dampers
 - b. Unit Controls
- I. Products Installed but Not Furnished Under This Section
 - 1. Packaged Heating Equipment:
 - a. Thermostats
 - b. Duct Static Pressure Sensors
- J. Products Integrated to but Not Furnished or Installed Under This Section
 - a. VFD's
 - b. Packaged Heaters
 - c. Exhaust Fans

1.11 WARRANTY

- A. Provide warranty per Division 20 Section "General Mechanical Requirements" and as supplemented in this section.
- B. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of 12 months from completion of system demonstration.
- C. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours.
- D. During normal building occupied hours, failure of items that are critical for system operation shall be provided within 4 hours of notification from the Owner's Representative.
- E. This warranty shall apply equally to both hardware and software.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. The Building Automation System (BAS) contractor shall furnish and install a networked system of HVAC controls. The contractor shall incorporate direct digital control (DDC) for heating equipment, building ventilation equipment, flood detection devices.
- B. The control system for this project shall be an extension of the Owner's existing Siemens Building Automation System and all controllers and software shall match existing or be latest version of existing.

- C. The BAS shall be based on the Niagara Framework (or “Niagara”), a Java-based framework developed by Tridium. Niagara provides an automation infrastructure that integrates diverse systems and devices (regardless of manufacturer, communication standard or software) into a unified platform that can be managed in real time over the Internet using a standard Web browser.
- D. The BAS shall be comprised of Network Area Controller or Controllers (NAC) within each facility. The NAC shall connect to the owner’s local or wide area network, depending on configuration. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard Web browsers, via the Internet and/or local area network. Each NAC shall communicate to BACnet Building Controllers and other open and legacy protocol systems/devices.
- E. Provide networking to new DDC equipment using industry accepted communication standards. System shall utilize BACnet communication according to ANSI/ASHRAE standard 135-2010 for interoperability with smart equipment, for the main IP communication trunk to the BAS Server and for peer-to-peer communication between DDC panels and devices. The system shall not be limited to only standard protocols, but shall also be able to integrate to a wide variety of third-party devices and applications via drivers and gateways.
- F. Provide standalone controls where called for on the drawings or sequences.
- G. The BAS shall be the Siemens TALON BACnet system by Powers of Louisiana

2.2 BUILDING AUTOMATION SYSTEM NETWORK

- A. All networked control products provided for this project shall be comprised of an industry standard open protocol internetwork. Communication involving control components (i.e. all types of controllers and operator interfaces) shall conform to ASHRAE 135-2010 BACnet standard. Networks and protocols proprietary to one company or distributed by one company are prohibited.
- B. Access to system data shall not be restricted by the hardware configuration of the building management system. The hardware configuration of the BAS network shall be totally transparent to the user when accessing data or developing control programs.
 - 1. Software applications, features, and functionality, including administrative configurations, shall not be separated into several network control engines working together.
- C. Provide at a minimum 1 operator interface to be designated as the BAS Server with server application software. Additional operator interfaces shall use operator workstation licenses or connect via a thick or thin-client application.
- D. BAS Server shall be capable of simultaneous direct connection and communication with BACnet/IP, OPC and TCP/IP corporate level networks without the use of interposing devices.
- E. Any break in Ethernet communication from the server to the controllers on the Primary Network shall result in a notification at the server.
- F. Any break in Ethernet communication between the server and standard client workstations on the Primary Network shall result in a notification at each workstation.
- G. The network architecture shall consist of three levels of networks:

1. The Management Level Network (MLN) shall utilize BACnet/IP over Ethernet along with other standardized protocol, such as web services, html, JAVA, SOAP, XML, etc., to transmit data to non-BAS software applications and databases. The BAS Server and Operator Workstations shall reside on this level of the network architecture.
 2. The Automation Level Network (ALN) shall utilize BACnet/IP over Ethernet. It shall connect BACnet Building Controllers to the BAS Server and Operator Workstations. Controllers for central plant equipment and large infrastructure air handlers shall reside on the ALN backbone BACnet/IP network. The building's Ethernet LAN shall be utilized for the ALN backbone and all ALN devices shall be connected to the building's LAN. Coordinate IP drops with Owner.
 3. The Floor Level Network shall utilize BACnet/IP over Ethernet or BACnet MS/TP over RS-485 to connect all the DDC-controlled heating and ventilation equipment on a floor or in a system that are controlled with BACnet Advanced Application Controllers or BACnet Application Specific Controllers. FLN devices are networked to a router that connects to the Automaton Level Network backbone.
- H. Provide a router for each RS-485 subnetwork to connect them to the base building backbone level network. The router shall connect BACnet MS/TP subnetworks to BACnet over Ethernet. Routers shall be capable of handling all of the BACnet BIBBs that are listed for the controller that reside on the subnetwork.
- I. The Building Level Controllers shall be able to support subnetwork protocols that may be needed depending on the type of equipment or application. Subnetworks shall be limited to:
1. BACnet MS/TP
 2. BACnet IP
 3. Modbus
- J. BACnet MSTP Setup rules
1. Addressing for the MSTP devices shall start at 00 and continue sequentially for the number of devices on the subnetwork.
 2. No gaps shall be allowed in the addresses.
 3. Set the Max Master property to the highest address of the connected device.
 4. Max Master property shall be adjusted when devices are added to the subnetwork.
- K. Provide all communication media, connectors, repeaters, bridges, switches, and routers necessary for the internetwork.
- L. Controllers and software shall be BTL listed at the time of installation.
- M. The system shall meet 8peer-to-peer communication services such that the values in any one BACnet Building Controller or BACnet Advanced Application Controller can be read or changed from all other controllers without the need for intermediary devices. The software shall provide transparent transfer of all data, control programs, schedules, trends, and alarms from any one controller through the internetwork to any other controller, regardless of subnetwork routers.
- N. Systems that use variations of BACnet using Point-to-Point (PTP) between controllers, gateways, bridges or networks that are not peer-to-peer are not allowed.
- O. Remote Communications: 12Provide a TCP/IP compatible communication port for connection to the Owner's network for remote communications. Provide coordination with the Owner for addressing and router configuration on both ends of the remote network.

- P. The system shall be installed with a 10% spare capacity on each subnetwork for the addition of future controllers.
- Q. On each floor, wing or major mechanical room provide an Ethernet RJ45 connection that allows connection to the BACnet network. An open port shall always be available and shall not require any part of the network to be disconnected. The location shall be accessible to the base building personnel and not in a location where the tenant can restrict the access.
- R. Distributed Control Requirements:
 - 1. The loss of any one DDC controller shall not affect the operation of other HVAC systems, only for the points connected to the DDC controller.
 - 2. The system shall be scalable in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, and operator devices.
 - 3. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of any control strategy, reporting, alarming and trending function, or any function at any operator interface device.
 - 4. DDC Controllers shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC Controller on the network without dependence upon a central processing device. DDC Controllers shall also be able to send alarms to multiple operator workstations without dependence upon a central or intermediate processing device.
 - 5. Operators shall have the ability to make database changes at the central system server while operator workstations are on-line without disrupting other system operations.
 - 6. The DDC control panel shall be mounted in the same mechanical room as the equipment being controlled, or an adjacent utility room.
 - 7. Multiple systems can be programmed on the same controller as long as they are in the same room. Systems on separate floors shall have separate controllers.
 - 8. Remote sensors shall be wired to the control panel of the equipment it is controlling, not across the network.
 - 9. Signals to remote motor control centers shall be hard wired to the control panel, not across the network.

2.3 BACNET ADVANCED WORKSTATION SOFTWARE

- A. The Graphical User Interface (GUI) shall include navigation with logical grouping of the equipment into equipment summary screens such that all equipment can be displayed together for comparison.
- B. The GUI shall logically group graphics navigation by building so that in a building, only the equipment graphics associated with the building can be easily viewed.
- C. The Custom Equipment graphics for equipment shall allow the user to initiate the creation of trend storage and collection of a system point through a simple drag and drop.
- D. Each custom equipment graphic shall have the ability to display the detailed sequence of operations controlling the space from within each unique device and/or application.
- E. The GUI shall provide a completely interactive user interface and must offer the following features as a minimum:

1. Operating System:
 - a. The GUI shall run on Microsoft Windows Operating Systems and/or standard Internet browsers including Internet Explorer, Firefox, and Chrome.
2. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands, and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.
3. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:
 - a. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
 - b. Graphics shall support layering and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.
 - c. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
 - d. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - e. Holidays shall be set by using a graphical calendar without requiring any keyboard entry from the operator.
 - f. Commands to start and stop binary objects shall be done by selecting the appropriate object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
 - g. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.
4. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:
 - a. Create, delete or modify control strategies.
 - b. Add/delete objects to the system.
 - c. Tune control loops through the adjustment of control loop parameters.
 - d. Enable or disable control strategies.
 - e. Generate hard copy records or control strategies on a printer.
 - f. Select points to be alarmable and define the alarm state.
 - g. Select points to be trended over a period of time and initiate the recording of values automatically.
5. On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.
6. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

7. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
8. Alarm Console:
 - a. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
 - b. When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

F. Web Browser Clients

1. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Chrome.
2. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the System, shall not be acceptable.
3. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
4. The Web browser client shall support at a minimum, the following functions:
 - a. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - b. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
 - c. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
 - d. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
 - e. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.
 - f. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - i. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
 - 1) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - 2) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
 - ii. Commands to start and stop binary objects shall be done by right clicking the selected object and selecting the appropriate

command from the pop-up menu. No entry of text shall be required.

- iii. View logs and charts
- iv. View and acknowledge alarms.
- v. Setup and execute SQL queries on log and archive information.
- g. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
- h. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

G. System Programming

- 1. The Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through password access as assigned by the system administrator.
- 2. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built-in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.
- 3. Programming Methods:
 - a. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
 - b. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.
 - c. The system shall support object duplication within a customer's database. An application, once configured, can be copied, and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

H. BACnet:

- 1. The BAS server and Operator Workstations shall meet the BACnet device profile of an Advanced Workstation Server (B-AWS) and Operator Workstation (B-OWS) and shall support the following BACnet BIBBs:
 - a. Data Sharing
 - i. Data Sharing-Read Property-Initiate, Execute (DS-RP-A,B)
 - ii. Data Sharing-Read Property Multiple-Initiate, Execute (DS-RPM-A,B)
 - iii. Data Sharing-Write Property-Initiate, Execute (DS-WP-A,B)
 - iv. Data Sharing-Write Property Multiple-Initiate (DS-WPM-A)

- v. Data Sharing-COV-Initiate (DS-COV-A)
 - b. Scheduling
 - i. Scheduling-Initiate (SCHED-A)
 - c. Trending
 - i. Trending-Viewing and Modifying Trends-Initiate (T-VMT-A)
 - ii. Trending-Automated Trend Retrieval-Initiate (T-ATR-A)
 - d. Network Management
 - i. Network Management-Connection Establishment-Initiate (NM-CE-A)
 - e. Alarming
 - i. Alarm and Event-Notification-Initiate (AE-N-A)
 - ii. Alarm and Event-ACK-Initiate (AE-ACK-A)
 - iii. Alarm and Event –Alarm Summary-Initiate (AE-ASUM-A)
 - iv. Alarm and Event –Enrollment Summary-Initiate (AE-ESUM-A)
 - v. Alarm and Event –Information-Initiate (AE-INFO-A)
 - f. Device Management
 - i. Device Management-Dynamic Device Binding- Initiate, Execute (DM-DDB-A, B)
 - ii. Device Management-Dynamic Object Binding- Initiate, Execute (DM-DOB-A,B)
 - iii. Device Management-Device Communication Control- Initiate (DM-DCC-A)
 - iv. Device Management-Private Transfer- Initiate, Execute (DM-PT-A,B)
 - v. Device Management-Text Message-Execute (DM-TM-B)
 - vi. Device Management-Time Synchronization- Initiate (DM-TS-A)
 - vii. Device Management-UTC Time Synchronization- Initiate (DM-UTC-A)
 - viii. Device Management-Reinitialize Device- Initiate (DM-RD-A)
 - ix. Device Management-Backup and Restore- Initiate (DM-BR-A)
 - x. Device Management-List Manipulation- Initiate, Execute (DM-LM-A,B)
 - xi. Device Management-Object Creation and Deletion- Initiate (DM-OCD-A)
2. The BAS Server and Workstations shall support the following Data Link Layers:
 - a. BACnet IP Annex J
 - b. BACnet IP Annex J Foreign Device
 - c. ISO 8802-3, Ethernet (Clause 7)
 3. The BAS Server and Workstations shall be able to interact with all of the BACnet objects in the controllers. In addition, the software shall be able to support the following objects as they relate to features in the workstation software:
 - a. Calendar – Creatable, Deletable
 - b. Command – Creatable, Deletable
 - c. Event Enrollment – Creatable, Deletable
 - d. Notification Class – Creatable, Deletable
 - e. Schedule - Creatable, Deletable
 4. The BAS Server and Workstations shall support transmitting and receiving segmented messages.
 5. The BAS Server and Workstation shall have the capability to be the BACnet/IP Broadcast Management Device (BBMD) and support foreign devices.

2.4 WEB BASED CONTROLLER SOFTWARE FOR CONFIGURATION, PROGRAMMING AND OPERATORS

- A. The purpose of this specification is to allow the Owner/Operator to have the same controller programming capabilities as the Controls Contractor Technician without additional software, tools, or licenses.

1. The controller programming shall be accessible to any user via a Web Services application over an IP or Internet connection through port 80.
- B. The following types of controllers shall have this feature:
 1. All BACnet BC level controllers
 2. Network Engine Controllers
 3. Controllers on equipment or sequences customized for this job.
- C. Manufacturer:
 1. Siemens Launch Pad™ (compatible with TC controllers)
 2. Controllers from other manufacturers shall meet the capabilities of this specification.
- D. The controller shall come with the software built-in and delivered with the controller as part of the controller purchase. It shall not require a separate software license to enable the software capability.
 1. The software shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher-level computer or another controller for execution.
- E. The software application shall be accessible from a PC using Web Services but shall use all of its own services and data files so as to not be susceptible to Microsoft Windows operating systems-based viruses.
- F. Access to the controller software shall be username and password protected. User shall be authenticated by the controller.
- G. The embedded Web Services shall provide the following functionality to users, based on their access and privilege rights:
 1. Point Navigation – Provide a screen that allows users to see all of the points that are active in the system. The points shall include hardwired, software, schedules, trends, alarms and network setup.
 - a. The point navigation shall display the point name, descriptor, command priority, alarm status, and current value.
 - b. The user shall be able to run and print a pre-configured point log report through a web interface client that shows the point name, descriptor, command priority, alarm status, and current value.
 - c. The interface and report shall allow selection filter such that the operator can select or deselect the types of point that are visible.
 2. Alarm Display –displays current BAS alarms to which the user has access will be displayed. Users will be able to acknowledge active alarms, erase resolved alarms, and directly link to the Point Commanding feature.
 - a. The alarm display must provide a filter that displays all alarms whether acknowledged or not.
 - b. The alarm display must provide a filter that displays only alarms that have not yet been acknowledged.
 - c. The alarm display must provide a persistent indication whenever there is one or more unacknowledged alarm in any connected field panel.
 3. Point details – users will have access to point detail information including operational status, operational priority, physical address, and alarm limits, for point objects to which they have access rights.
 4. Point Commanding – users will be able to override, and command points they have access to via the Web browser interface.

5. Scheduling – allows operators, depending on their current user privileges, to override schedules selected by date, and to modify the properties of a selected schedule.
 - a. The scheduler display must be able to represent facility mode schedules in a graphical format.
 6. Trend Data Report – allows users to run and print a pre-configured trend data report for historical data reporting, including a representation of the alarm status of the each point for each Trend sample. The report shall allow selection of individual points or wildcard selection of points.
 - a. Trend data shall be exportable to a data file, such as .csv or other comparable.
 7. Network navigation - Provide a screen that allows users to navigate to the panels and units via the network architecture.
- H. The web server shall be able to send SMTP text messages to notify users of alarm status. The owners shall provide a mail server and a connection port. SSL shall not be required.
- I. The operator shall be able to add modify and delete controller database program, including points, schedules, alarms, and trends.
1. The operator shall be able to edit the custom program in the field panel that executes the sequences of operations, control loops and logic for the systems controlled.
 2. The operator shall be able to add unit controllers that reside on field panel subnetworks.
- J. Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the Owner as required to support the Web access feature.
- K. Coordinate with the Owner/Operator's IT representatives to setup and allow access to controllers via IP connections and Web Services through port 80.
1. It shall be the responsibility of the Owner/IT to setup and maintain security for user access to the private networks.
 2. Coordinate IP addressing scheme.

2.5 NETWORK AREA CONTROLLERS (NAC)

- A. The Network Area Controller (NAC) shall provide the interface between the LAN or WAN and the field control devices and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:
1. Calendar functions
 2. Scheduling
 3. Trending
 4. Alarm monitoring and routing
 5. Time synchronization
 6. Integration of controller data through drivers installed in the NAC.
 7. Network Management functions for all controllers
- B. The Network Area Controller must provide the following hardware features as a minimum:
1. One Ethernet Port – 10/100 Mbps
 2. One RS-232 port
 3. One RS-485 ports
 4. Battery Backup

5. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
 6. The NAC must be capable of operation over a temperature range of 32 to 122°F
 7. The NAC must be capable of withstanding storage temperatures of between 0 and 158°F
 8. The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing.
- C. The NAC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NAC shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.
- D. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 32 simultaneous users.
- E. Provide a “query” feature to allow review of specific alarms by user defined parameters.
- F. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
- G. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.
- H. Network Access
1. Remote Access:
 - a. For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The Owner shall provide a connection to the Internet to enable this access via high-speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer’s Intranet to a corporate server providing access to an Internet Service Provider (ISP). Customer agrees to pay monthly access charges for connection and ISP.
 2. Event Alarm Notification and actions
 - a. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
 - b. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
 - c. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
 - i. To alarm
 - ii. Return to normal.
 - iii. To fault
 - d. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
 - e. Provide timed (schedule) routing of alarms by class, object, group, or node.
 - f. Provide alarm generation from binary object “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
 3. Control equipment and network failures shall be treated as alarms and annunciated.

4. Alarms shall be annunciated in any of the following manners as defined by the user:
 - a. Screen message text
 - b. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
 - i. Day of week
 - ii. Time of day
 - iii. Recipient
 - c. Pagers via paging services that initiate a page on receipt of email message.
 - d. Graphic with flashing alarm object(s)
 - e. Printed message, routed directly to a dedicated alarm printer.
5. The following shall be recorded by the NAC for each alarm (at a minimum):
 - a. Time and date
 - b. Location (building, floor, zone, office number, etc.)
 - c. Equipment (air handler #, accessway, etc.)
 - d. Acknowledge time, date, and user who issued acknowledgement.
 - e. Number of occurrences since last acknowledgement.
6. Alarm actions may be initiated by user defined programmable objects created for that purpose.
7. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
8. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.
9. Provide a "query" feature to allow review of specific alarms by user defined parameters.
10. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
11. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

I. Data Collection and Storage

1. The NAC shall have the ability to collect data for any property of any object and store this data for future use.
2. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:
 - a. Designating the log as interval or deviation.
 - b. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
 - c. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 - d. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
 - e. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
3. All log data shall be stored in a relational database in the NAC and the data shall be accessed from a server (if the system is so configured) or a standard Web browser.
4. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
5. All log data shall be available to the user in the following data formats:
 - a. HTML
 - b. XML
 - c. Plain Text

- d. Comma or tab separated values
- 6. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.
- 7. The NAC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties, at a minimum:
 - a. Archive on time of day
 - b. Archive on user-defined number of data stores in the log (buffer size)
 - c. Archive when log has reached its user-defined capacity of data stores.
 - d. Provide ability to clear logs once archived.

J. Audit Log

- 1. Provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:
 - a. Time and date
 - b. User ID
 - c. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

K. DATABASE BACKUP AND STORAGE

- 1. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.
- 2. Copies of the current database and, at the most recently saved database shall be stored in the NAC. The age of the most recently saved database is dependent on the user-defined database save interval.
- 3. The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2.6 DIRECT DIGITAL CONTROLLER SOFTWARE

- A. Provide a full capability user license to the owner for the operator to be able to see, modify, create, upload, download and save control programs to the DDC controllers.
- B. The software program shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher-level computer or another controller for execution.
- C. The software application shall be accessible from a PC using the Windows environment, but shall use all of its own services and data files so as to not be susceptible to Microsoft Windows operating systems based viruses.
- D. The software shall be provided with an interactive HELP function to assist operators with syntax, abbreviations, commands and saving programs.
- E. Point naming and communication format:
 - 1. All points, panels, and programs shall be identified by a 30-character name. All points shall also be identified by a 16-character point descriptor. The same names shall be displayed at both Building Controller and the Operator Interface.
 - 2. All digital points shall have a consistent, user-defined, two-state status indication with 8 characters minimum (e.g., Summer, Enabled, Disabled, Abnormal).

3. The Building Controller Software shall be capable of BACnet communications. The BACnet Building Controller (B-BC) shall have demonstrated interoperability during at least one BTL Interoperability Workshop, have demonstrated compliance to BTL through BTL listing and shall substantially conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135-2004, Annex L.

F. System Security

1. User access shall be secured using individual security passwords and usernames.
2. Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
3. Building Controllers shall be able to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any Operator Interface or portable operator terminal) shall enable the operator to monitor, adjust and control only the points that the operator is authorized for. All other points shall not be displayed at the Operator Interface or portable terminal. Passwords and priorities for every point shall be fully programmable and adjustable.
4. User Log On/Log Off attempts shall be recorded.
5. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.
6. Use of workstation resident security as the only means of access control is not an acceptable alternative to resident system security in the DDC controller software.

G. User Defined Control Applications: The applications software shall program DDC routines to meet the sequences of operations.

1. Building Controllers shall have the ability to perform energy management routines including but not limited to time of day scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides, start stop time optimization, automatic daylight savings time switch over, night setback control, enthalpy switch over, peak demand limiting, temperature-compensated duty cycling, heating interlock, supply temperature reset, priority load shedding, and power failure restart.
2. The Building Controllers shall have the ability to perform the following pre-tested control algorithms:
 - a. Two positions with differential control and time delays
 - b. Floating control
 - c. Proportional control
 - d. Proportional plus integral control
 - e. Proportional, integral, plus derivative control
 - f. Automatic tuning of control loops
 - g. Start Stop Time Optimization
3. Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
4. Each controller shall support plain language text comment lines in the operating program to allow for quick troubleshooting, documentation, and historical summaries of program development.

H. Peer-to-peer access to other DDC controllers

1. It shall be possible to use any actual or virtual point data or status, any system calculated data, a result from any process, or any user-defined constant in any controller in the system.
2. Any process shall be able to issue commands to points in any and all other controllers in the system.

3. Processes shall be able to generate operator messages and advisories to other operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of an advanced annunciation feature, such as:
 - a. Generate a report.
 - b. Annunciate an alarm.
 - c. Issue a text message or email.

I. Alarm Management

1. Alarm management shall be provided within the controller software to monitor and direct alarm information to operator devices.
2. Each Building Controller shall perform distributed, independent alarm analysis, minimize network traffic and prevent alarms from being lost. At no time shall the Building Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.
3. Conditional alarming shall allow generation of alarms based upon user defined multiple criteria.
4. An Alarm "shelving" feature shall be provided to disable alarms during testing. (Pull the Plug, etc.).
5. Binary Alarms. Each binary alarm object shall be set to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
6. Analog Alarms. Each analog alarm object shall have both high and low alarm limits. Alarming must be able to be automatically and manually disabled.
7. All alarm shall include the point's user-defined language description and the time and date of occurrence.
8. Alarm reports and messages shall be routed to user-defined list of operator workstations, or other devices based on time and other conditions. An alarm shall be able to start programs, print reports, be logged in the event log, generate custom messages, and display graphics.
9. The user shall be able to add a 200-character alarm message to each alarm point to more fully describe the alarm condition or direct operator response. Each Building Controller shall be capable of storing a library of at least 50 alarm messages. Each message may be assigned to any number of points in the Controller.
10. Operator-selected alarms shall be capable of initiating a trigger to an advanced annunciation, such as text, email, etc.
11. An alarm history log shall report the start of the alarm condition, acknowledgement by a user and return of the alarm to normal condition.

J. Scheduling:

1. Provide a comprehensive menu driven program to automatically start and stop designated multiple objects or events in the system according to a stored time.
2. Schedules shall reside in the building controller and shall not rely on external processing or network.
3. It shall be possible to define a group of objects as a custom event (i.e., meeting, athletic activity, etc.). Events can then be scheduled to operate all necessary equipment automatically.
4. For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start and/or stop within that group.
5. The operator shall be able to define the following information:
 - a. Time, day
 - b. Commands such as on, off, auto, etc.
 - c. Time delays between successive commands.

- d. There shall be provisions for manual overriding of each schedule by an authorized operator.
- 6. It shall be possible to schedule calendar-based events up to one year in advance based on the following:
 - a. Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start, optimal stop. When a group of objects are scheduled together as an Event, provide the capability to adjust the start and stop times for each member.
 - b. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.
- K. Peak Demand Limiting (PDL):
 - 1. The Peak Demand Limiting (PDL) program shall limit the consumption of electricity to prevent electrical peak demand charges.
 - 2. PDL shall continuously track the amount of electricity being consumed, by monitoring one or more electrical kilowatt-hour/demand meters. These meters may measure the electrical consumption (kWh), electrical demand (kW), or both.
 - 3. PDL shall sample the meter data to continuously forecast the demand likely to be used during successive time intervals.
 - 4. If the PDL forecasted demand indicates that electricity usage is likely to exceed a user preset maximum allowable level, then PDL shall automatically shed electrical loads.
 - 5. Once the demand peak has passed, loads that have been shed shall be restored and returned to normal control.
- L. Temperature-compensated duty cycling
 - 1. User defined conditions shall be able to initiate a Duty Cycle Control Program.
 - 2. The Duty Cycle Control Program (DCCP) shall be configured to periodically stop and start loads according to various patterns.
 - 3. The loads shall be cycled such that there is a net reduction in both the electrical demands and the energy consumed.
- M. Automatic Daylight Savings Time Switchover. The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.
- N. Night setback control. The system shall provide the ability to automatically adjust setpoints for night control.
- O. Control Loop Algorithm
 - 1. Provide a PID (proportional-integral-derivative) closed-loop control algorithm with direct or reverse action and anti-windup. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, setpoint, and weighting parameters shall be accessible from the operator workstation.
- P. Adaptive Loop Tuning
 - 1. Building Controllers shall also provide high resolution sampling capability for verification of DDC control loop performance. Documented evidence of tuned

control loop performance shall be provided on a monthly, seasonal, quarterly, annual period.

2. For PID control loops, operator-initiated automatic and manual loop tuning algorithms shall be provided for all operator-selected PID control loops. Evidence of tuned control loop performance shall be provided via graphical plots or trended data logs for all loops.
 - a. In automatic mode, the controller shall perform a step response test with a minimum one-second resolution, evaluate the trend data, calculate the new PID gains and input these values into the selected LOOP statement.
 - b. Loop tuning shall be capable of being initiated either locally at the Building Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

Q. Logic programming: Provide a software routine that can build ladder logic to control using many conditional statements.

1. The logic programming syntax shall be able to combine ladder logic with other software features, such as combining status, scheduling, PDL and alarm conditions into one conditional decision.
2. Logic programming shall be able to reference conditions in any other controller in the system.

R. Staggered Start:

1. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user definable in an application and shall not require written scripts or ladder logic.
2. Upon the resumption of power, each Building Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.

S. Totalization Features:

1. Run-Time Totalization. Building Controllers shall automatically accumulate and store run-time hours for all digital input and output points. A high runtime alarm shall be assigned, if required, by the operator.
2. Consumption totalization. Building Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for all analog and digital pulse input type points.
3. Event totalization. Building Controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis for all points. The event totalization feature shall be able to store the records associated with events before reset.

T. Data Collection:

1. A variety of historical data collection utilities shall be provided to manually or automatically sample, store, and display system data for all points.
2. Building Controllers shall store point history data for selected analog and digital inputs and outputs:
3. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each Building Controllers point group.

4. Two methods of collection shall be allowed: either by up to four pre-defined time intervals or upon a pre-defined change of value. Sample intervals of 1 minute to 7 days shall be provided.
5. Each Building Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of 10,000 data samples.
6. Trend data shall be stored at the Building Controllers and uploaded to the workstation when retrieval is desired. Uploads shall occur based upon either user-defined interval, manual command or when the trend buffers are full. All trend data shall be available for use in third-party personal computer applications.

2.7 BACNET BUILDING CONTROLLERS

- A. Provide all necessary hardware for a complete operating system as required. The Building Controller shall be able to operate as a standalone panel and shall not be dependent upon any higher-level computer or another controller for operation.
- B. Basis of design is Siemens TC Modular and TC Compact Controllers.
- C. This controller shall have the BTL listing and meet the BACnet device profile of a Building Controller (B-BC) and shall support the following BACnet BIBBs:
 1. Data Sharing
 - a. Data Sharing-Read Property-Initiate, Execute (DS-RP-A,B)
 - b. Data Sharing-Read Property Multiple- Initiate, Execute (DS-RPM-A,B)
 - c. Data Sharing-Write Property- Initiate, Execute (DS-WP-A,B)
 - d. Data Sharing-Write Property Multiple- Execute (DS-WPM-B)
 - e. Data Sharing-COV- Initiate, Execute (DS-COV-A,B)
 - f. Data Sharing-COV-Unsolicited- Initiate, Execute (DS-COVU-A,B)
 2. Scheduling
 - a. Scheduling-Internal- Execute (SCHED-I-B)
 - b. Scheduling-External- Execute (SCHED-E-B)
 3. Trending
 - a. Trending-Viewing and Modifying Trends - Initiate (T-VMT-A)
 - b. Trending-Viewing and Modifying Trends Internal- Execute (T-VMT-I-B)
 - c. Trending-Viewing and Modifying Trends-External- Execute (T-VMT-E-B)
 - d. Trending-Automated Trend Retrieval- Execute (T-ATR-B)
 4. Network Management
 - a. Network Management-Connection Establishment- Initiate (NM-CE-A)
 5. Alarming
 - a. Alarm and Event-Notification- Initiate (AE-N-A)
 - b. Alarm and Event-Notification Internal- Execute (AE-N-E-B)
 - c. Alarm and Event-Notification External- Execute (AE-N-E-B)
 - d. Alarm and Event-ACK- Initiate, Execute (AE-ACK-A,B)
 - e. Alarm and Event –Alarm Summary- Execute (AE-ASUM-B)
 - f. Alarm and Event –Enrollment Summary- Execute (AE-ESUM-A,B)
 - g. Alarm and Event –Information- Initiate, Execute (AE-ESUM-A,B)
 6. Device Management
 - a. Device Management-Dynamic Device Binding- Initiate, Execute (DM-DDB-A,B)
 - b. Device Management-Dynamic Object Binding- Initiate, Execute (DM-DOB-A,B)
 - c. Device Management-Device Communication Control- Execute (DM-DCC-B)
 - d. Device Management-Private Transfer- Initiate, Execute (DM-PT-A,B)
 - e. Device Management-Text Message- Initiate, Execute (DM-TM-A,B)
 - f. Device Management-Time Synchronization- Execute (DM-TS-B)
 - g. Device Management-Reinitialize Device- Execute (DM-RD-B)

- h. Device Management-Backup and Restore- Execute (DM-RD-B)
- i. Device Management-List Manipulation- Execute (DM-RD-B)
- j. Device Management-Object Creation and Deletion- Execute (DM-OCD-B)
- 7. The Building Level Controller shall support the following Data Link Layers:
 - a. BACnet IP Annex J
 - b. BACnet IP Annex J Foreign Device
 - c. MS/TP Master (Claus 9)
- 8. The Building Level Controller shall be able to interact with all of the BACnet objects in the controllers. In addition, the software shall be able to support the following objects as they relate to features in the workstation software:
 - a. Calendar – Creatable, Deletable
 - b. Command – Creatable, Deletable
 - c. Event Enrollment – Creatable, Deletable
 - d. Notification Class – Creatable, Deletable
 - e. Schedule - Creatable, Deletable
- 9. The Building Level Controller shall support transmitting and receiving segmented messages.
- 10. The Building Level Controller shall have the capability to be the BACnet/IP Broadcast Management Device (BBMD) and support foreign devices.
- 11. The Building Level Controller shall have the capability to act as a BACnet router between MS/TP subnetworks and BACnet/IP.

D. This level of controller shall be used for the following types of systems:

- 1. Systems with over 24 input/output points
- 2. Packaged Units

E. Computing power and memory minimum:

- 1. A 32 bit, stand alone, multi-tasking, multi-user, real-time 100MHz digital control microprocessor module.
- 2. Inputs shall be 16-bit minimum analog-to-digital resolution.
- 3. Outputs shall be 10-bit minimum digital-to-analog resolution.
- 4. Memory module (24 Megabyte, minimum) to accommodate all Primary Control Panel software requirements, including but not limited to, its own operating system and databases (see Controllers Software section), including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, operator I/O, dial up communications.
- 5. Real time clock and battery
- 6. Data collection/ Data Trend module sized for 10,000 data samples.
- 7. Flash Memory Firmware: Each Building Level Control Panel shall support firmware upgrades without the need to replace hardware.

F. Onboard or Modular hardware and connections:

- 1. Primary Network communication module, if needed for primary network communications.
- 2. Secondary Network communication module, if needed for secondary network communications.
- 3. RJ45 port 10/100Mbaud
- 4. RS485 ports for subnetworks and point expansion
- 5. Man to Machine Interface port (MMI)
- 6. USB Port
- 7. Local Controller Interface. A local user interface to the controller shall be provided. The interface shall be hot swappable and may be mounted on any building controller and automatically read and initiate commands of local database points

without further set-up or configuration. The Controller Interface shall be provided for interrogating and editing data, commanding point values at user defined priorities, viewing and acknowledging alarms, and viewing point monitoring reports. An optional system security password shall be available to prevent unauthorized use of the local controller interface and display.

G. Input and Output Points Hardware

1. Input/output point modules as required including spare capacity.
2. Input/output point modules shall have removable terminal blocks.
3. Monitoring of the status of all hand off auto switches.
4. Monitoring of all industry standard types of analog and digital inputs and outputs, without the addition of equipment to the primary control panel.
5. Local status indication for each digital input and output for constant, up to date verification of all point conditions without the need for an operator I/O device. Each primary control panel shall perform diagnostics on all inputs and outputs and a failure of any input or output shall be indicated both locally and at the operator workstation.
6. Graduated intensity LEDs or analog indication of value for each analog output.

H. Code compliance

1. Approvals and standards: UL916; CE; FCC
2. Provide UL864-UUKL where called for in the sequences of operations.

I. Accessories:

1. Appropriate NEMA rated metal enclosure.
2. Power supplies as required for all associated modules, sensors, actuators, etc.

J. The operator shall have the ability to manually override automatic or centrally executed commands at the primary control panels via local, point discrete, on board hand/off/auto operator override switches. If on board switches are not available, provide separate control panels with HOA switches. Mount panel adjacent to primary control panel. Provide hand/off/auto switch for each digital output, including spares.

K. Each Building Level Control Panel shall continuously perform self diagnostics on all hardware modules and network communications. The System Level Control Panel shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication with any system.

L. Panel setup, point definitions and sequencing diagrams shall be backed up on EEPROM memory.

M. Power loss. In the event of the loss of power, there shall be an orderly shutdown of all Building Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 30 days.

N. Building Level control panels shall provide at least two serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. Primary control panels shall allow temporary use of portable devices without interrupting the normal communications, operation of permanently connected modems, printers or terminals.

- O. Building Level Controllers shall have the capability to serve as a gateway between Modbus subnetworks and BACnet objects. Provide software, drives and programming.
- P. Isolation shall be provided at all primary control panel terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587 1980.
- Q. Spare Capacity: Provide enough inputs and outputs to handle the equipment shown to be "future" on drawings and 10% more of each point type. Provide all hardware modules, software modules, processors, power supplies, communication controllers, etc. required to ensure adding a point to the spare point location only requires the addition of the appropriate sensor/actuator and field wiring/tubing.
- R. Environment.
 - 1. Controller hardware shall be suitable for the anticipated ambient conditions.
 - 2. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).
 - 3. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).
 - 4. Controller hardware shall be optionally suitable for rooftop environments.
- S. Immunity to power and noise.
 - 1. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
 - 2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
 - 3. Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
 - a. RF-Conducted Immunity (RFCl) per ENV 50141 (IEC 1000-4-6) at 3V.
 - b. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact.
 - c. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500V signal, 1 kV power.
 - d. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max).
 - 4. Isolation shall be provided at all Building Controller's AC input terminals to suppress induced voltage transients consistent with:
 - a. IEEE Standard 587 1980
 - b. UL 864 Supply Line Transients
 - c. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

2.8 BACNET ADVANCED APPLICATION CONTROLLERS

- A. Provide all necessary hardware for a complete operating system as required. The Advanced Application-level control panel shall be able to operate as a standalone panel and shall not be dependent upon any higher-level computer or another controller for operation.
- B. Basis of design is Unitary Equipment Controller.
- C. The Advanced Application Controller Software shall be capable of BACnet communications. The BACnet Advanced Application Controller (B-AAC) shall have demonstrated compliance to BTL through BTL listing and shall substantially conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135-2004 or ANSI/ASHRAE 135-2008. Supported BIBBS shall include:

1. Data Sharing
 - a. Data Sharing-Read Property-Initiate, Execute (DS-RP-A,B)
 - b. Data Sharing-Read Property Multiple- Initiate, Execute (DS-RPM-A,B)
 - c. Data Sharing-Write Property- Initiate, Execute (DS-WP-A,B)
 - d. Data Sharing-Write Property Multiple- Execute (DS-WPM-B)
 - e. Data Sharing-COV- Initiate, Execute (DS-COV-A,B)
2. Scheduling
 - a. Scheduling-Internal- Execute (SCHED-I-B)
3. Trending
 - a. Trending-Viewing and Modifying Trends Internal- Execute (T-VMT-I-B)
 - b. Trending-Automated Trend Retrieval- Execute (T-ATR-B)
4. Network Management
 - a. Network Management-Connection Establishment- Initiate (NM-CE-A)
5. Alarming
 - a. Alarm and Event-Notification Internal- Execute (AE-N-I-B)
 - b. Alarm and Event-ACK- Initiate, Execute (AE-ACK-A,B)
 - c. Alarm and Event –Enrollment Summary- Execute (AE-ESUM-B)
 - d. Alarm and Event –Information- Execute (AE-INFO-B)
6. Device Management
 - a. Device Management-Dynamic Device Binding- Initiate, Execute (DM-DDB-A,B)
 - b. Device Management-Dynamic Object Binding- Initiate, Execute (DM-DOB-A,B)
 - c. Device Management-Device Communication Control- Execute (DM-DCC-B)
 - d. Device Management-Time Synchronization- Execute (DM-TS-B)
 - e. Device Management-Reinitialize Device- Execute (DM-RD-B)
 - f. Device Management-Backup and Restore- Execute (DM-BR-B)
 - g. Device Management-List Manipulation- Execute (DM-LM-B)
 - h. Device Management-Object Creation and Deletion- Execute (DM-OCD-B)
7. The Advanced Application Controller shall be able to interact with all of the BACnet objects in the controllers. In addition, the software shall be able to support the following objects as they relate to features in the workstation software:
 - a. Calendar – Creatable, Deletable
 - b. Command – Creatable, Deletable
 - c. Event Enrollment – Creatable, Deletable
 - d. Notification Class – Creatable, Deletable
 - e. Schedule - Creatable, Deletable
8. The Advanced Application Controller shall support transmitting and receiving segmented messages.

D. Communication:

1. BAS Network: The Advanced Application Controller shall support the following Data Link Layers:
 - a. MS/TP Master
2. Serial Communication: Temporary use of portable devices shall not interrupt the BAS communication, nor the normal operation of permanently connected printers or terminals.
 - a. Provide at least one EIA-232C serial data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, and portable laptop operator's terminals.
 - b. A USB port shall alternatively be available to support local HMI tools connection.

E. Software

1. The software programs specified in this section shall be provided as an integral part of Advanced Application Controllers and shall not be dependent upon any higher-level computer or another controller for execution.
2. Advanced Application Controllers shall have the ability to perform energy management routines including but not limited to
 - a. scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides
 - b. automatic daylight savings time switch over
 - c. night setback control
 - d. peak demand limiting,
 - e. temperature-compensated duty cycling
 - f. heating interlock
 - g. supply temperature reset
 - h. priority load shedding
 - i. power failure restart
3. The software shall have a routine for automatic tuning of control loops.
4. System Security in the Field Panel
 - a. User access shall be secured using individual security passwords and user names.
 - b. Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
 - c. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.
 - d. Use of workstation resident security as the only means of access control is not an acceptable alternative to resident system security in the field panel.
5. User Defined Control Applications:
 - a. Controllers shall be fully-programmable. Controllers shall execute custom, job-specific sequences to automatically perform calculations and special control routines. Factory installed or pre-configured sequences shall only be allowed if they exactly match the sequence specified herein.
 - b. Programs shall combine control logic, control loop algorithms, and energy management routines
 - c. Each controller shall support plain language text comment lines in the operating program to allow for quick troubleshooting, documentation, and historical summaries of program development.
 - d. Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task oriented information from the user manual.

F. Adaptive Loop Control.

1. Each AAC controller shall come standard with an Adaptive Control Loop Algorithm
 - a. Tuning parameter shall automatically adjust for non-linear applications.
2. Model-Free Adaptive (MFA) algorithm
 - a. The algorithm shall not require modeling of the non-linear system in order to maintain control at all points of the non-linear load.
 - b. The controlled variable, setpoint, and weighting parameters shall be user-selectable.
3. Output shall be analog or shall stage a series of outputs.
4. Adaptive Control shall take the place of Proportional, Proportional + Integral, and PID type algorithms for non-linear applications. Adaptive Control routines shall:
 - a. Improve response time.
 - b. Improve System efficiency.
 - c. Improve Stability

- d. Result in Consistent outputs
- e. Reduce cycling and repositioning.
- f. Reduce wear and tear on actuators.
- 5. Adaptive control shall auto-adjust to compensate for
 - a. mode changes
 - b. load changes
 - c. seasonal changes
 - d. Flow across a heat exchanger
- 6. Adaptive control shall auto-adjust to compensate for
 - a. heat exchangers
 - b. Duct Static reset routines
- 7. Auto-Tune PID loops are not acceptable substitutions.
- 8. If Adaptive Loop Control is not available, then the BAS contractor shall provide re-tuning of the control loops for coils and heat exchangers for each of the following conditions:
 - a. Dual temperature systems tune for heating modes.

G. This level of controller shall be used for the following types of systems:

- 1. Systems with custom sequences that meet all of the criteria below:
- 2. Room control sequences that cannot be achieved with an application specific controller.
- 3. BAS Network or Architecture or Sequences do not require the system to be on an IP network.
- 4. No systems that require integration to meters, VFDs or other smart equipment
- 5. Integration to smart thermostats is allowed.

H. Input/Outputs

- 1. Inputs shall be 16-bit minimum digital resolution
- 2. Outputs shall be 10-bit minimum digital resolution
- 3. The following I/O port types shall be available on the controller
 - a. Universal Input (software configurable):
 - i. Digital Input choices:
 - 1) Pulse Accumulator
 - 2) Contact Closure Sensing
 - 3) Dry Contact/Potential Free inputs only
 - 4) Digital Input (10 ms settling time)
 - 5) Counter inputs up to 20 Hz, minimum pulse duration 20 ms (open or closed)
 - ii. Analog Input Choices:
 - 1) 0-10 Vdc
 - 2) 4-20 mA
 - 3) 1K Ni RTD @ 32°F (Siemens, JCI, DIN Ni 1K)
 - 4) 1K Pt RTD (375 or 385 alpha) @ 32°F
 - 5) 10K NTC Type 2 or Type 3 Thermistor
 - 6) 100K NTC Type 2 Thermistor
 - b. Universal Input or Output (software configurable):
 - i. All of the above input types
 - ii. Analog Output Types:
 - 1) 0 to 10 Vdc @ 1 mA max
 - c. Super Universal Input or Output (software configurable):
 - i. All of the above input types
 - ii. All of the above output types
 - iii. Super digital output type:
 - 1) 0 to 24 Vdc, 22 mA max. (for controlling pilot relay)

- iv. Super Analog Output Choices:
 - 1) 0 to 20 mA @ 650 Ω max.
- 4. Provide software configurable I/O ports such that a programmer make a port either an input or an output
- I. Each System Level Control Panel shall, at a minimum, be provided with:
 - 1. Appropriate NEMA rated metal enclosure.
 - 2. A 32 bit, multi-tasking, real-time 100 MHz digital control microprocessor with plug-in, enclosed processors.
 - 3. Each Advanced Application Controller shall have sufficient memory, a minimum of 24 megabyte, to support its own operating system and databases, including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, and operator I/O.
 - 4. Real time clock and battery
 - 5. Data collection/ Data Trend module sized for 10,000 data samples.
 - 6. Power supplies as required for all associated modules, sensors, actuators, etc.
 - 7. Monitoring of all industry standard types of analog and digital inputs and outputs, without the addition of equipment to the primary control panel.
 - 8. Local status indication for each digital input and output for constant, up to date verification of all point conditions without the need for an operator I/O device.
 - 9. Each control panel shall perform diagnostics on all inputs and outputs and a failure of any input or output shall be indicated both locally and at the operator workstation.
 - 10. Graduated intensity LEDs or analog indication of value for each analog output.
- J. Power loss. In the event of the loss of power, there shall be an orderly shutdown of all controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for the operating system software and firmware.
 - 1. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
 - 2. Brownout protection and power recovery circuitry protect the controller board from power fluctuations.
 - 3. Battery backup shall be provided to support the real-time clock for 10 years
 - 4. The program and database information stored SDRAM memory shall be battery backed for a minimum of 30 days and up to 60 days. This eliminates the need for time consuming program and database re-entry in the event of an extended power failure.
- K. Database Restore: Each AAC controller shall automatically save the latest programmed database. The controller shall be able to automatically restore a lost or corrupt database without involvement from the operator.
- L. Each System Level Control Panel shall continuously perform self diagnostics on all hardware modules and network communications. The System Level Control Panel shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication with any system.
- M. Each Control Panel shall support firmware upgrades without the need to replace hardware.
- N. System Level control panels shall provide at least two RS 232C serial data communication ports for operation of operator I/O devices such as operator terminals, and additional memory. Control panels shall allow temporary use of portable operator interface devices without interrupting the normal communications.

- O. Immunity to noise.
 - 1. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
 - 2. Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
 - a. RF-Conducted Immunity (RFCl) per ENV 50141 (IEC 1000-4-6) at 3V.
 - b. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact.
 - c. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500V signal, 1 kV power.
 - d. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max).
 - 3. Isolation shall be provided at all Advanced Application Controller's AC input terminals to suppress induced voltage transients consistent with:
 - a. IEEE Standard 587 1980
 - b. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

- P. Agency Compliance
 - 1. UL UL916 PAZX (all models)
 - 2. UL916 PAZX7 (all models)
 - 3. FCC Compliance CFR47 Part 15, Subpart B, Class B

- Q. Spare Capacity: Provide enough inputs and outputs to handle the equipment shown to be "future" on drawings and 10% more of each point type. Provide all hardware modules, software modules, processors, power supplies, communication controllers, etc. required to ensure adding a point to the spare point location only requires the addition of the appropriate sensor/actuator and field wiring/tubing.

- R. Local Operator Interfaces
 - 1. Controllers shall support an optional Operator Interface Module.
 - 2. Optional local user interface to the controller shall be hot swappable and may be mounted on any building controller and automatically read and initiate commands of local database points without further set-up or configuration. The Controller Interface shall be provided for interrogating and editing data, commanding point values at user defined priorities, viewing and acknowledging alarms, and viewing point monitoring reports. An optional system security password shall be available to prevent unauthorized use of the local controller interface and display.

2.9 CONTROL PANELS

- A. Controllers in mechanical rooms shall be mounted in NEMA 1 enclosures.
- B. Controllers in areas where moisture is a concern shall be mounted in NEMA 12 enclosures.
- C. Controllers installed outdoors shall be mounted in NEMA 4X enclosures. Provide heaters where freezing temperatures are normally experienced.
- D. Mount on walls at an approved location or provide a free-standing rack.
- E. Panels shall be constructed of 16-gauge, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with ANSI 61 gray polyester-powder painted finish, UL listed. Provide common keying for all panels.
- F. Provide power supplies for control voltage power.

- G. Dedicate 1 power supply to the DDC controller. Other devices shall be on a separate power supply unless the power for the control device is derived from the controller terminations.
- H. Power supplies for controllers shall be a transformer with a fuse or circuit breaker. Power supplies for other devices can be plain transformers.
- I. All power supplies for 24V low voltage wiring shall be class 2 rated and less than 100VA. If low voltage devices require more amps, then provide multiple power supplies. If a single device requires more amps, then provide a dedicated power supply in a separate enclosure and run a separate, non-class 2 conduit to the device.
- J. Surge transient protection shall be incorporated in design of system to protect electrical components in all DDC Controllers and operator's workstations.
- K. All devices in a panel shall be permanently mounted, including network switches, modems, media converters, etc.
- L. Provide a pocket to hold documentation.

2.10 SENSORS

A. General

1. Provide mounting hardware for all devices, including actuator linkages, wells, installation kits for insertion devices, wall boxes and fudge plates, brackets, etc.
2. If a special tool is required to mount a device, provide that tool.
3. Digital Display temperature sensor specifications – Wired:
 - a. As called for in the sequences of operations or on the drawings, provide temperature sensors with digital displays.
 - b. The sensing element for the space temperature sensor must be IC-based and provide the following.
 - i. Digitally communicating with the Application Specific Controller.
 - ii. Mountable to and fully covering a 2 x 4 electrical junction box without the need for an adapter wall plate.
 - iii. IC Element Accuracy: +/- 0.9°F
 - iv. Operating Range: 55 to 95°F
 - v. Setpoint Adjustment Range: User limiting, selectable range between 55 and 95°F
 - vi. Display of temperature setpoint with numerical temperature values
 - vii. Display of temperature setpoint graphically, with a visual Hotter/Colder setpoint indication
 - viii. Calibration: Single point, field adjustable at the space sensor to +/- 5°F
 - ix. Installation: Up to 100 ft. from controller
 - x. Auxiliary Communications Port: included
 - xi. Local OLED Temperature Display: included
 - xii. Display of Temperature to one decimal place
 - xiii. Temperature Setpoint Adjustment included
 - xiv. Occupancy Override Function included
 - c. Auxiliary Communication Port. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. RS-232 communications port shall allow the operator to query and modify operating parameters of the local room unit from the portable operator's terminal.

4. Provide the following options as they are called for in the sequences or on the drawings:
 - a. Setpoint Adjustment. The setpoint adjustment function shall allow for modification of the temperature by the building operators. Setpoint adjustment may be locked out, overridden, or limited as to time or temperature through software by an authorized operator at any central workstation, Building Controller, room sensor two-line display, or via the portable operator's terminal.
 - b. Override Switch. An override button shall initiate override of the night setback mode to normal (day) operation when activated by the occupant and enabled by building operators. The override shall be limited to two (2) hours (adjustable.) The override function may be locked out, overridden, or limited through software by an authorized operator at the operator interface, Building Controller, room sensor two-line display or via the portable operator's terminal.
 - c. Space Combination Temperature and Humidity Sensors. Each controller performing space temperature control shall be provided with a matching room temperature sensor, which also includes the ability to measure humidity for either monitoring or control purposes. The combination temperature and humidity sensors shall have the same appearance as the space temperature sensors. Humidity elements shall measure relative humidity with a +/- 2% accuracy over the range of 10 to 90% relative humidity. Humidity element shall be an IC (integrated circuit) sensing element. Humidity sensing elements shall be removable and field replaceable if needed.

B. Temperature Sensors

1. All temperature sensors shall meet the following specifications:
 - a. Accuracy: Plus or minus 0.2 percent at calibration point.
 - b. Wire: Twisted, shielded-pair cable.
 - c. Vibration and corrosion resistant
2. Space temperature sensors shall meet the following specifications:
 - a. 10k ohm type 2 thermistors
3. Insertion Elements in Ducts shall meet the following specifications:
 - a. Single point 10k ohm thermistor
 - b. Use where not affected by temperature stratification.
 - c. The sensor shall reach more than 1/3 the distance from the duct wall.
 - d. Junction box for wire splices
4. Averaging Elements in Ducts shall meet the following specifications:
 - a. 72 inches (183 cm) long
 - b. Flexible
 - c. Use where prone to temperature stratification, in front of coils, or where ducts are larger than 9 sq. ft.
 - d. Junction box for wire splices
5. Insertion Elements for Liquids shall meet the following specifications:
 - a. Platinum RTD with 4-20mA transmitter
 - b. Threaded mounting with matching well
 - c. Brass well with minimum insertion length of 2-1/2 inches for pipes up to 4" diameter
 - d. Brass well with insertion length of 6 inches for pipes up to 10" diameter
 - e. Junction box for wire splices
6. Outside-Air Sensors Platinum RTD with 4-20mA transmitter:
 - a. Watertight enclosure, shielded from direct sunlight.
 - b. Circulation fan
 - c. Watertight conduit fitting.

- C. Where called for in the sequences of operations, provide the following feature on space sensors and thermostats:
1. Security Sensors: Stainless-steel cover plate with insulated back and security screws.
 2. Space sensors with setpoint adjust: Plain white plastic cover with slide potentiometer to signal a setpoint adjustment to the DDC.
 3. Space Sensors with LCD display:
 - a. Operator buttons for adjusting setpoints, setting fans speeds and overriding unit to on/off.
 - b. Graphical LCD icons for signaling heating mode, fans speed, schedule mode, actual temperature and current setpoint.
- D. Humidity Sensors shall meet the following specifications:
1. Bulk polymer sensor element
 2. Accuracy: 2 percent full range with linear output
 3. Room Sensors: With locking cover matching room thermostats, span of 0 to 100 percent relative humidity.
 4. Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity
- E. Air Static Pressure Transmitter shall meet the following specifications:
1. Non-directional sensor with suitable range for expected input, and temperature compensated.
 2. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 3. Output: 4 to 20 mA.
 4. Building Static-Pressure Range: 0 to 0.25 inches wg.
 5. Duct Static-Pressure Range: 0 to 5 inches wg.
- F. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.
- G. Equipment operation sensors as follows:
1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 inches wg.
 2. Status Inputs for direct drive electric motors: Current-sensing relay with current transformers, adjustable and sized for 175 percent of rated motor current.
 3. Status inputs for belt drive electric motors: Current sensing transmitter with linear 4-20mA output.
- H. Air Differential Pressure Switches: Diaphragm type air differential pressure switches with die cast aluminum housing, adjustable setpoint, minimum 5 amp switch rating at 120VAC, SPDT switches, and the switch pressure range shall be suited for the application. Provide Dwyer or equal. These switches shall be utilized for filter status.
- I. Leak detectors: Provide spot leak detectors that can be secured to the floor or secured to a drain pan. The detection shall use a microchip controlled energized probes. The detector shall operate on 24V or less. Provide a way to adjust the height of the leak probes. The SPDT contacts shall be inside a watertight enclosure.

2.11 ELECTRONIC ACTUATOR SPECIFICATION

A. ELECTRONIC DAMPER ACTUATORS

1. Actuator shall be direct coupled (over the shaft), enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The actuator-to-shaft clamp shall use a "V" bolt and "V" shaped, toothed cradle to attach to the damper shaft for maximum holding strength. Single bolt or set screw type fasteners are not acceptable.
2. Actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator. End switches to deactivate the actuator at the end of rotation or magnetic clutch are not acceptable.
3. For power-failure/safety applications, a mechanical, spring return mechanism shall be used.
4. Actuators with spring return mechanisms shall be capable of either clockwise or counterclockwise spring return operation by simply changing the mounting orientation.
5. Proportional actuators shall accept a 2-10VDC, 4-20mA signal, or be of the 2 point floating type and provide a 2-10VDC actuator position feedback signal.
6. All actuators shall have an external manual gear release (clutch) or manual crank to aid in installation and for allowing manual positioning when the actuator is not powered.
7. All actuators shall have an external direction of rotation switch to aid in installation and to allow proper control response.
8. Actuators shall be provided with a factory-mounted 3-foot electrical cable and conduit fitting to provide easy hook-up to an electrical junction box.
9. Actuators shall be listed under Underwriters Laboratories Standard 873 and Canadian Standards Association. They must be manufactured under ISO 9001.

2.12 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 2. Install exposed cable in raceway.
 3. Install concealed cable in raceway.
 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.
- B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.
- C. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate—or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others.

3.2 INSTALLATION

- A. Provide all relays, switches, sources of emergency and UPS battery back-up electricity and all other auxiliaries, accessories, and connections necessary to make a complete operable system in accordance with the sequences specified. All field wiring shall be by this contractor.
- B. Install controls so that adjustments and calibrations can be readily made. Controls are to be installed by the control equipment manufacturer.
- C. Mount surface-mounted control devices on brackets to clear the final finished surface on insulation.
- D. Install equipment level and plumb.
- E. Install control valves horizontally with the power unit up.
- F. Unless otherwise noted, install wall mounted thermostats and humidistat 60" above the floor measured to the center line of the instrument, or as otherwise directed by the Architect.
- G. Install averaging elements in ducts and plenums in horizontal crossing or zigzag pattern.
- H. Install outdoor sensors in perforated tube and sunshield.
- I. Install damper motors on outside of duct in protected areas, not in locations exposed to outdoor temperatures.
- J. Install labels and nameplates on each control panel listing the name of the panel referenced in the graphics and a list of equipment numbers served by that panel.
- K. Furnish hydronic instrument wells, valves, and other accessories to the mechanical contractor for installation.
- L. Furnish automatic dampers to mechanical contractor for installation.

3.3 GRAPHIC DISPLAY GENERATION

- A. All workstation(s) shall be provided with color graphics. All workstation(s) software shall include a graphical viewing and control environment and definition and construction of dynamic color graphic displays.
- B. Provide a main default screen showing the basic layout of the building. Each color graphic screen shall have transfer links to allow the building operator to transfer between system associated screens (both forward and backward), as well as a transfer link back to the main default screen.
- C. Basic CAD floor plans with layers for walls, windows, low pressure ductwork only, supply diffusers and room numbers shall be provided for all units and fans. Floor plans shall show the location of each space temperature sensor with a dashed line to the associated unit and fan. Display in real time the difference between the space temperature and the current setpoint.
 - 1. Display the
 - a. heating % (if applicable)
 - b. current CFM of each unit.
 - 2. Provide a transfer link for each unit to allow the operator to access the flow graphic for each individual unit. Use a different color to shade the background area for each part of a floor plan graphic served by a different air handling unit.
- D. Thermal floor plan graphics:
 - 1. Show heating zones throughout the building in a range of colors (minimum 5) that provide a visual display of temperatures relative to their respective setpoints. The colors shall be updated dynamically as zones' comfort conditions change. Locations of space sensors shall also be shown for each zone. Floor plan humidity's shall be represented similarly to zone temperatures. Setpoint adjustment and color band displays shall be provided as a tool for user adjustment.
 - 2. These full screen plans shall be accessible by rolling over the floor on the building elevation rendering. This will provide the viewer a quick and accurate overview of which zones are at setpoint, near setpoint, or need attention.
 - 3. The viewer may then click on any zone to be brought to the unit that is related to that zone. Rolling over any zone will bring up the zone description and temperature in a pop-up flag. Flags are used to keep the zone information legible regardless of how small the zone is depicted on the plan.
 - 4. All floor plans shall be vector based to allow for zooming in and out of floor plans without pixelization.
 - 5. If zone lighting controls are tied into the BAS, then produce the same floor viewing and control for lights.
 - 6. If a Web-based graphical interface is specified, then the floor plan graphics shall be accessible through the Web Browser Interfaces.
- E. All control set points shall be easily adjustable from the system's color graphic screen by operators with the proper access level. Each controlled point on the BAS operator workstation color graphic screens shall have the set point indicated along with the actual controlled variable reading (preferred set point on top and actual reading on bottom). All points shall indicate the associated engineering unit. All analog outputs points shall indicate engineering units such as "%-open" or "%-closed" as required by the application. All normally-closed or normally-open points shall indicate the normal position (such as "N.C." or "N.O." next to the controlled device).

- F. Provide system color graphics for each HVAC system and for each electrical, plumbing and/or piping system that is monitored and/or controlled by the BAS. Provide scaled floor plans indicating equipment location, service, and system data as required.
- G. Provide color graphic floor plan displays and system schematics for each piece of mechanical equipment, including but not limited to packaged gas fired heaters, and fans to optimize system performance analysis and speed alarm recognition.
- H. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands.
- I. Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention.
- J. The windowing environment of the PC operator workstation(s) shall allow the user to simultaneously view several graphics at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
 - 1. Provide libraries of pre-engineered screens and symbols depicting standard unit components (e.g., fans, coils, filters, dampers, etc.), complete mechanical systems and electrical symbols.
 - 2. Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout or any other logical grouping of points which aids the operator in the analysis of the facility.
- K. Provide an automatically updated, dynamic display of the site-specific BAS architecture indicating the status of primary and secondary controllers, PC workstation(s) and networks.
- L. Provide a separate dynamic display page of each HVAC (AHU, AC, chiller, cooling tower, fuel oil, etc.), electrical, and/or plumbing system connected to the BAS.
- M. Provide a separate dynamic display page of each piece of equipment (packaged gas fired heater, fan, etc.) connected to the BAS.
- N. Provide an additional (10) separate dynamic, graphic display pages at each workstation as required by the operating staff to further assist in daily system operations.
- O. Graphics shall incorporate all system integration points communicated via hardware or software gateways and/or interfaces. Origin of information shall be transparent to the operator and shall be controlled, displayed, trended, etc. as if the points were hardwired to the BAS.
- P. Each graphic shall have a "BACK" button and a "HOME" or "MAIN" button located in the same location on all graphics.
- Q. The operator shall be able to clearly distinguish the difference between the following types of points on a graphic either by color, shape, icon or text label:
 - 1. Real-time sensor reading
 - 2. Setpoint
 - 3. Manually set vs. program set Setpoint.
 - 4. Real-time output reading
 - 5. Manually Overridden or commanded output vs program set output.
 - 6. Status feedback from a piece of equipment vs the output command

- R. When the operator selects a graphic from a menu or a hyperlink, the system shall also make the following adjustments for the operator:
1. Highlight the system name on the system tree.
 2. Highlight the controller's name on the network tree.
 3. Make appear links to additional information associated with the data on the graphic, such as:
 - a. Adjustable modes of operation
 - b. Setpoints
 - c. Alarm statuses
 - d. Trend logs
 4. Make appear links to additional information associated with the system on the graphic, such as:
 - a. Controls as-built schematics and wiring diagrams
 - b. As-built Sequence of Operation
 - c. Mechanical drawings
 - d. Electrical drawings
- S. For control loops that have a 4-point setpoint reset schedule, the operator shall have access to adjust the 4 points in the graphics. Provide a separate graphic with the 4 adjustable data points and a line graph with labels vertices showing the scale of the reset ramp. Display the current calculated output setpoint.
- T. Integration graphics shall be representative of personnel standing in front of equipment. The graphics for equipment specified in the Building Systems Integration paragraph shall be representative of the manufacturers' local display panel and each shall be completely operable from the computer workstation.

3.4 ELECTRICAL WIRING SCOPE

- A. This contractor shall be responsible for power that is not shown on the electrical drawings, to controls furnished by this contractor. If power circuits are shown on the electrical drawings, this contractor shall continue the power run to the control device. If power circuits are not shown, this contractor shall coordinate with the electrical contractor to provide breakers at distribution panels for power to controls. This contractor is then responsible for power from the distribution panel.
1. Coordinate panel locations. If enclosures for panels are shown on the electrical drawings, furnish the enclosures according to the electrician's installation schedule.
- B. This contractor shall not be responsible for power to control panels and control devices that are furnished by others unless it is part of the control interlock wiring.
- C. Refer to Coordination section for what devices this contractor is responsible to mount, and which are turned over to others to mount.
- D. This contractor shall be responsible for wiring of any control device that is furnished as part of this section of specification.
- E. Interlock wiring shall be run in separate conduits from BAS associated wiring.
- F. Provide network wiring for equipment that is called to be integrated to the BAS.

3.5 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. All low voltage control wiring shall be class 2. Control wiring that is not class 2 shall be run in separate conduits from class 2 wiring. Plenum rated wire is acceptable when concealed.
- B. Floor level network wiring between units can be combined with thermostat and other low voltage wiring in the same conduit. All other network wiring shall be in dedicated conduits.
- C. Install raceways, boxes, and cabinets according to Division 26 Section "Raceways and Boxes."
- D. Install building wire and cable according to Division 26 Section "Conductors and Cables."
- E. Installation shall meet the following requirements:
 - 1. Conceal cable and conduit, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Install exposed cable in raceway or conduit.
 - 3. Install concealed cable using plenum rated cable.
 - 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - 7. All wiring in lab areas shall be in conduit.
 - 8. All unsupported risers shall be rigid steel conduit. Supported risers shall be EMT.
- F. Rigid conduit shall be steel, hot dip galvanized, threaded with couplings, ¾ inch minimum size, manufactured in accordance with ANSI C-80-1. Electrical metallic tubing (EMT) with compression fittings or intermediate metallic conduit (IMC) may be used as conduit or raceway where permitted by the NEC.
- G. Concealed control conduit and wiring shall be provided in all spaces except in the Mechanical Equipment Rooms and in unfinished spaces. Install in parallel banks with all changes in directions made at 90 degree angles.
- H. Install conduit adjacent to machine to allow service and maintenance.
- I. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- J. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.
- K. Ground equipment.

3.6 COMMUNICATION WIRING

- A. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.
- B. Do not install communication wiring in raceway and enclosures containing Class 1 wiring. Plenum rated wire is acceptable.
- C. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

- D. Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.
- E. Cable bundling:
1. RS485 cabling run open air in accessible areas can be bundled with other class 2 low voltage cabling.
 2. RS485 cabling run between units in conduits above ceilings or under floors or in inaccessible areas can be bundled with other class 2 low voltage cabling.
 3. RS485 cabling run between floors shall be in a communication only conduit.
 4. RS485 conduit run long distances between utility rooms or between buildings shall be in a communication only conduit.
 5. Ethernet cabling shall be in a communication only conduit.
 6. Ethernet and RS485 can be run together.
 7. Fiber optics can be run with Ethernet and RS485 cabling as long as the conduit is bent to fiber optic standards and junction boxes are sized for fiber optic use.
- F. RS485 Cabling
1. RS485 cabling shall be used for BACnet MS/TP networks.
 2. RS485 shall use low capacitance, 20-24 gauge, twisted shielded pair.
 3. The shields shall be tied together at each device.
 4. The shield shall be grounded at one end only and capped at the other end.
 5. Provide end of line (EOL) termination devices at each end of the RS485 network or subnetwork run, to match the impedance of the cable, 100 to 120ohm.
- G. Ethernet Cabling
1. Ethernet shall not be run with any Class 1 or low voltage Class 2 wiring.
 2. CAT6, unshielded twisted pair (UTP) cable shall be used for BAS Ethernet.
 3. Solid wire shall be used for long runs, between mechanical rooms and between floors. Stranded cable can be used for patch cables and between panels in the same mechanical room up to 50 feet away.
 4. When the BAS Ethernet connects to an Owner's network switch, document the port number on the BAS As-builts.
- H. Fiber-Optic Cabling
1. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer's specifications.
 2. All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.
 3. All terminations shall to be made into a patch panel, designed for such use. Free air terminations with patch panels are prohibited.
- I. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to the manufacturer's instructions.
- J. All runs of communication wiring shall be unspliced length when that length is commercially available.
- K. All communication wiring shall be labeled to indicate origination and destination data.

- L. Grounding of coaxial cable shall be in accordance with NEC regulations article on “Communications Circuits, Cable, and Protector Grounding.”

3.7 IDENTIFICATION

- A. Permanent warning labels shall be affixed to all equipment that can be automatically started by the DDC system.
 - 1. Labels shall use white lettering (12-point type or larger) on a red background.
 - 2. Warning labels shall read as follows: C A U T I O N This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to “Off” position before servicing.
- B. Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.
 - 1. Labels shall use white lettering (12-point type or larger) on a red background.
 - 2. Warning labels shall read as follows: C A U T I O N This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.
- C. Control Equipment and Device labeling:
 - 1. Labels and tags shall match the unique identifiers shown on the as-built drawings.
 - 2. All Enclosures shall be labeled to match the as-built drawing by either control panel name or the names of the DDC controllers inside.
 - 3. All sensors and actuators not in occupied areas shall be tagged.
 - 4. Airflow measurement arrays shall be tagged to show flow rate range for signal output range, duct size, and pitot tube AFMS flow coefficient.
 - 5. Duct static pressure taps shall be tagged at the location of the pressure tap.
 - 6. Each device inside enclosures shall be tagged.
 - 7. Equipment needs only have a tag for the unique terminal number, not for each device. Match the unique number on:
 - a. First, the design drawings, or
 - b. Second, the control as-builts, or
 - c. Third, the DDC addressing scheme.
 - 8. Tags on the units shall be displayed on the Operator Workstation Graphics.
- D. Tags shall be mechanically printed on permanent adhesive backed labeling strips, 12-point height minimum.
- E. Manufacturers’ nameplates and UL or CSA labels are to be visible and legible after equipment is installed.
- F. Identification of Wires
 - 1. Tag each wire with a common identifier on each end of the wire, such as in the control panel and at the device termination.
 - 2. Tag each network wire with a common identifier on each end.
 - 3. Tag each 120V power source with the panel and breaker number it is fed by.
- G. Identification of Conduits:
 - 1. Identify the low voltage conduit runs as BAS conduit, power feeds not included.
 - 2. Identify each electric box, junction box, utility box and wiring tray with a blue paint mark or blue permanent adhesive sticker.

3. For conduit runs that run more than 8 ft between junction boxes in 1 room, place a blue identifier at least every 8 feet.
4. Place a blue identifier on each side of where a conduit passed through a wall or other inaccessible path.
5. Identify all BAS communication conduits the same as above.

3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
 3. Calibration test controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
- B. Engage a factory-authorized service representative to perform startup service.
- C. Replace damaged or malfunctioning controls and equipment.
 1. Start, test, and adjust control systems.
 2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
 3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

3.9 SYSTEM CHECKOUT AND STARTUP

- A. Inspect each termination in the MER control panels and devices to make sure all wires are connected according to the wiring diagrams and all termination are tight.
- B. After the controls devices and panels are installed and power is available to the controls, perform a static checkout of all the points, including the following:
 1. Inspect the setup and reading on each temperature sensor against a thermometer to verify its accuracy.
 2. Inspect the setup and reading on each humidity sensor against a hygrometer to verify its accuracy.
 3. Inspect the reading on each CO2 sensor using a calibration kit to verify the sensor range accuracy matches the DDC setup.
 4. Inspect the reading of each status switch to verify the DDC reads the open and close correctly.
 5. Command each relay to open and close to verify its operation.
 6. Command each 2-position damper actuator to open and close to verify operation.
 7. Command each 2-position valve to open and close to verify operation.
 8. Ramp each modulating actuator to 0%, 25%, 50%, 75% and 100% to verify its operation.
 9. Ramp each modulating output signal, such as a VFD speed, to verify its operation.
 10. Test each safety device with a real life simulation, for instance check freeze-stats with ice water, water detectors with water, etc.
- C. Document that each point was verified and operating correctly. Correct each failed point before proceeding to the dynamic startup.

- D. Verify that each DDC controller communicates on its respective network correctly.
- E. After all of the points are verified, and power is available to the mechanical system, coordinate a startup of each system with the mechanical contractor. Include the following tests:
 - 1. Start systems from DDC.
 - 2. Verify that each setpoint can be met by the system.
 - 3. Change setpoints and verify system response.
 - 4. Change sensor readings to verify system response.
 - 5. Test safety shutdowns.
 - 6. Verify time delays.
 - 7. Verify mode changes.
 - 8. Adjust filter switches and current switches for proper reactions.
 - 9. Adjust proportional bands and integration times to stabilize control loops.
- F. Perform all program changes and debugging of the system for a fully operational system.
- G. Verify that all graphics at the operator workstations correspond to the systems as installed. Verify that the points on the screens appear and react properly. Verify that all adjustable setpoints and manual commands operate from the operator workstations.
- H. After the sequence of operation is verified, setup the trends that are listed in the sequence of operations for logging and archiving for the commissioning procedure.

3.10 SYSTEM COMMISSIONING, DEMONSTRATION AND TURNOVER

- A. The BAS Contractor shall prepare and submit for approval a complete acceptance test procedure including submittal data relevant to point index, functions, sequence, inter-locks, and associated parameters, and other pertinent information for the operating system. Prior to acceptance of the BAS by the Owner and Engineer, the BAS contractor shall completely test the BAS using the approved test procedure.
- B. After the BAS contractor has completed the tests and certified the BAS is 100% complete, the Engineer shall be requested, in writing, to approve the satisfactory operation of the system, sub-systems and accessories. The BAS contractor shall submit Maintenance and Operating manuals at this time for approval. An acceptance test in the presence of the Engineer and Owner's representative shall be performed. The Owner will then shake down the system for a fixed period of time (30 days).
- C. The BAS contractor shall fix punch list items within 30 days of acceptance.
- D. When the system performance is deemed satisfactory in whole or in part by these observers, the system parts will be accepted for beneficial use and placed under warranty.

3.11 TRAINING

- A. During System commissioning and at such time as acceptable performance of the Building Automation System hardware and software has been established, the BAS contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction during normal working hours shall be performed by a competent building automation contractor representative familiar with the Building Automation System's software, hardware and accessories.

- B. At a time mutually agreed upon, during System commissioning as stated above, the BAS contractor shall give hours of onsite training on the operation of all BAS equipment. Describe its intended use with respect to the programmed functions specified. Operator orientation of the automation system shall include, but not be limited to:
 - 1. Explanation of drawings and operator's maintenance manuals.
 - 2. Walk through of the job to locate all control components.
 - 3. Operator workstation and peripherals.
 - 4. DDC Controller and ASC operation/sequence.
 - 5. Operator control functions including scheduling, alarming, and trending.
 - 6. Explanation of adjustment, calibration and replacement procedures.
- C. Additional 8-hours of training shall be given after the 30 day shakedown period.
- D. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Contractor. If the Owner requires such training, it will be contracted at a later date. Provide description of available local and factory customer training. Provide costs associated with performing training at an off-site classroom facility and detail what is included in the manufacturer's standard pricing such as transportation, meals, etc.

3.12 SEQUENCE OF OPERATION FOR HVAC EQUIPMENT

- A. Sequence of operation for Gas-Fired, outdoor, commercial power-vented packaged duct furnace:
 - 1. The Gas-Fired, outdoor, packaged commercial power-vented duct furnace shall operate continuously (24/7) to provide make-up air for the ventilation systems and heating during winter conditions. The unit's blower shall only operate to provide unconditioned make-up air when the heating is not needed. Once the indoor air temperature reaches 65 degrees then heat in the unit shall be activated. These units shall be controlled by both temperature and airflow sensors. These units shall be monitored and controlled through the BAS system that shall communicate seamlessly to the existing campus wide BAS system.
 - 2. Provide and install smoke detector in the supply duct of each gas-fired packaged duct furnace. Mechanical sub-contractor shall provide and install smoke detectors. Smoke detectors shall be interlocked with the associated fan/blower. Interlock the smoke detectors to de-energize the gas-fired packaged duct furnace blower/fans if products of combustion are detected. Control contractor shall provide wiring diagram indicating interlocking of equipment listed above to stop fan on actuation of smoke detector.
- B. Sequence of operation for exhaust fans:
 - 1. Exhaust fans shall run continuously to limit overheating of the breeding runs and sustain a minimum 10 Air changes. The fans shall be controlled by both temperature and airflow sensors. Exhaust fans shall be interlocked with the Gas-Fired, outdoor, packaged commercial power-vented duct furnace. VFD's are provided for balancing purposes. These fans shall be monitored and controlled through the BAS system that shall communicate seamlessly to the existing campus wide BAS system.
- C. Transfer from Utility power to Emergency Generator Power:
 - 1. When the utility power fails, the transfer switch (or ATS) detects the change in voltage and frequency. Once the generator is running and stable, the transfer switch automatically (in the case of an ATS) or manually (in the case of a manual

switch) switches the electrical load from the utility power to the generator's power. When utility power returns, the transfer switch monitors the restored power, ensuring it's stable before switching the load back to the utility power source.

3.13 POINTS LIST

A. PHTR -1 & 2:

Supply Fan Start/Stop	DO
Supply Fan Status	DI
Filter DP Sensor	AI
Freeze Stat	DI
Outside Air Temp Sensor	AI
Supply Air Temp Sensor	AI
VFD / Starter Integration	

B. EF-1,2,3, & 4:

Start/Stop	DO
Status	DI
OA Air VFD	AO
VFD BACnet Integration	

END OF SECTION 23 09 00



SECTION 23 31 13 – METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. Section Includes:
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Sheet metal materials.
 - 3. Sealants and gaskets.
 - 4. Hangers and supports.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical System
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.4 SUBMITTALS

- A. Product Data: For each type of the following products:
 - 1. Liners and adhesives.
 - 2. Sealants and gaskets.
- B. Shop Drawings:
 - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 2. Factory- and shop-fabricated ducts and fittings.
 - 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
 - 4. Elevation of top of ducts.
 - 5. Dimensions of main duct runs from building grid lines.
 - 6. Fittings.
 - 7. Reinforcement and spacing.
 - 8. Seam and joint construction.

9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

D. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including but are not limited to the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.
 - g. F/A devices, wi-fi antennas, etc.

E. Welding certificates.

F. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized. (Paint Grip)
 - 3. Aluminum in lieu of coated galvanized is acceptable.
- C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Rolled Mastic Sealant

1. Pressure-Sensitive rolled mastic sealant comprised of a foil facer with butyl adhesive
2. Rolled Mastic Sealant: 2-inch minimum width.
3. Rolled Mastic Sealant: 17-mil thickness; minimum
4. Water Resistant
5. Mold and Mildew Resistant
6. Maximum Pressure Class: 16-inch W.C., positive/negative
7. Service: Indoor and Outdoor
8. Service Temperature: Minus 20 F to 200 F
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum
10. VOC: 0 g/l, EPA Standard Method 24
11. UL 181B-FX

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 16-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
10. UI-181 Listed
11. UL 2818, Green Guard Compliance

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Maximum Static-Pressure Class: 16-inch wg, positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
13. UL-181 Listed

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards.
- C. Install ducts with fewest possible joints.
- D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- H. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- I. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Duct Accessories" for fire and smoke dampers.
- J. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 3. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 4. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 5. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 6. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
 - 7. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
 - 8. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 9. Conditioned Space, Return-Air Ducts: Seal Class C.
- C. Seal all duct penetrations through interior and exterior building walls per 07 92 00 Joint Sealants and Section 09 29 00: 3.5 for a complete penetration seal to the satisfaction of engineer.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Duct straps shall be a minimum 26 gauge galvanized steel construction and have a minimum width of 1".
- C. Building Attachments: Concrete inserts or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for seismic restraints.
- D. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- E. Hangers Exposed to View: Threaded rod and angle or channel supports.

- F. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.
- G. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test the following systems:
 - a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections, selected by Architect from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
 - b. Supply Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - c. Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - d. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - e. Outdoor Air Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 4. Test for leaks before applying external insulation.

5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 6. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
1. Visually inspect duct system to ensure that no visible contaminants are present.
 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.8 DUCT CLEANING

- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. Use service openings for entry and inspection.
1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Duct Accessories" for access panels and doors.
 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 3. Remove and reinstall ceiling to gain access during the cleaning process.
- C. Particulate Collection and Odor Control:
1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
 2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
- D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
 2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
 3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
 4. Coils and related components.
 5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
 6. Supply-air ducts, dampers, actuators, and turning vanes.
 7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within new duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.9 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing."

3.10 DUCT SCHEDULE

A. Supply Ducts:

1. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A
 - c. SMACNA Leakage Class for Rectangular: 3.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.

B. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 1-inch wg.
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.

C. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.

- c. SMACNA Leakage Class for Rectangular: 6
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
 - 2. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6
- D. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel
- E. Elbow Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Velocity 700 fpm or Lower:
 - i. Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - ii. Mitered Type RE 4 without vanes.
 - b. Velocity 700 to 1500 fpm:
 - i. Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - ii. Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - iii. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - i. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - ii. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - iii. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 - 2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
- H. Branch Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.

END OF SECTION 23 31 13



SECTION 23 33 00 – DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. This Section includes the following:
 - 1. Backdraft dampers.
 - 2. Manual volume control dampers.
 - 3. Motorized Dampers.
 - 4. Turning vanes.
 - 5. Duct-mounted access doors and panels.
 - 6. Flexible connectors.
 - 7. Accessories hardware.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.
- B. Product data including details for materials, dimensions of individual components, profiles, and finishes for the following items:
 - 1. Backdraft dampers.
 - 2. Manual volume control dampers.
 - 3. Duct-mounted access panels and doors.
 - 4. Flexible ducts.
- C. Shop drawings from manufacturer detailing assemblies. Include dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection. Detail the following:
 - 1. Special fittings, volume control damper installation (both manual and automatic), and transformers details.
- D. Product Certification: Submit certified test data on dynamic insertion loss; self-noise power levels; and airflow performance data, static pressure loss, and dimensions and weights.

1.4 QUALITY ASSURANCE

- A. NFPA Compliance: Comply with the following NFPA Standards:
 - 1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
 - 2. NFPA 90B, "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.1 BACKDRAFT DAMPERS

- A. Description: Suitable for horizontal or vertical installation.
- B. Frame: 0.063-inch-thick 6063T extruded aluminum.
- C. Blades: 0.025-inch-thick roll-formed aluminum.
- D. Blades: 0.050-inch-thick 6063T extruded aluminum.
- E. Blade Seals: Vinyl.
- F. Blade Axles: Nonferrous.
- G. Tie Bars and Brackets: Aluminum.
- H. Return Spring: Adjustable tension.
- I. Wing-Nut Operator: Galvanized steel, with 1/4-inch galvanized-steel rod.
- J. Adjustable Pressure Controls.
- K. Dampers to be Greenheck EM-30, Ruskin BD6, Pottorff BD-150, or approved equal.

2.2 MANUAL VOLUME CONTROL DAMPERS

- A. General: Provide factory-fabricated volume-control dampers, complete with required hardware and accessories. Stiffen damper blades to provide stability under operating conditions. Provide locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class. Provide end bearings or other seals for ducts with pressure classifications of 3 inches or higher. Extend axles full length of damper blades. Provide bearings at both ends of operating shaft.
- B. Standard Volume Control Dampers: Multiple or single-blade, parallel or opposed-blade design as indicated, standard-leakage rating, with linkage outside of air stream, and suitable for horizontal or vertical applications. Greenheck MDB-15, Ruskin MD-15, Pottorff CD-10 & MD-41, or approved equal.

2.3 MOTORIZED DAMPERS

- A. Mechanical Contractor shall furnish and install motorized dampers as indicated on mechanical and architectural drawings. Damper shall be opposed blade motorized type equivalent to Greenheck Model VCD-23, Ruskin CD36/OB, Pottorff CD-41, or equal. Motorized dampers shall be operated by 120/1/60 electric actuator as indicated on plans. Damper shall be complete with outboard support bearing, blade, and jamb seals. Dampers shall be low - leakage type. Dampers shall go to closed position when units are off unless otherwise noted.

2.4 TURNING VANES

- A. Fabricate turning vanes according to SMACNA HVAC Duct Construction Standards, Figures 2-2 through 2-7.

- B. Manufactured Turning Vanes: Fabricate of 1-1/2-inch-wide, curved blades set at 3/4 inch) on center, support with bars perpendicular to blades set at 2 inches on center, and set into side strips suitable for mounting in ducts.
- C. Acoustic Turning Vanes: Fabricate of airfoil-shaped aluminum extrusions with perforated faces and fiber glass fill.

2.5 DUCT-MOUNTED ACCESS DOORS AND PANELS

- A. General: Provide construction and airtightness suitable for duct pressure class.
- B. Frame: Galvanized sheet steel. Provide with bend-over tabs and foam gaskets.
- C. Door: Double-wall, galvanized sheet metal construction with insulation fill and thickness, number of hinges and locks as indicated for duct pressure class. Provide vision panel where indicated. Provide 1-inch by 1-inch butt hinge or piano hinge and cam latches.
- D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber seals.
- E. Insulation: 1-inch- thick fiber glass or polystyrene foam board.
- F. Access doors shall be Ruskin Model ADH-22, Kees ADH, Pottorff HAD, or approved equal.

2.6 FLEXIBLE CONNECTORS

- A. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL Standard 181, Class 1.
- B. Standard Metal-Edged Connectors: Factory-fabricated with a strip of fabric 3-1/2 inches wide attached to 2 strips of 2-3/4-inch-wide, 24-gage, galvanized sheet steel or 0.032-inch (0.8-mm) aluminum sheets. Select metal compatible with connected duct system. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA HVAC Duct Standard, 1st Edition, Figure 2-19.

2.7 ACCESSORIES HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket and a flat mounting gasket. Size to allow insertion of pilot tube and other testing instruments and provide in length to suit duct insulation thickness.
- B. Splitter Damper Accessories: Zinc-plated damper blade bracket, 1/4-inch, zinc-plated operating rod, and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.
- C. Flexible Duct Clamps: Stainless steel band with cadmium-plated hex screw to tighten band with a worm-gear action. Provide in sizes from 3 to 18 inches to suit duct size.
- D. Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline and grease.
- E. Provide all necessary transformers, electrical components suitable for each system installation including duct damper controllers, fire dampers and smoke dampers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of duct accessories. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install duct accessories according to manufacturer's installation instructions and applicable portions of details of construction as shown in SMACNA standards.
- B. Install volume control dampers in lined duct with methods to avoid damage to liner and to avoid erosion of duct liner.
- C. Provide test holes at fan inlet and outlet and elsewhere as indicated.
- D. Install fire and smoke dampers according to the manufacturer's UL-approved printed instructions.
- E. Label access doors according to Division 23 for "Mechanical Identification."

3.3 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Final positioning of manual dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 23 33 00



SECTION 23 34 23 - 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 down-blast fans.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
 - 2. Rated capacities, operating characteristics, and furnished specialties and accessories.
 - 3. Certified fan performance curves with system operating conditions indicated.
 - 4. Certified fan sound-power ratings.
 - 5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 6. Material thickness and finishes, including color charts.
 - 7. Dampers, including housings, linkages, and operators.
 - 8. Prefabricated roof curbs.
 - 9. Fan speed controllers.
- 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.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Loren Cook.
 - 2. GREENHECK.
 - 3. ACME
 - 4. Loren Cook Company.
 - 5. PennBarry.
 - 6. Twin City.

2.2 CENTRIFUGAL ROOF DOWNBLAST FANS

- A. Fan shall be a spun aluminum, roof mounted, direct driven, down-blast centrifugal exhaust ventilator.
- B. Certifications: Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.
- C. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The discharge baffle shall have a rolled bead for added strength. An integral conduit chase shall be provided through the curb cap and into the motor compartment to facilitate wiring connections. The motor shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM and static pressure. Unit shall be shipped in ISTA certified transit tested packaging.
- D. Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision machined cast aluminum hub. An aerodynamic aluminum inlet cone shall be provided for maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans.
- E. Motor shall be NEMA design B with a minimum of class B insulation rated for continuous duty and furnished at the specified voltage, phase and enclosure.
- F. Prefabricated 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. Manufactured to accommodate roof slope.
 - 2. Overall Height: 13.5". Coordinate with General Contractor and Architect prior to Ordering.
 - 3. Sound Curb: Curb with sound-absorbing insulation.
 - 4. Hinged sub-base to provide access to damper or as cleanout for grease applications.
 - 5. Burglar Bars: 1/2-inch-thick steel bars welded in place to form 6-inch squares.
 - 6. Pitch Mounting: Manufacture curb for roof slope.
 - 7. Metal Liner: Galvanized steel.

2.3 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 05 13 "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. Fan motors are to be rated for VFD's.

2.4 SOURCE QUALITY CONTROL

- 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. AMCA Certification: Fans shall comply with AMCA 11 and bear the AMCA-Certified Ratings Seal.
- C. Fan Sound Ratings: Comply with AMCA 311, and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.
- D. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.
- E. Operating Limits: Classify according to AMCA 99.
- F. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

PART 3 - EXECUTION

3.1 INSTALLATION OF HVAC POWER VENTILATORS

- A. Install power ventilators level and plumb.
- B. Secure roof-mounted fans to roof curbs with zinc-plated hardware.
- C. Install units with clearances for service and maintenance.
- D. Label units with engraved aluminum nameplate. Nameplate shall include the make, model, date of installation, design CFM and static pressure.
- E. For fans installed on metal roofs, coordinate roof curb with the shape profiles of the roof panels. Provide custom color prefinished galvalume exterior cladding on the exterior or the roof curb. Coordinate color of the custom-colored cladding with the Architect.

3.2 DUCTWORK CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.

3.3 ELECTRICAL CONNECTIONS

- A. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.

3.5 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.

- C. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain ventilator fans.

END OF SECTION 23 34 23



SECTION 23 37 13 – DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary, and other Conditions) and Division 00 and 01 as appropriate, apply to the Work specified in this Section.
- B. Refer to all Sections, as well as the Specifications for the other various trades and materials and be thoroughly familiar with all provisions regarding all work.

1.2 SCOPE OF WORK

- A. Section Includes:
 - 1. Adjustable bar, registers and grilles
 - 2. Eggcrate grille

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.
- C. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.
- D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Duct access panels.
 - a. Source quality-control reports.

PART 2 - PRODUCTS

2.1 REGISTERS AND GRILLES

- A. Adjustable Bar Register:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - i. Anemostat Products
 - ii. Krueger
 - iii. METALAIRE, Inc.
 - iv. Nailor Industries Inc.
 - v. Price Industries
 - vi. Titus
- 2. Material: Aluminum.
- 3. Finish: Baked enamel, white.
- 4. Face Blade Arrangement: Horizontal spaced 3/4 inches apart.
- 5. Core Construction: Removable.
- 6. Rear-Blade Arrangement: Vertical spaced 3/4 inch apart.
- 7. Frame: 1 inch wide.
- 8. Mounting Frame: Filter
- 9. Mounting: Countersunk screw or Lay in.
- 10. Damper Type: Adjustable opposed blade.
- 11. Accessories:
 - a. Front-blade gang operator.

B. Adjustable Bar Grille:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - i. Anemostat Products
 - ii. Krueger
 - iii. METALAIRE, Inc.
 - iv. Nailor Industries Inc.
 - v. Price Industries
 - vi. Titus
 - 2. Material: Aluminum
 - 3. Finish: White baked enamel, unless noted otherwise.
 - 4. Face Blade Arrangement: Horizontal spaced 3/4 inches apart.
 - 5. Core Construction: Integral
 - 6. Rear-Blade Arrangement: Vertical spaced 3/4 inch apart.
 - 7. Frame: 1 inch wide.
 - 8. Mounting: Countersunk screw or Lay in.

C. Eggcrate Grille:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - i. Anemostat Products
 - ii. Krueger
 - iii. METALAIRE, Inc.
 - iv. Nailor Industries Inc.
 - v. Price Industries
 - vi. Titus
 - 2. Material: Aluminum Grid and border.

3. Finish: White baked enamel, unless noted otherwise. Finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes.
4. Mounting: Countersunk screw
5. Return grilles must provide a free area of at least 90%.
6. Outer borders shall be constructed of heavy extruded aluminum with a thickness of 0.040-0.050 inch and shall have countersunk screw holes for a neat appearance.
7. Border width shall be 1¼ inches on all sides and shall be interlocked at the four corners and mechanically staked to form a rigid frame.
8. Aluminum grid shall be ½ x ½ x ½ inch.
9. The manufacturer shall provide published performance data for the grille.
10. The grille shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

2.2 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13



SECTION 23 80 00 – GAS-FIRED, OUTDOOR, COMMERCIAL
POWER-VENTED PACKAGED DUCT FURNACE

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Gas-Fired, outdoor, commercial power-vented packaged duct furnace shall be used to provide make-up air to the building year-round 24 hours a day, 7 days a week. During winter conditions the unit will be used to provide heating to the building.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of design is Reznor model series RPBL. Other acceptable manufacturers include Modine, and Sterling. All other manufacturers shall be prior approved equal.

2.2 GENERAL

A. Description:

1. Systems shall be approved for outdoor use.
2. Systems are to be provided for use of natural gas.
3. Each unit shall be equipped with all required limit safety controls.
4. Systems are to be completely weather sealed. No additional protective covering are to be required. Each packaged unit is designed for installation on a full roof curb or field supplied supports.
5. Units shall feature an integral power vented system.

B. Certification:

1. These packaged systems include duct furnaces that are design-certified to ANSI and CSA standards by the Canadian Standards Association and that are approved for installation in the United States and in Canada. The furnaces are approved for use with either natural gas or propane. The type of gas for which the furnace is equipped, the correct firing rate, and electrical requirements are shown on the unit's rating plate.
2. These gas-fired products are certified by ANSI Z83 family of standards governing the safe usage of heating equipment in the industrial/commercial marketplace. This includes using the heaters in makeup air applications to supply corridor pressurization in commercial buildings such as office structures and apartment complexes.
3. The heaters are not certified as residential heating equipment and should not be used as such.

C. Installation Codes:

1. Units must be installed in accordance with local building codes. In the absence of local codes, in the United States, the unit must be installed in accordance with the National Fuel Gas Code (ANSI Z223 .1, latest edition). Local authorities having jurisdiction should be consulted before installation is made to verify local codes and installation procedure requirements.

D. Curb Cap Base:

1. Units are equipped with a load bearing curb cap that forms an integral part of the unit. The curb cap is welded at all joints.
2. The curb cap has a skirt that fits over a roof curb to provide a weatherproof installation. Four holes are provided at the curb cap corners for lifting the unit. These holes do not interfere with unit weatherproofing. The curb cap is not designed to be placed directly on the roof surface. The system may be mounted on an optional roof curb purchased with the unit, a field-supplied roof curb, or field-supplied supports. If the system has a downturn plenum and/or a bottom return air opening, a roof curb is recommended to provide a weatherproof installation as well as more workable clearances for ductwork.
3. Refer to the installation manual for further information on curb dimensions, assembly, and installation.

E. Venting Requirements:

1. Locate power-vented furnaces so that flue discharge is not directed at fresh air inlets. The flue discharge openings are located on the side of the furnace just above the control access panel. The position of this opening discourages recirculation of combustion products and provides for furnace operation in all normal weather conditions.
2. Vertical flue discharge: These power vented furnaces are certified with 4 feet of vertical pipe connected. The distance is measured from the top of the unit to the bottom of the vent cap. The vent pipe and supports are field-supplied. Vertical vent piping provides compliance with local codes that require either 10-foot horizontal or 4-foot vertical clearance between the flue outlet and the fresh air intake of the heating system and/or building.

F. Gas Supply Pressure:

1. The unit is equipped for a maximum gas supply pressure of 1/2 psi, 3.5 kPa, or 14 IN WC.

G. Disconnect Switch:

1. TA disconnect switch is a required part of this installation. Switches are available as options or parts or may be supplied locally. When ordered as an optional component, the disconnect switch is shipped separately. The disconnect switch may be fusible or non-fusible. When providing or replacing fuses in a fusible disconnect switch, use dual element time delay fuses and size according to 1.25 × maximum total input amps. When installing, ensure that the conduit and switch housing are clear of furnace panels and inspection plates. Allow at least 4 feet (1.2 meters) of service room between the switch and removable panels. Refer to the installation manual for further information on electrical connections.

H. Standard Features:

1. Orifices for Natural Gas.
2. Aluminized steel burners with stainless steel insert
3. 208-volt power supply
4. 24-volt control transformer
5. Redundant single-stage combination gas valve on each furnace
6. Intermittent spark pilot
7. Fan and limit safety controls
8. Reverse air flow limit
9. Fan and limit safety controls

10. Pre-wired to terminal blocks
11. Power venter
12. Twin centrifugal blowers with adjustable belt drive
13. Galvanized steel cabinet with interlocking joint construction
14. Horizontal discharge air opening with duct flanges
15. Curb cap base with hangers for suspension
16. Blower cabinet (less optional insulation, filter rack and filters) with horizontal inlet-air opening.

I. Optional Features – Factory Installed:

1. E-3 (409) stainless steel heat exchanger
2. E-3 (409) stainless steel burners
3. E-3 (409) stainless steel drip pan
4. Intermittent spark safety pilot with timed lockout
5. Two-stage gas control on each furnace section.
6. Effective 2 to 6 stage gas control
7. Electronic modulation 50%-100% turndown or 20%-100% turndown
8. Variable frequency drive with open drip proof or totally enclosed motor.
9. VFD control options: Soft Start, Two speed control, & DDC signal from remote device.
10. Makeup air control/dampers
11. 1 HP through 20 HP open drip-proof or totally enclosed motors available (motors meet EISA specifications for efficiency)
12. Firestat(s)
13. Freezestat
14. Convenience outlet
15. Filter rack with filters (2" disposable, permanent or pleated)
16. Double wall cabinet construction
17. GAP, FM manifold arrangements
18. High ambient burner cutoff
19. Gas pressure safety switches
20. Air flow proving switch.
21. Right side controls (facing airstream) – Verfiy in Field

J. Optional Provided (Options codes are for the Reznor Heater - basis of design):

1. AA1 Unit equipped for natural gas heating. Natural gas is a naturally occurring gas mixture consisting primarily of methane and includes varying volumes of alkanes, carbon dioxide, nitrogen, and hydrogen sulfide.1, Therm = 100,000 BTU = 29.3kWh.
2. AB1 Burner orifices for elevations 0-2000 Feet.
3. AC2 Heat exchanger is manufactured from die-formed halves of 409 E-3 Stainless Steel. Design for improved corrosion resistance over standard heat exchanger material.
4. AD1 Unit has steel die-formed atmospheric burners constructed with 409 E-3 stainless steel ribbon inserts. Burners are designed with a die-formed flared venturi inlet port. Units are provided with aluminized steel burner body construction.
5. AE1 Standard Burner no air shutters.
6. AF1 Burner drip pan and unit bottom panel of aluminized steel are provided to manage condensation from heat exchanger cells.
7. AG21 Gas controls designed for makeup air heating applications. Furnace is provided with a 24-volt, electronic modulating gas valve which provides for firing rates between 50% and 100%. The valve is controlled by an electronic signal

conditioner that uses a direct digital control signal of either 4-20 mA., or 0-10 Volts, provided by an external D.D.C. system.

8. AH2 Spark-ignited, intermittent safety pilot with electronic flame supervision.
9. AJ1 Left side control location facing airstream standard.
10. AK5 208 Volt, Three Phase, 60 cycle supply voltage.
11. AL27 5 HP 3600 RPM totally enclosed motor.
12. AM13 Fan/drive at 1001-1050 RPM.
13. AN10 Motor starter, IEC open, for single-speed motors.
14. AQ2 Horizontal Air Discharge.
15. AR1 100% O/A Makeup -- Constant Supply Air Volume, Horizontal Discharge.
16. AY3 Double wall cabinet construction, solid liner with insulation.
17. BY1 Units to be supplied from factory certified by AGA and US standards of ANSI.
18. DR2 Adjustable V-Belt Drive Blower
19. PC0 Standard Motor/Blower Mount
20. SH2 Ship Via LTL crate unit
21. ZZ0 Unit has no cooling provided.
22. Thermostat guard with locking cover.

PART 3 - EXECUTION

3.1 START-UP SERVICES

- A. Installation of gas-fired packaged units and all its components, accessories, etc. shall be in compliance and in accordance with manufacturer's instructions, drawings, and recommendations.

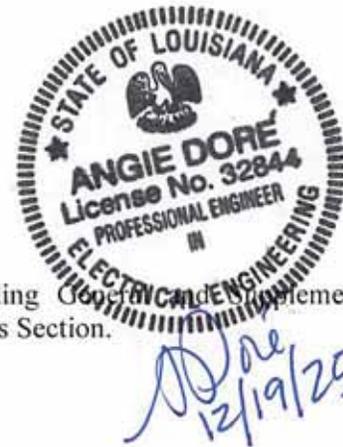
3.2 WARRANTY

- A. Manufacturer product limited warranty:
 1. Manufacturer warrants the original owner-user that this product will be free from defects in material and workmanship. This warranty is limited to twelve (12) months from the date of original installation, whether or not actual use begins on that date, or eighteen (18) months from date of shipment, whichever occurs first.
- B. Manufacturer Replacement Part Limited Warranty:
 1. Manufacturer warrants replacement parts of thirty (30) days after installation or thirteen (13) months from date of shipment, whichever occurs first.
- C. Manufacturer Extended Warranty on Heat Exchanger
 1. Extended nine (9) years for a total of (10), non-prorated warranty on heat exchanger shall be provided.

END OF SECTION 23 80 00

SECTION 264313 - TRANSIENT VOLTAGE SUPPRESSION

PART 1 - GENERAL



1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes transient voltage surge suppressors for low-voltage power, control, and communication equipment.
- B. Related Sections include the following:
 - 1. Division 26 Section "Panelboards" for factory-installed transient voltage surge suppressors.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
- B. Maintenance Data: For transient voltage suppression devices to include in maintenance manuals specified in Division 1.
- C. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.
- B. 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.

1.5 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two weeks in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.

- B. Service Conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:
1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
 2. Operating Temperature: 30 to 120 deg F.
 3. Humidity: 0 to 85 percent, noncondensing.
 4. Altitude: Less than 20,000 feet above sea level.

1.6 COORDINATION

- A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance. Integrate mount as direct buss connected to panelboards.

1.7 WARRANTY

- A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

1.8 EXTRA MATERIALS

- 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.
1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 SERVICE ENTRANCE SUPPRESSORS:

- A. Surge Protective Device Description: Modular design with field-replaceable modules and the following features and accessories:
1. Fabrication using bolted compression lugs for internal wiring.
 2. Integral disconnect switch.
 3. Redundant suppression circuits.
 4. Redundant replaceable modules.
 5. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 6. Red and green LED indicator lights for power and protection status.
 7. Audible alarm, with silencing switch, to indicate when protection has failed.
 8. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
 9. Surge-event operations counter.
- B. Peak Single-Impulse Surge Current Rating: 400 kA per phase or as per plans

- C. Connection Means: Permanently wired directly to buss with integral disconnect means.
- D. Protection modes clamping voltage for grounded wye circuits with voltages of 480Y/277 and 208Y/120; 3-phase, 4-wire circuits, shall be as follows:
 - 1. Line to Neutral: 800 V for 480Y/277 and 400 V for 208Y/120.
 - 2. Line to Ground: 800 V for 480Y/277 and 400 V for 208Y/120.
 - 3. Neutral to Ground: 800 V for 480Y/277 and 400 V for 208Y/120.

2.2 CONTROL AND DATA TERMINALS

- A. Protectors for copper data and telephone conductors entering the building from the outside shall be as recommended by the manufacturer for the type of line being protected.

2.3 ENCLOSURES

- A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTIVE DEVICES

- A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.
- B. Install devices for panelboard and auxiliary panels with conductors between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
 - 1. Connect directly to buss at panelboards.

3.2 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values

3.3 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
 - 1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with requirements.
 - 2. Complete startup checks according to manufacturer's written instructions.
 - 3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.19. Certify compliance with test parameters.
- B. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

- C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 - 1. Verify that electrical wiring installation complies with manufacturer's installation requirements.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain surge protective devices.
 - 1. Train Owner's maintenance personnel on procedures and schedules for maintaining suppressors.
 - 2. Review data in maintenance manuals. Refer to Specification Section "Contract Closeout".
 - 3. Review data in maintenance manuals. Refer to Specification Section "Operation and Maintenance Data".
 - 4. Schedule training with Owner, through Architect, with at least seven days' advance notice. Include one hour of training for owners team.

END OF SECTION 264313

SECTION 262816 - ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.



1.2 SUMMARY

- A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
 1. Fusible switches.
 2. Nonfusible switches.
 3. Molded-case circuit switches.
 4. Molded-case switches.
 5. Enclosures.

1.3 DEFINITIONS

- A. GD: General duty.
- B. GFCI: Ground-fault circuit interrupter.
- C. HD: Heavy duty.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 1. Enclosure types and details for types other than NEMA 250, Type 1.
 2. Current and voltage ratings.
 3. Short-circuit current rating.
 4. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- B. Shop Drawings: Diagram power, signal, and control wiring.

- C. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - 2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.5 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. Comply with NFPA 70.
- C. 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.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.

1.7 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 EXTRA MATERIALS

- 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.
 - 1. Spares: For the following:
 - a. Fuses for Fusible Switches: 1% but not less than one of each type.
 - b. Fuses for Fused Power Circuit Devices: 1% but not less than one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Manufacturers:
 - 1. Square D/Group Schneider.
 - 2. Eaton
- B. Fusible Switch, 1200 A and Smaller: NEMA KS 1, Type HD, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Nonfusible Switch, 1200 A and Smaller: NEMA KS 1, Type HD, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- D. 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; and labeled for copper and aluminum neutral conductors.
 - 3. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

- B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.
- C. Comply with mounting and anchoring requirements specified in Division 26 Section "Seismic Controls for Electrical Work".
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.4. IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification".
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Electrical Identification",

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.
 - 1. Inspect mechanical and electrical connections.
 - 2. Verify switch and relay type and labeling verification.
 - 3. Verify rating of installed fuses.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Infrared Scanning:
 - c. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Open or remove doors or panels so connections are accessible to portable scanner.
 - d. Follow-Up Infrared Scanning: Perform an additional follow-up infrared scan of each unit 11 months after date of Substantial Completion.
 - e. Instruments, Equipment and Reports:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 2) Prepare a certified report that identifies enclosed switches and circuit breakers included and describes scanning results. Include notation of

deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Set field-adjustable switches.

3.7 CLEANING

- A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.
- B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 262816

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:

1. Single and duplex receptacles, ground-fault circuit interrupters, integral surge suppression units, and isolated-ground receptacles.
2. Single- and double-pole snap switches and dimmer switches.
3. Device wall plates.
4. Receptacles

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. PVC: Polyvinyl chloride.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Field quality-control test reports.

1.5 QUALITY ASSURANCE



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- A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.
- B. 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.
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Wiring Devices:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. Leviton Mfg. Company Inc.
 - c. Pass & Seymour/Legrand; Wiring Devices Div.

2.2 RECEPTACLES

- A. Straight-Blade-Type Receptacles: (Leviton 5362 or approved equal) Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498.
- B. Straight-Blade and Locking Receptacles: Heavy-Duty grade.
- C. GFCI Receptacles: Straight blade, non-feed-through type, Heavy-Duty grade, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch- deep outlet box without an adapter. (Leviton Model # GFNT2 or approved equal)

2.3 SWITCHES (Leviton Models 1221-2,1222-2,1223-2 and 1224-2 or approved equal)

- A. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20.
- B. Snap Switches: Heavy-Duty grade, quiet type.

- C. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.
 - 1. Switch: 20 A, 120/277-V ac.
 - 2. Receptacle: NEMA WD 6, Configuration 5-15R.
- 2.4 WALL PLATES (Hubbell, Leviton or approved equal)
 - A. Single and combination types to 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.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 2. Material for Wet Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
- 2.5 FINISHES
 - A. Color:
 - 1. Wiring Devices Connected to Normal Power System: **As selected by Architect, unless otherwise indicated or required by NFPA 70.**

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install devices and assemblies level, plumb, and square with building lines.
- B. Install wall dimmers to achieve indicated rating after derating for ganging according to manufacturer's written instructions.
- C. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' written instructions.
- D. 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.
- E. Remove wall plates and protect devices and assemblies during painting.
- F. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Electrical Identification."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding."
- B. Connect wiring according to Division 26 Section "Conductors and Cables."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
 2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
- B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 262726

SECTION 260533 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 26 Section "Basic Electrical Materials and Methods" for supports, anchors, and identification products.
 - 2. Division 26 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. RNC: Rigid nonmetallic conduit.
- E. LFMC: Liquidtight flexible metal conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: Show fabrication and installation details of components for raceways, fittings, boxes, enclosures, and cabinets.
- C. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:
 - 1. Ceiling suspension assembly members.



2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

1.5 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. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 METAL CONDUIT AND TUBING

- A. Manufacturers:
 1. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
 2. LTV Steel Tubular Products Company.
 3. O-Z Gedney; Unit of General Signal.
 4. Wheatland Tube Co.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Aluminum Rigid Conduit: ANSI C80.5.
- D. IMC: ANSI C80.6.
- E. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.

- F. Plastic-Coated IMC and Fittings: NEMA RN 1.
- G. EMT and Fittings: ANSI C80.3.
 - 1. Fittings: Compression type.
- H. LFMC: Flexible steel conduit with PVC jacket.
- I. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.3 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers:

- 1. American International.
- 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
- 3. Arnco Corp.
- 4. Cantex Inc.
- 5. Certainteed Corp.; Pipe & Plastics Group.
- 6. Condux International.
- 7. ElecSYS, Inc.
- 8. Lamson & Sessions; Carlon Electrical Products.
- 9. Manhattan/CDT/Cole-Flex.
- 10. RACO; Division of Hubbell, Inc.
- 11. Thomas & Betts Corporation.

- B. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

2.4 METAL WIREWAYS

A. Manufacturers:

- 1. Hoffman.
- 2. Square D.
- 3. Wiegman

- B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 3R.

- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

- D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

- E. Wireway Covers: Screw-cover type.
- F. Finish: Manufacturer's standard enamel finish.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. Emerson/General Signal; Appleton Electric Company.
3. Erickson Electrical Equipment Co.
4. Hoffman.
5. Hubbell, Inc.; Killark Electric Manufacturing Co.
6. O-Z/Gedney; Unit of General Signal.
7. RACO; Division of Hubbell, Inc.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet-PLM Division.
10. Spring City Electrical Manufacturing Co.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

D. Floor Boxes: Cast metal, fully adjustable, rectangular. On grade listed.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

G. Hinged-Cover Enclosures: EMA 250, Type 1, with continuous hinge cover and flush latch.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

H. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.6 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors:

1. Exposed: Rigid steel or IMC.
2. Concealed: Rigid steel or IMC.
3. Underground, Single Run: RNC.
4. Underground, Grouped: RNC.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
6. Boxes and Enclosures: NEMA 250, Type 3R.

B. Indoors:

1. Exposed: EMT.
2. Concealed: EMT.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): except use LFMC in damp or wet locations.
4. Damp or Wet Locations: Rigid steel conduit.
5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:

- a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.

C. Minimum Raceway Size: 1/2-inch trade size above grade, 3/4" C min below grade

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

E. Do not install aluminum conduits embedded in or in contact with concrete unless properly protected where routed through or in concrete.

3.2 INSTALLATION

- A. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- B. Complete raceway installation before starting conductor installation.
- C. Support raceways as specified in Division 26 Section "Basic Electrical Materials and Methods."
- D. Install temporary closures to prevent foreign matter from entering raceways.
- E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

- F. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
 - 1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- H. Raceways Below Slabs: Do not install raceways embedded in slabs.
 - 1. Secure raceways to reinforcing rods to prevent sagging or shifting, using stainless steel straps.
 - 2. Space raceways laterally to prevent voids in concrete.
 - 3. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 4. Change from nonmetallic tubing to rigid steel conduit, or IMC before rising above the floor.
- I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
 - 1. Run parallel or banked raceways together on common supports.
 - 2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- J. Join raceways with fittings designed and approved for that purpose and make joints tight.
 - 1. Use insulating bushings to protect conductors.
- K. Terminations:
 - 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 - 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- L. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- M. Telephone and Signal System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
- N. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box

with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where otherwise required by NFPA 70.
- O. **Stub-up Connections:** Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
- P. **Flexible Connections:** Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, install jbox above each fixture to transition from conduit to flex; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections at all instances.
- Q. **Surface Raceways:** Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
- R. Set floor boxes level and flush with finished floor surface.
- S. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.3 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

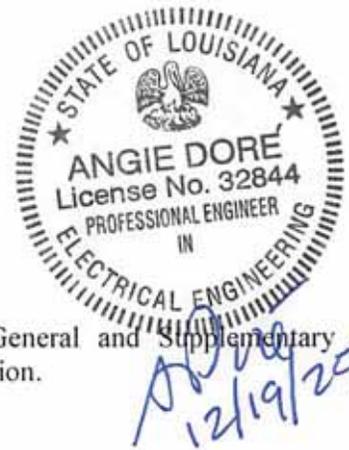
3.4 CLEANING

- A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 260533

SECTION 260553 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL



1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Schedule of Nomenclature: An index of electrical equipment and system components used in identification signs and labels.
- C. Samples: For each type of label and sign to illustrate color, lettering style, and graphic features of identification products.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

- A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
 - 1. Color: Black letters on orange field.
 - 2. Legend: Indicates voltage and service.
- B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend overlaminated with a clear, weather- and chemical-resistant coating.

- C. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.
 - 1. Not less than 6 inches wide by 4 mils thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed legend indicating type of underground line.
- D. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- E. Aluminum, Wraparound Marker Bands: Bands cut from 0.014-inch- thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- F. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.

2.2 NAMEPLATES AND SIGNS

- A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
- C. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for the application. 1/4-inch grommets in corners for mounting.
- D. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength: 50 lb minimum.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: According to color-coding.
- B. Paint: Formulated for the type of surface and intended use.
 - 1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.

2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.
- C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.
- D. Install painted identification according to manufacturer's written instructions and as follows:
 1. Clean surfaces of dust, loose material, and oily films before painting.
 2. Prime surfaces using type of primer specified for surface.
 3. Apply one intermediate and one finish coat of enamel.
- E. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below:
 1. Bands: Pretensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
 2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.
- G. Circuit Identification Labels on Boxes: Install labels externally.
 1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
 2. Concealed Boxes: Plasticized card-stock tags.
 3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent including voltage.
- H. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches

overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

- I. Color-Coding of Secondary Phase Conductors: Use the following colors for service, feeder and branch-circuit phase conductors:
 1. 208/120-V and 240/120-V Conductors:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 2. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:
 - a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch-wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
 - b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.
- J. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, manholes, and switchboard rooms.
 1. Legend: 1/4-inch- steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
 2. Tag Fasteners: Nylon cable ties.
 3. Band Fasteners: Integral ears.
- K. Apply identification to conductors as follows:
 1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
 2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
 3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.
- L. Apply warning, caution, and instruction signs as follows:
 1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed

- for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch- high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.
 3. The arc flash labels are required to be printed in such a way or on such a medium that they are impervious to liquids and other environmental damage.
- M. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch- high lettering on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:
1. Panelboards, electrical cabinets, and enclosures.
 2. Access doors and panels for concealed electrical items.
 3. Electrical switchgear and switchboards.
 4. Disconnect switches.
 5. Enclosed circuit breakers.
 6. Power transfer equipment.
 7. Contactors.
 8. Dimmers.
 9. Control devices.
 10. Transformers.

END OF SECTION 260553

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SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

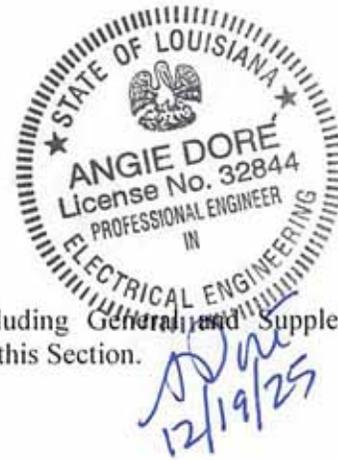
- A. This Section includes the following:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RFI: Radio-frequency interference.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 1.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of panelboards and overcurrent protective devices.
 - d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.



2. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports including the following:
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
 - D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
 - E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals.
 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.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated
- C. 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.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 1. Ambient Temperature: Not exceeding 104 deg F.
 2. Altitude: Not exceeding 6600 feet.

1.7 COORDINATION

- 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, and encumbrances to workspace clearance requirements.

1.8 EXTRA MATERIALS

- 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.
 - 1. Keys: Six spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - a. Square D.
 - b. Eaton.
 - c. ABB

2.2 MANUFACTURED UNITS

- A. Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1.
 - 1. Rated for environmental conditions at installed location.
 - a. Outdoor Locations: NEMA 250, Type 3R.
 - b. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
 - 4. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.
- B. Phase and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
- C. Conductor Connectors: Suitable for use with conductor material.

1. Main and Neutral Lugs: Compression type.
 2. Ground Lugs and Bus Configured Terminators: Compression type.
- D. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.
- 2.3 PANELBOARD SHORT-CIRCUIT RATING
- A. Fully rated to interrupt symmetrical short-circuit current available at terminals.
- 2.4 DISTRIBUTION PANELBOARDS
- A. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- B. Main Overcurrent Protective Devices: Circuit breaker.
- C. Branch Overcurrent Protective Devices:
1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
 2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers
- 2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS
- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- 2.6 OVERCURRENT PROTECTIVE DEVICES
- A. Molded-Case Circuit Breaker: 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. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 4. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
4. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
5. Multipole units enclosed in a single housing or factory-assembled to operate as a single unit.

2.7 ACCESSORY COMPONENTS AND FEATURES

- A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mount top of trim 74 inches above finished floor, unless otherwise indicated.
- C. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- D. Install overcurrent protective devices and controllers.
 1. Set field-adjustable switches and circuit-breaker trip ranges. Per coordination study 260573.
- E. Install filler plates in unused spaces.
- F. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.
- G. Arrange conductors in gutters and within panelboard into associated circuit groups and bundle and wrap with wire ties after completing load balancing.
- H. **ALL panel cans and covers with-in the same space shall be the same height.**

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."

- B. Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Provide room being served identification for each circuit.
- C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding."
- B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 4. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 5. Test continuity of each circuit.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- C. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
- 6. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
- 7. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.
- E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 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 panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 262416

SECTION 260526 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements described in other Sections.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Data: For the following:
 - 1. Ground rods.
- B. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- C. Field Test Reports: Submit written test reports to include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.



1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.
- B. 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.
 - 1. Comply with UL 467.

- C. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.
- D. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Grounding Conductors, Cables, Connectors, and Rods:
 - a. Apache Grounding/Erico Inc.
 - b. Boggs, Inc.
 - c. Chance/Hubbell.
 - d. Copperweld Corp.
 - e. Dossert Corp.
 - f. Erico Inc.; Electrical Products Group.
 - g. Framatome Connectors/Burndy Electrical.
 - h. Galvan Industries, Inc.
 - i. Ideal Industries, Inc.
 - j. ILSCO.
 - k. Kearney/Cooper Power Systems.
 - l. Korns: C. C. Korns Co.; Division of Robroy Industries.
 - m. Lyncole XIT Grounding.
 - n. O-Z/Gedney Co.; a business of the EGS Electrical Group.
 - o. Raco, Inc.; Division of Hubbell.
 - p. Salisbury: W. H. Salisbury & Co.
 - q. Superior Grounding Systems, Inc.
 - r. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section "Conductors and Cables."
- B. Material: Copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. Grounding Electrode Conductors: Stranded cable.
- E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- F. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B 3.
2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

G. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

H. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.
- C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.
- D. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- E. Wirenuts to be used with equipment grounding conductors.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Sectional type; **copper-clad** steel.
 1. Size: 3/4 by 120 inches in diameter.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. In raceways, use insulated equipment grounding conductors.

- C. Exothermic-Welded Connections: Use for connections to structural steel, ground rods and for underground connections, except those at test wells.
- D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- E. Ground Rod Clamps at Test Wells: Use bolted pressure clamps with at least two bolts.
- F. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Use insulated spacer; space 1 inch from wall and support from wall 18 inches above finished floor, unless otherwise indicated.
- G. Underground Grounding Conductors: Use copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade

3.2 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all feeders and branch circuits.
- C. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.
- D. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
- E. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 12 slot copper grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- F. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

3.3 INSTALLATION

- A. Ground Rods:

1. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated. Provide test well at ground rod at main service location flush with concrete.
 2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
- B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
- E. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
- F. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.
- G. Install one test well for each service at the ground rod electrically closest to the service entrance. Set top of well flush with finished grade or floor.

Propose location by contractor for engineer review in counterpoise shop drawings.

3.4 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- E. Connections at Test Wells: Use compression-type connectors on conductors and make bolted-and clamped-type connections between conductors and ground rods.
- F. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
 - 1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
 - 2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.
 - 3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
 - a. Equipment Rated 500 kVA and Less: 10 ohms.
 - b. Equipment Rated 500 to 1000 kVA: 5 ohms.

- c. Equipment Rated More Than 1000 kVA: 3 ohms.
 - d. Substations and Pad-Mounted Switching Equipment: 5 ohms.
 - e. Manhole Grounds: 10 ohms.
4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.6 GRADING AND PLANTING

- A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 2 Section "Landscaping." Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION 260526

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following lighting control devices:

- 1. Time switches.
- 2. Outdoor photoelectric switches.

- B. Related Sections include the following:

- 1. Division 26 Section "Wiring Devices" for manual light switches.

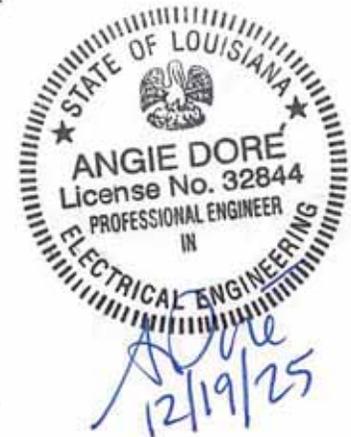
1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Lighting plan showing location, orientation, and coverage area of each sensor.
 - 2. Interconnection diagrams showing field-installed wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For each type of product 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, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

- A. Line-Voltage Surge Protection: An integral part of the devices for 120- and 277-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.

2.3 TIME SWITCHES

- A. Manufacturers:
 - 1. Area Lighting Research, Inc.
 - 2. Fisher Pierce.
 - 3. Grasslin Controls Corporation.
 - 4. Intermatic, Inc.
 - 5. Leviton Mfg. Company Inc.
 - 6. Lightolier Controls; a Genlyte Company.
 - 7. Lithonia Lighting.
 - 8. Paragon Electric Co.
 - 9. Square D.
 - 10. TORK.
 - 11. Touchplate Technologies, Inc.
 - 12. Watt Stopper (The).
- B. Digital Time Switches: Electronic, solid-state programmable units with alphanumeric display complying with UL 917.

1. Contact Configuration: As indicated.
2. Contact Rating: As indicated.
3. Program: Single channel, on-off set points on a 24-hour schedule with skip-a-day weekly schedule.
4. Circuitry: Allow connection of a photoelectric relay as substitute for on and off function of a program.
5. Astronomical Time: All channels.
6. Battery Backup: For schedules and time clock.

2.4 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers:

1. Area Lighting Research, Inc.
2. Fisher Pierce.
3. Grasslin Controls Corporation.
4. Intermatic, Inc.
5. Lithonia Lighting.
6. Novitas, Inc.
7. Paragon Electric Co.
8. Square D.
9. TORK.
10. Touchplate Technologies, Inc.
11. Watt Stopper (The).

B. Description: Solid state, with DPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, microprocessor input, and complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: 15-second minimum, to prevent false operation.
3. Surge Protection: Metal-oxide varistor type, complying with IEEE C62.41 for Category A1 locations.
4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the North sky exposure.

2.6 CONDUCTORS AND CABLES

- ### A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG, complying with Division 26 Section "Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Conductors and Cables." Minimum conduit size shall be ½ inch.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
- 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.
- F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Electrical Identification."
- B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Verify actuation of each sensor and adjust time delays.
- B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

END OF SECTION 260923

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SECTION 26 05 73.19 – OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

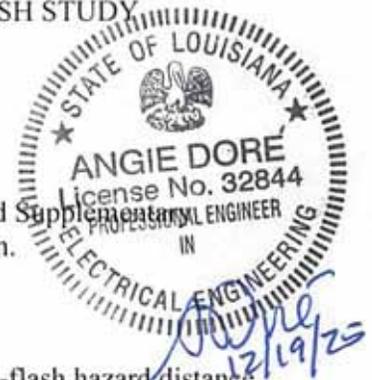
- A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment for all new electrical gear.

1.3 DEFINITIONS

- A. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- D. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
- E. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- F. SCCR: Short-circuit current rating.
- G. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- H. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals may be in digital form:
1. Arc-flash study input data, including completed computer program input data sheets.
 2. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.
 3. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.



1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
 - 1. For Power Systems Analysis Software Developer.
 - 2. For Power System Analysis Specialist.
 - 3. For Field Adjusting Agency.
- B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
 - 1. Provide maintenance procedures in equipment manuals according to requirements in NFPA 70E.
 - 2. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

- A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Computer program shall be designed to perform arc-flash analysis or have a function, component, or add-on module designed to perform arc-flash analysis.
 - 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer in charge of performing the arc-flash study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- F. Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by Power Systems Analysis Specialist.
- G. Field Adjusting Agency Qualifications:
 - 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
 - 2. A member company of NETA.
 - 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. SKM Systems Analysis, Inc.
 - 2. ETAP
 - 3. Easy Power
- B. Comply with IEEE 1584 and NFPA 70E.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies." Coordination Study shall be completed and changes incorporated into model prior to performing Arc Flash Study.
- F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."
- G. Arc-Flash Study Output Reports:
 - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
- H. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Restricted approach boundary.
6. Limited approach boundary.
7. Working distance.
8. Incident energy.
9. Hazard risk category.
10. Recommendations for arc-flash energy reduction.

- I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

2.3 ARC-FLASH WARNING LABELS

- A. Labels are required to be printed in such a way or on such a medium that they are impervious to liquids and other environmental damage.
- B. 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. Protection boundaries.
 - a. Arc-flash boundary.
 - b. Restricted approach boundary.
 - c. Limited approach boundary.
 4. Arc flash PPE category.
 5. Required minimum arc rating of PPE in Cal/cm squared.
 6. Available incident energy.
 7. Working distance.
 8. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies: Perform the Short Circuit and Coordination Study prior to starting the Arc-Flash Study.
 1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 05 73.13 "Overcurrent Protective Device Short Circuit Study."
 2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 26 05 73.13 "Overcurrent Protection Coordination Studies."

- C. Calculate maximum and minimum contributions of fault-current size.
 - 1. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
 - 2. Calculate arc-flash energy at 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.
 - 3. Calculate arc-flash energy at 38 percent of maximum short-circuit current according to NFPA 70E recommendations.
 - 4. Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.
- D. Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.
- E. Include medium- and low-voltage equipment locations, except equipment rated 240 V ac or less fed from transformers less than 125 kVA.
- F. Calculate the limited, restricted, and prohibited approach boundaries for each location.
- G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
 - 1. Fault contribution from induction motors shall not be considered beyond three to five cycles.
 - 2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).
- H. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:
 - 1. When the circuit breaker is in a separate enclosure.
 - 2. When the line terminals of the circuit breaker are separate from the work location.
- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the arc-flash hazard analysis.
 - 1. Verify completeness of data supplied on one-line diagram on Drawings and under Preparatory Studies paragraph in “Arc Flash Study” Article. Call discrepancies to Architect’s attention.
 - 2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
 - 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.
- B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control

of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance or available short circuit current at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

3.4 LABELING

- A. Apply arc-flash label on the front cover of each section of equipment included in the study. Base arc-flash label data on highest values calculated at each location.
- B. Each piece of equipment listed below shall have an arc-flash label applied to it:
 1. All Panelboard and safety switch.
 2. Control panel.
- C. Note on record Drawings the location of equipment where the personnel could be exposed to arc-flash hazard during their work.
 1. Indicate arc-flash energy.
 2. Indicate protection level required.

3.5 APPLICATION OF WARNING LABELS

- A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

3.6 DEMONSTRATION

- A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

END OF SECTION 26 05 73.19

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SECTION 26 05 73.16 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.
 - 1. Study results shall be used to determine coordination of series-rated devices.

1.3 DEFINITIONS

- A. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- D. Power System Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
- E. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.
- F. SCCR: Short-circuit current rating.
- G. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- H. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. For computer software program to be used for studies.
 - 2. Submit the following after the approval of system protective devices submittals. Submittals may be in digital form.
 - a. Coordination-study input data, including completed computer program input data sheets.
 - b. Study and equipment evaluation reports.
 - 3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.



- a. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
 1. For Power System Analysis Software Developer.
 2. For Power Systems Analysis Specialist.
 3. For Field Adjusting Agency.
- B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For overcurrent protective devices to include in emergency, operation, and maintenance manuals.
 1. The following are from the Coordination Study Report:
 - a. Final one-line diagram.
 - b. Final protective device coordination study.
 - c. Coordination study data files.
 - d. List of all protective device settings.
 - e. Time-current coordination curves.
 - f. Power system data.

1.7 QUALITY ASSURANCE

- A. Studies shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications:
 1. Computer program shall be designed to perform coordination studies or have a function, component, or add-on module designed to perform coordination studies.
 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- F. Field Adjusting Agency Qualifications:
 1. Employer of a NETA ETT-Certified Technician Level III responsible for all field adjusting of the Work.
 2. A member company of NETA.
 3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. SKM Systems Analysis, Inc
 - 2. ETAP
 - 3. Easy Power
- B. Comply with IEEE 242 and IEEE 399.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
 - 1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

2.2 COORDINATION STUDY REPORT CONTENTS

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram of modeled power system, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations.
 - 6. Any revisions to electrical equipment required by the study.
 - 7. Study Input Data: As described in "Power System Data" Article. (Section 3.2 below)
 - a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 26 05 73.13 Overcurrent Protection Short-Circuit Study
- D. Protective Device Coordination Study:
 - 1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
 - a. Phase and Ground Relays:
 - 1) Device tag.
 - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
 - 3) Recommendations on improved relaying systems, if applicable.

- b. Circuit Breakers:
 - 1) Adjustable pickups and time delays (long time, short time, and ground).
 - 2) Adjustable time-current characteristic.
 - 3) Adjustable instantaneous pickup.
 - 4) Recommendations on improved trip systems, if applicable.
 - c. Fuses: Show current rating, voltage, and class.
- E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
- 1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
 - 2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
 - 3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
 - 4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Medium-voltage equipment overcurrent relays.
 - c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - f. Cables and conductors damage curves.
 - g. Ground-fault protective devices.
 - h. Motor-starting characteristics and motor damage points.
 - i. Generator short-circuit decrement curve and generator damage point.
 - j. The largest feeder circuit breaker in each motor-control center and panelboard.
 - 5. Maintain selectivity for tripping currents caused by overloads.
 - 6. Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.
 - 7. Provide adequate time margins between device characteristics such that selective operation is achieved.
 - 8. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.
 - 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the overcurrent protective device study.
- OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

1. Verify completeness of data supplied in one-line diagram on Drawings. Call any discrepancies to Architect's attention.
 2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
 3. For equipment which is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.
- B. Gather and tabulate all required input data to support the coordination study. List below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:
1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Electrical power utility impedance at the service.
 3. Power sources and ties.
 4. Short-circuit current at each system bus (three phase and line to ground).
 5. Full-load current of all loads.
 6. Voltage level at each bus.
 7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
 10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
 12. Maximum demands from service meters.
 13. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
 14. Motor horsepower and NEMA MG 1 code letter designation.
 15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
 16. Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).
 17. Data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.

- f. Special overcurrent protective device settings or types stipulated by utility company.
- g. Time-current-characteristic curves of devices indicated to be coordinated.
- h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
- i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- j. Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.
- k. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.3 COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Extent of electrical power system to be studied is all electrical gear required of the project.
- E. Begin analysis at the service, extending down to system overcurrent protective devices as follows:
 - 1. To normal system low-voltage load buses where fault current is 10 kA or less.
 - 2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- H. Motor Protection:
 - 1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
 - 2. Select protection for motors served at voltages more than 600 V according to IEEE 620.
- I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that

equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

- J. Generator Protection: Select protection according to manufacturer's written instructions and to IEEE 242.
- K. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.
- L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.
 - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- M. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 - 2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
 - 3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.
 - 4. Include in the report identification of any protective device applied outside its capacity.

3.4 FIELD ADJUSTING

- A. Adjust relay and protective device settings according to recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of equipment manufacturer under the "Startup and Acceptance Testing" contract portion.
- B. Make minor modifications to equipment as required to accomplish compliance with overcurrent protective device coordination studies and short circuit studies.
- C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.
 - 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 all adjustable overcurrent protective devices.

3.5 DEMONSTRATION

- A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in the following:
 - 1. Acquaint personnel in fundamentals of operating the power system in normal and emergency modes.
 - 2. Hand-out and explain the coordination study objectives, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting time-current coordination curves.

3. For Owner's maintenance staff certified as NETA ETT-Certified Technicians Level III or NICET Electrical Power Testing Level III Technicians, teach how to adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION 26 05 73.16

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SECTION 260519 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.2 SUBMITTALS

- A. Field quality-control test reports.

1.3 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. Comply with NFPA 70.



PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 CONDUCTORS AND CABLES

- A. Manufacturers:
 - 1. American Insulated Wire Corp.; a Leviton Company.
 - 2. Southwire Company.
 - 3. Encore Wire
- B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.
- C. Conductor Material: Copper; solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.

- D. Conductor Insulation Types: Type THHN-THWN, and XHHW complying with NEMA WC 5 or 7.

2.3 CONNECTORS AND SPLICES

A. Manufacturers:

1. AMP Incorporated/Tyco International.
2. Hubbell/Anderson.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. Burndy

- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway.
- B. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN-THWN, single conductors in raceway.
- D. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: .
- F. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.
- G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.
- H. Fire Alarm Circuits: Type THHN-THWN, in raceway.
- I. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- J. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.2 INSTALLATION

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 26 Section "Basic Electrical Materials and Methods."
- F. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."
- G. Identify and color-code conductors and cables according to Division 26 Section "Basic Electrical Materials and Methods Electrical Identification."
- H. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- I. Wiring at Outlets: Install conductor at each outlet, with at least 8 inches of slack.

3.3 FIELD QUALITY CONTROL

- A. Testing: Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.
- B. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 26 05 73.13 - OVERCURRENT PROTECTIVE DEVICE SHORT-CIRCUIT STUDIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices required for electrical system branches.

1.3 DEFINITIONS

- A. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- D. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
- E. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.
- F. SCCR: Short-circuit current rating.
- G. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- H. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. For computer software program to be used for studies.
 - 2. Submit the following after the approval of system protective devices submittals. Submittals may be in digital form.
 - a. Short-circuit study input data, including completed computer program input data sheets.
 - b. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.
 - 1) Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause



- delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
- 2) Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
 1. For Power Systems Analysis Software Developer.
 2. For Power System Analysis Specialist.
 3. For Field Adjusting Agency.
- B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
 1. For overcurrent protective devices to include in emergency, operation, and maintenance manuals.
 2. The following are from the Short-Circuit Study Report:
 - a. Final one-line diagram.
 - b. Final Short-Circuit Study Report.
 - c. Short-circuit study data files.
 - d. Power system data.

1.7 QUALITY ASSURANCE

- A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
 1. Power System Analysis Software Qualifications: Computer program shall be designed to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.
 2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- D. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.
- E. Short-Circuit Study Certification: Short-Circuit Study Report shall be signed and sealed by Power Systems Analysis Specialist.
- F. Field Adjusting Agency Qualifications:
 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.

2. A member company of NETA.
3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 1. SKM Systems Analysis, Inc.
 2. ETAP
 3. Easy Power
- B. Comply with IEEE 399 and IEEE 551.
 1. Analytical features of power systems analysis software program shall have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram of modeled power system, showing the following:
 1. Protective device designations and ampere ratings.
 2. Conductor types, sizes, and lengths.
 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 4. Motor and generator designations and kVA ratings.
 5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
 6. Derating factors and environmental conditions.
 7. Any revisions to electrical equipment required by the study.
- D. Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.
- E. Protective Device Evaluation:
 1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
 2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
 3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
 5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors

at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

- F. Short-Circuit Study Input Data:
1. One-line diagram of system being studied.
 2. Power sources available.
 3. Manufacturer, model, and interrupting rating of protective devices.
 4. Conductors.
 5. Transformer data.
- G. Short-Circuit Study Output Reports:
1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Equivalent impedance.
 2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Calculated asymmetrical fault currents:
 - 1) Based on fault-point X/R ratio.
 - 2) Based on calculated symmetrical value multiplied by 1.6.
 - 3) Based on calculated symmetrical value multiplied by 2.7.
 3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the study.
1. Verify completeness of data supplied on one-line diagram. Call any discrepancies to Architect's attention.
 2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
 3. For equipment which is new and installed, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.
- B. Gather and tabulate the required input data to support the short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective

device characteristics. Record data on a Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at the service.
3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
9. Motor horsepower and NEMA MG 1 code letter designation.
10. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
11. Derating factors.

3.2 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Extent of electrical power system to be studied is all electrical gear included in project.
- E. Begin short-circuit current analysis at the service, extending down to system overcurrent protective devices as follows:
 1. To normal system low-voltage load buses where fault current is 10 kA or less.
 2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.

- H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.
 - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- I. Include in the report identification of any protective device applied outside its capacity.

END OF SECTION 26 05 73.13

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SECTION 260100 - ELECTRICAL GENERAL CONDITIONS

PART 1 - GENERAL



1.1 DESCRIPTION

- A. The General Conditions and all pertinent sections are a part of the contract and the Contractor shall consult them in detail for instructions pertaining to his work. He shall consult all other sections of the specifications to determine if he is required to perform any work relative to that particular section.

1.2 SCOPE OF WORK

- A. The work contemplated under this specification comprises the furnishing of all labor and materials required and necessary for the complete installation of electrical wiring in conduit for lighting control and power from the various panelboards to each ultimate outlet hereinafter specified and/or shown on the accompanying drawings. Said work shall be done in accordance with the latest edition of the National Electrical Code, NFPA codes and all local codes and ordinances. The specifications are intended to describe a complete workable system and bidders shall report any discrepancies or omissions preventing such workability prior to the time their bids are submitted.
- B. The work covered by this specification shall be as shown on the plans and called for herein, and shall be comprised generally of the following:
 - 1. Furnish and install all conduit and wiring raceways, conductors, disconnects, panels, etc.
 - 2. Furnish and install feeders and branch circuits.
 - 3. Furnish and install service to all mechanical devices.
 - 4. Furnish and install light fixtures.
- C. All equipment installed by this contractor shall be installed in strict accordance with instructions of the manufacturer.
- D. He shall install his work to meet existing conditions as found at the building site.
- E. The Electrical contractor is referred to the Architectural and Structural details for information in regards to the Architectural details. His work shall be done in strict accordance with local and state ordinances governing this class of work.

1.3 REJECTED WORK AND MATERIALS

- A. Should contractor introduce any materials different from those called for and described in specifications or shown on plans, it must on notification from the engineers, be immediately removed from building or premises.

1.4 SHOP DRAWINGS

- A. Before proceeding with work and/or within thirty (30) days award of the General Contract for this work, the Electrical Contractor shall furnish to the Architect/Engineer, complete shop and working drawings of such apparatus, equipment, controls, insulation, etc. to be provided in this project. These drawings shall give dimensions, weights, mounting data, performance curves, and other pertinent information. Shop drawings to be submitted as listed below.
 - 1. Panels/Panelboards/Switchboards.
 - 2. Disconnects.
 - 3. Lighting Fixtures.
 - 4. Conduit & Fittings.
 - 5. Electrical devices.
 - 6. Automatic Transfer Switch and Gen Set
- B. The contractor may be required to submit shop drawings on any other material he supplies in construction of this project. These drawings shall be submitted at time requested by Architect/Engineer.

1.5 ADDITIONS AND CHANGES

- A. The accompanying drawings show approximate location of feeders, branch circuits, light and power circuits, etc. Complete and accurate details in regard to location of outlets, apparatus, etc. from location shown shall be made before roughing-in and without additional cost to the owner.

1.6 STANDARDS OF MATERIALS AND WORKMANSHIP

- A. All materials shall be new and listed by UL as conforming to its standards. Work shall be executed in a workmanlike manner and present a neat finished appearance when completed.

1.7 PRIOR APPROVAL AND DRAWINGS

- A. Whenever manufacturers or trade names are mentioned in these plans or specifications, the words "or approved equivalent" shall be assumed to follow whether or not so stated. Manufacturers or trade names are used to establish a standard of quality only and should not in any way be construed to infer a preference. Equivalent products which meet the Engineer's approval will be accepted, however these products must be submitted to the Engineer a minimum of ten (10) days prior to bid date. Submission shall include manufacturer's name, model number, rating table and construction features. Upon receipt and checking of this submittal, the Architect will issue an addendum listing items which are approved as equivalent to those specified. The Contractor shall base his bid solely on the items specified or included in the "Prior Approval Addendum" as no other items will be acceptable. Prior approval of a particular piece of equipment does not mean automatic final acceptance and will not relieve the Contractor of the responsibility of assuring himself that this equipment is in complete accord with plans and specifications and will fit into the space provided. Submit shop drawings on all items of equipment for approval as hereinafter specified. The Engineer's approval of shop

drawings shall not relieve the Contractor from the responsibility of incorrectly figured dimensions or any other errors that may be contained in these drawings. The omissions from the shop drawings, or specifications, even though approved by the Engineer, shall not relieve this Contractor from furnishing and erecting same. **Prior Approvals submitted electronically will be accepted but the burden of delivery confirmation is by Contractor.**

1.8 GUARANTEE

- A. The Contractor for this work shall be required to keep the work installed by him in repair and perfect working order for one year from date of completion and final acceptance; said guarantee shall be based on defective materials and substandard workmanship. Contractor shall furnish, free of cost to owner, all materials and labor necessary to comply with this guarantee.

1.9 LAWS, PERMITS AND INSPECTIONS

- A. This contractor shall at his own cost obtain all necessary permits, pay all legal fees and charges, and comply with all building and safety laws, ordinances and regulations relating to the building and the public health and safety, including NEC, NFPA, IBC and OSHA.
- B. Pay any and all fees required by local electric utility company to obtain electrical services outlined.

1.10 TESTS

- A. After installation is complete and at such time as the Engineers may direct, Contractor shall conduct an operating test for approval. Equipment shall be demonstrated to operate in accordance with requirements of this specification. The test shall be performed in the presence of Engineers. Contractor shall furnish all instruments and personnel required for the test.

1.11 CUTTING AND PATCHING

- A. Contractor shall do all cutting and patching where necessary at his own expense with approval of the Engineers as to cutting of any structural beams or joists, but all patching shall be done by crafts whose work is involved. After initial surfacing has been done, all further cutting, patching, and painting shall be done at this contractor's expense.

1.12 SAFETY PRECAUTIONS

- A. Contractor shall furnish and place proper guards for prevention of accidents. He shall provide and maintain any other necessary construction required to secure safety of life or property, including maintenance of sufficient lights during all night hours to secure such protection.
- B. Temporary electrical services shall be provided by electrical contractor during construction and shall be maintained in perfect condition. Frayed, loose or opened connections shall not be used for temporary services. The Electrical Contractor shall use only equipment in first class working conditions for construction services. Contractor shall not use electrical services at existing

school for construction.

1.13 SUPERVISION

- A. Contractor shall personally, or through an authorized and competent representative, constantly supervise the work done from beginning to completion and final acceptance. To the best of his ability he shall keep the same foreman and workmen throughout the project duration. During the progress of the work, it shall be subject to inspection by the representatives of the Engineers, and at these times, the contractor shall furnish the required information.

1.14 INSERTS AND OPENINGS

- A. Contractor shall furnish and install all inserts and hangers required to support conduit, cables, wireways, disconnect switches, etc.

1.15 OPENINGS THROUGH WALLS AND FLOORS

- A. Provide all slots, sleeved holes and other openings necessary through walls and floors, and through any other parts of the structure. Where conduits pass through walls which are intended as rated fire walls, leave-outs, penetrations or sleeves shall be sealed so as not to interfere with the rating of the wall.

1.16 BACKFILLING

- A. Contractor shall be responsible to backfill any trenches for electrical runs under the building, paving, or any area of the site by backfilling the bottom of the trench-up to the top of the conduit with sand, then placing compacted fill in 6" layers using power tamping equipment.

1.17 RECORD DRAWINGS

- A. The Contractor shall be provided with a set of prints of the original bidding documents by the Architect. The Contractor shall then have a set of sepia (reproducible plans) made.
- B. If the Contractor elects to vary from the contract documents and secures prior approval from the architect for any phase of the work, he shall record in a neat and readable manner, ALL such variances on the print in red. These changes shall then be transferred to the permanent set (sepia) at the completion of the job. Both the sepia and the original print shall be returned to the Engineer for documentation.
- C. All deviations from sizes, locations and from all other features of the installations shown in the Contract Documents shall be recorded.
- D. In addition, it shall be possible using these drawings to correctly and easily locate, identify and establish sizes of all piping, directions, and the like, as well as other features of work which will be concealed underground and/or in the finished building. Locations of underground work shall be established by dimensions to columns, lines or walls, locating all turns, etc. and by properly referenced centerline.

- E. For work concealed in the building, sufficient information shall be given so it can be located with reasonable accuracy and ease. In some cases this may be by dimension. In others, it may be sufficient to illustrate the work on the drawings in relation to the spaces in the building near which it was actually installed. Architect's/Engineer's decision in this matter will be final.

- F. The following requirements apply to all "record" drawings:
 - 1. They shall be maintained at the contractor's expense.
 - 2. All such drawings shall be done carefully and neatly and in a form approved by the Engineer.
 - 3. Additional drawings shall be provided as necessary for clarification.
 - 4. They shall be kept up-to-date during the entire course of the work and shall be available upon request for examination by Engineer and when necessary, to establish clearances for other parts of the work.
 - 5. "Record" drawings shall be returned to the Architect upon completion of the work and are subject to approval of the Engineer.
 - 6. The Contractor shall refer to the Architectural section under "RECORD DRAWINGS" for further requirements and procedures.

PART 2 – Not Used

PART 3 – Not Used

END OF SECTION 260100

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior solid-state luminaires that use LED technology.
2. Lighting fixture supports.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.2 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of luminaire
- G. Luminaire: Complete lighting unit, including driver, reflector, and housing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, arranged by designation.
- B. Shop Drawings: For nonstandard or custom luminaires.
 1. Include plans, elevations, sections, and mounting and attachment details.
 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.



- C. Product Schedule: For luminaires (**See Plans.**)

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale and coordinated with each other, using input from installers of the items involved:
- B. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
- C. Product Certificates: For each type of luminaire.
- D. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period for all LED Fixtures: **Five (5) years** from date of Substantial Completion.

1.7 EXTRA MATERIALS

- 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.
 - 1. Drivers: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 LUMINAIRE 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. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. Recessed Fixtures: Comply with NEMA LE 4.
- E. CCT at 4000K (See Fixture Schedule)
- F. Rated **50,000** hours minimum or equal to specified fixtures which is more.
- G. LED Driver dimmable from 100 percent to 0 percent of maximum light output.
- H. Internal driver for all fixtures.
 - 1. Driver to be high efficiency
 - 2. Include 0-10V dimming.
 - 3. 2.5kV common and differential mode for indoor applications, complies with ANSI C62.41 Test Severity III - Cat A (ANSI C82.77-5-2017 Surge and Transient Standard)
 - 4. UL listed- 1310 and 8750 – Light Emitting Diode (LED) equipment for use in lighting products.
- I. Nominal Operating Voltage: **120V**.
 - 1. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

2.2 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging
- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally.
- C. Diffusers, and Globes:
 - 1. Acrylic: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - 3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

2.3 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.4 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 26 “Basic Electrical Materials and Methods” for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel.
- D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Supports: Sized and rated for luminaire weight.
- D. Flush-Mounted Luminaire Support: Secured to outlet box.
- E. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with four-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and rod for suspension for each unit length of luminaire chassis, including one at each end.
- F. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 “Electrical Identification”.

3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 265119

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SECTION 260500 - BASIC ELECTRICAL MATERIALS AND METHODS

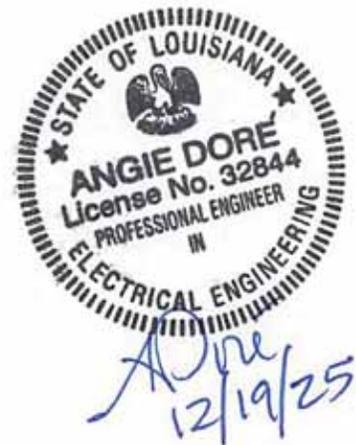
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Supporting devices for electrical components.
 - 2. Electricity-metering components.
 - 3. Concrete equipment bases.
 - 4. Electrical demolition.
 - 5. Cutting and patching for electrical construction.
 - 6. Touchup painting.



1.3 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. Comply with NFPA 70, most recent addition.

1.4 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
 - 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- C. Coordinate electrical service connections to components furnished by utility companies.
 - 1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.

2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.
- D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section "Access Doors."
 - E. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.
 - F. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch- diameter slotted holes at a maximum of 2 inches o.c., in webs.
- D. Slotted-Steel Channel Supports: Comply with Division 5 Section "Metal Fabrications" for slotted channel framing.
 1. Channel Thickness: Selected to suit structural loading.
 2. Fittings and Accessories: Products of the same manufacturer as channel supports.
- E. Nonmetallic Channel and Angle Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- diameter holes at a maximum of 8 inches o.c., in at least one surface.
 1. Fittings and Accessories: Products of the same manufacturer as channels and angles.
 2. Fittings and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
- F. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
- G. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- H. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.

I. Expansion Anchors: Carbon-steel wedge or sleeve type.

J. Toggle Bolts: All-steel springhead type.

K. Powder-Driven Threaded Studs: Heat-treated steel.

2.2 CONCRETE BASES

A. Concrete Forms and Reinforcement Materials: As specified in Division 3 Section "Cast-in-Place Concrete."

B. Concrete: 4000-psi, 28-day compressive strength as specified in Division 3 Section "Cast-in-Place Concrete."

2.3 TOUCHUP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 – EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Dry Locations: Steel materials.

C. Selection of Supports: Comply with manufacturer's written instructions.

D. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.3 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components. Support solely from structural steel framing members.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- F. Install 1/4-inch- diameter or larger threaded steel hanger rods, unless otherwise indicated.
- G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Simultaneously install vertical conductor supports with conductors.
- J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.
- K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
 - 1. Wood: Fasten with wood screws or screw-type nails.
 - 2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
 - 3. New Concrete: Concrete inserts with machine screws and bolts.
 - 4. Existing Concrete: Expansion bolts.

5. Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used in existing concrete.
6. Steel: Welded threaded studs or spring-tension clamps on steel.
 - a. Field Welding: Comply with AWS D1.1.
7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
8. Light Steel: Sheet-metal screws.
9. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.4 FIRESTOPPING

- A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly.

3.5 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.6 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work, including the following:
 1. Supporting devices for electrical components.
 2. Electricity-metering components.
 3. Concrete bases.
 4. Electrical demolition.
 5. Cutting and patching for electrical construction.
 6. Touchup painting.

3.7 REFINISHING AND TOUCHUP PAINTING

- A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Painting."
 1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
 2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
 3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

4. Repair damage to paint finishes with matching touchup coating recommended by manufacturer.

3.8 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION 260500

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