NORTHERN ARIZONA UNIVERSITY

STUDENT AND ACADEMIC SERVICES BUILDING
NAU Project No: 09.600.141

PROJECT MANUAL
DIVISIONS 22 -33

RECORD DRAWINGS
JANUARY 29, 2016

hardison/downey construction, inc.

DWL ARCHITECTS + PLANNERS, INC.

DWL Architects – Planners, Inc.
2333 N. Central Avenue
Phoenix, AZ 85004
DWL No. 1400.00

NORTHERN ARIZONA UNIVERSITY

STUDENT AND ACADEMIC SERVICES BUILDING
DWL Project No. 1400.00

OWNER	Northern Arizona University Flagstaff, Arizona 86011
CONSTRUCTION MANAGER/CONTRACTOR	Hardison - Downey 6150 N. 16th Street, Suite A. Phoenix, AZ 85016
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CIVIL ENGINEER	The WLB Group 500 N. Beaver Street Flagstaff, AZ 86001
AUDIO – VISUAL	CCS PRESENTATION SYSTEMS / SOUTHWEST 17350 N. Hartford Dr. Scottsdale, AZ 85255

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SECTION 21 05 00

GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE

A. Provisions of this section apply to all work specified in all sections under Division 21.

B. In addition, work in Division 21 is governed by the provisions of the Bidding Requirements, Contract Forms, General Conditions, and all sections under Division 01, General Requirements.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 EXAMINATION OF PREMISES

A. Visit the site, verify all measurements and job conditions, and pay all costs necessary to perform the work.

1.4 FIRE SPRINKLER CONTRACTOR

A. The Fire Sprinkler Contractor shall be licensed and hold a current contracting license that has been valid for a minimum of two years in the State of Arizona as a fire sprinkler contractor.

1.5 REGULATIONS, PERMITS, FEES, CHARGES, INSPECTIONS

A. Regulations: Comply with all applicable codes, rules and regulations.

B. Fees and Permits: Pay all connection, installation, use, development, etc., fees and/or charges. Obtain and pay for all required permits and licenses. Refer to Division 01.

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C. Inspections: All work must be inspected and approved by local authorities. Prior to final approval, furnish the Architect with certificates of inspections and approvals by the local authorities in accordance with Division 01.

1.6 DRAWINGS AND SPECIFICATIONS

A. Refer to Division 01 for additional information on submittals and shop drawings.

B. If a conflict exists on the drawings or between the drawings and specifications, promptly notify the Architect.

1.7 SUBMITTALS

A. Submittals are for information and coordination only. The Engineer will diligently review the submittals and attempt to verify compliance with the project requirements. Such review, however, does not constitute approval or disapproval of obligation to comply with all project requirements. The submittals are not to be construed to be contract documents. Any failure by the Engineer to note a point of non-compliance shall not be construed to be acceptance or approval of the discrepancy.

B. Product Information Sheets: Provide manufacturer's literature which includes the information required by the Product Data paragraph of the applicable Specification Section. Where Product Information Sheets show multiple models or options, clearly mark the model and options to be provided.

C. Assembly: Assemble all required submittal information for each specification section and submit in PDF format.

1. Assemble PDF submittals in one PDF file for each Division. Separate and order sections within each file by corresponding specification number. Provide bookmarks at the first page of each section and label each bookmark with the specification number and name to allow for easy navigation of the submittal.
2. Partial submittals will be returned without review.

D. Identification and Information:

1. Name the PDF file with the Project name, Division number and sequential submittal number. (I.E. The first submittal shall be No. 1; the second submittal shall be No. 2.)
2. Provide a cover sheet at the front of each submittal with the following information:

    a. Project name.
    b. Date.
    c. Name of Engineer.
    d. Name of Contractor.
    e. Name of subcontractor.

3. Provide a cover sheet at the front of each submittal section with the following information:

    a. Name of supplier.
    b. Name of manufacturer.
    c. Number and title of appropriate Specification Section.
    d. Drawing number and detail references, as appropriate.
    e. Other necessary identification.

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E. Options:

1. Identify options requiring selection by the Engineer.
2. Identify options included with submittal item.

F. Deviations: Identify deviations from the Contract Documents on submittals

1.8 MATERIAL SAFETY DATA SHEETS

A. Provide current, Material Safety Data Sheets (MSDS), for all hazardous chemicals that are proposed for use at the project site.

1. Provide one complete set to the Owner for review and approval a minimum of one week prior to the delivery of any hazardous chemicals to the site.
2. Maintain a second complete set at the project location, readily accessible by both the Owner's personnel and the contractor's personnel.

1.9 REQUEST FOR INFORMATION

A. Request for Information:

1. A document submitted by the Contractor requesting clarification of a portion of the Contract Documents, hereinafter referred to as RFI.
2. A properly prepared request for information shall include a detailed written statement of the clarification, apparent conflict, or information requested that indicates the specific drawings or specification in need of clarification and the nature of the clarification requested.

    a. Drawings shall be identified by drawing number and location on the drawing sheet.
    b. Specifications shall be identified by section number, page, and paragraph.

3. Include a proposed solution, where appropriate, based upon the field conditions and best knowledge of the Contractor.

B. Improper or Frivolous RFIs: RFIs which are not properly prepared or that request information which is clearly shown in the contract documents will be returned unanswered. Processing time for multiple submissions of improper or frivolous RFIs will be billed at the Engineer's standard hourly rate to the Owner who may deduct an equal amount from the monies due the Contractor.

1.10 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings, Submittals and Shop Drawings.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Include underground and overhead piping.

    a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    b. Include dimensions both horizontally and vertically to permanent points of reference accurate within 6 inches. Include descriptors such as "below slab", "above ceiling", etc.
    c. Record data daily or as soon as possible after obtaining it.

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d. Record and check the markup before enclosing concealed installations.

2. Mark the Contract Drawings, Submittals and Shop Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of marked-up record prints.
3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Identification: As follows:

a. Project name.
b. Date.
c. Designation "PROJECT RECORD DRAWINGS."
d. Name of Engineer.
e. Name of Contractor.

3. Remove or obscure Engineer's seal from Record Drawings.

1.11 OPERATION AND MAINTENANCE MANUAL

A. Prior to completion of the project, compile a complete equipment, operation and maintenance manual for all equipment supplied under Division 21.

B. Schedule:

1. Submit a preliminary copy of the manual not less than 30 days prior to substantial completion for review and comment.
2. Submit the final version the manual not more than four weeks after substantial completion of the project.

C. Format: Submit manuals in both of the following formats:

1. PDF electronic file. Assemble each manual into a composite electronically-indexed file. Submit on digital media acceptable to Engineer.

a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically-linked operation and maintenance directory.
b. Enable inserted reviewer comments on draft submittals.
c. Provide one final copy to Engineer and two copies to Owner.

2. Three paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. Engineer will return three copies.

D. Provide operating and maintenance manuals for all systems, subsystems, and equipment that requires operation and regular maintenance, or has replaceable parts.

E. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, product data, manufacturers' maintenance documentation, maintenance procedures,

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maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below. In addition to requirements in this Section, include operation and maintenance data required in individual Specification Sections.

F. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

G. Product Data: Include the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Approved submittals.
3. Include the following if not shown on approved submittals:

    a. Product name and model number. Use designations for products indicated on Contract Documents.
    b. Manufacturer's name.
    c. Equipment identification with serial number of each component.
    d. Equipment function.
    e. Operating characteristics.
    f. Limiting conditions.
    g. Performance curves.
    h. Engineering data and tests.

H. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures. Including precautions against improper use.
10. Operating logs.

I. Wiring Diagrams: Diagram of factory installed wiring including any options as well as any field modifications.

J. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

K. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

L. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

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1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

M. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

N. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

O. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

P. Licenses: Include copies of any licenses with requirements including inspection and renewal dates.

Q. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1.12 WORK AND MATERIALS

A. Unless otherwise specified, all materials must be new and of the quality specified. The workmanship shall be of a quality that is acceptable to the Architect, Engineer and Owner, and is equal to the standards of the trades. Contractor must staff the project with sufficient skilled workmen, including a fully qualified construction superintendent, to complete the work in the time allotted. The superintendent must be qualified to supervise all of the work in his work category.

B. Uniformity: Unless otherwise specified, provide all equipment and products of same type or classification by the same manufacturer.

1.13 APPROVALS OF MATERIALS AND EQUIPMENT

A. Refer to Division 01 for description of material and equipment for prior approvals and substitutions.

1.14 COOPERATIVE WORK

A. Correct without charge any work requiring alteration due to lack of proper supervision or failure to make proper provision in time. Correct without charge any damage to adjacent work caused by the alteration. See Division 01 for additional requirements.

B. Cooperative Work Includes:

1. General supervision and responsibility for proper location, rough-in and size of work related to Division 21 but provided under other divisions of these specifications.
2. Installation of sleeves, inserts and anchors bolts for work under sections in Division 21.

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1.15 CONSTRUCTION FACILITIES

A. General: Under this division of the specifications, execute all work in a manner to provide safe and lawful ingress and egress to the Owner's establishment and such facilities shall be kept clear of materials or equipment. Refer to Division 01 for additional requirements.

B. Furnish and maintain from the beginning to the completion of all work all lawful and necessary guards, railings, fences, canopies, lights, and warning signs. Take all necessary precautions required by city and state laws to avoid injury or damage to any and all persons and property.

1.16 GUARANTEE

A. Guarantee all material, equipment, installation and workmanship for all sections under Division 21 in writing to be free from defects of material and workmanship for one year from date of final acceptance as outlined in Division 01. Equipment warranties shall be a minimum of two years from date of substantial completion or as specified elsewhere. Replace without charge any material or equipment proving defective during this period. The guarantee shall include performance of the equipment under all conditions.

1.17 ELECTRICAL WORK

A. Electrical wiring, including power wiring and control wiring, except as otherwise specified under Division 21, all raceways, outlet and junction boxes, and labor for installation of the wiring and equipment shall be included in Division 26 and Division 28 of the specifications.

B. All loose starters and control devices, except as otherwise specified under Division 21, are to be furnished and installed under Division 26.

C. Contractor shall be responsible for the checking and testing of all controls and the interlocks for a complete and satisfactory operating system.

D. Before ordering any motors and equipment, verify the available voltage and phase for all motors with the Division 26 Contractor.

E. Submit a complete list of all motors prior to final closeout of job indicating the location, horsepower, voltage, phase, and amperage draw of each motor.

F. All field wiring and equipment must conform to the applicable Division 26 specification sections.

1.18 COMMISSIONNING

A. This project will be commissioned. See commissioning requirements in Division 01.

PART 2 - PRODUCTS

2.1 MACHINERY DRIVES

A. Unless otherwise specified in Division 21 equipment sections, use V-belts designed for 150% of capacity for all belt drives. For multiple belt drives, use matched sets, so marked at the factory.

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B. On drives with not more than two belts, provide adjustable pitch motor sheaves with the midpoint of the adjustment range equal to that required to achieve the specified fan capacity.

C. On motors with drives with more than two belts, furnish non-adjustable sheaves, providing the specified fan capacity.

2.2 MACHINERY ACCESSORIES

A. Guards: Provide totally-enclosed OSHA type belt guards for all rotating equipment. Design guards to be readily removable for access to belt drives.

2.3 EQUIPMENT DESIGN AND INSTALLATION

A. Design: Design all equipment in accordance with latest edition of ASME, AGA, UL and other applicable technical standards as follows:

1. Pressure Vessels: ASME Code constructed and stamped.
2. Electric Appliances: UL labeled.
3. Fire Protection Equipment: UL approved and labeled.

2.4 GROUT

A. Description: ASTM C1107, Grade B, non-shrink and non-metallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, non-staining, non-corrosive, non-gaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SUBMITTALS

A. Prepare submittals as directed for review by the Contractor, Owner, Architect, and Engineer.

B. Submit one copy of PDF submittals via email, project website or other electronic media.

3.2 RECORD DRAWINGS

A. Recording: Post changes and modifications to project record documents as they occur; do not wait until the end of Project.

B. Maintenance of Record Documents and Samples: Store record documents in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Engineer's reference during normal working hours.

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3.3 OPERATION AND MAINTENANCE MANUALS

A. Prepare Operation and Maintenance Manuals as directed for review by the Contractor, Owner, Architect, and Engineer.

B. Make corrections and resubmit as required.

3.4 VERIFICATION OF DIMENSIONS

A. Scaled and figured dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions at site, and be responsible for properly fitting equipment and materials together and to the structure in spaces provided.

B. Drawings are essentially diagrammatic and many offsets, bends, special fittings and exact locations are not indicated. Carefully study drawings and premises in order to determine best methods, exact locations, routes, building obstructions, and install apparatus and equipment in available locations. Install apparatus and equipment in manner and in locations to avoid obstructions, preserve headroom, and keep openings and passageways clear.

3.5 CUTTING AND PATCHING

A. Cut work and patch per Division 01 as necessary to properly install the new work. As the work progresses, coordinate necessary openings, holes, chases, etc., in their correct location. If the required openings, holes and chases are not in their correct locations, make the necessary corrections at no cost to the Owner. Avoid excessive cutting and do not cut structural members without the consent of the Architect. Include as a part of the work all structural framing required by penetrations through the roof and necessary steel to support ducts and pipes between structural steel unless shown on the structural drawings.

3.6 CLOSING-IN OF UNFINISHED WORK

A. Cover no work until inspected, tested and approved. Where work is covered before inspection and test, uncover it, and when inspected, tested and approved, restore all work to original proper condition.

3.7 EXCAVATION AND BACKFILL

A. Perform all necessary excavation, shoring and backfilling required for the proper laying of all pipes inside the building and premises, and outside as may be necessary. Remove all excess excavated materials from the site or dispose of on site as directed by General Contractor.

B. Excavate all trenches open cut, keep trench banks as nearly vertical as practicable, and sheet and brace trenches where required for stability and safety. Excavate trenches true to line and make bottoms not less than 18" wide but no wider than necessary to provide ample work room. Grade trench bottoms accurately to provide uniform bearing and support for each section of pipe on undisturbed soil along its entire length. Dig "bell" holes after the trench bottom has been graded. Machine grade only to the top line of the pipes, doing the balance by hand. Do not cut any trench near or under footings without first consulting the Architect. Comply with OSHA requirements.

C. Provide not less than 4 inches of granular material as pipe bedding prior to laying pipe in trench to continuously support pipe and maintain required slope. Granular material shall be pea gravel or sand per MAG Standards.

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D. Provide backfilling and compaction in accordance with provisions of these specifications and under the direction of the Architect to the required density.

E. Provide not less than 4 inches of granular material, same as piping bedding, all around pipe. Make the first 2 feet of fill in 6 inch layers, each thoroughly compacted as directed, and free from rocks, large clods of earth, leaves, branches, and debris. Compact the rest of the backfill as directed, using in the backfill no rocks larger than 4 inches in diameter, and using no rock in the top 12 inches.

3.8 ACCESSIBILITY

A. Install valves, gauges, control devices or other specialties requiring reading, adjustment, inspection, repairs, removal or replacement conveniently and accessibly throughout the finished building. Where any of these devices are shown on the contract drawings to be installed above any inaccessible ceiling or behind any inaccessible wall, the Fire Sprinkler Contractor shall furnish access doors or panels as required.

B. All access doors or panels in walls and ceilings required for access to control devices, traps, valves and similar devices are to be furnished and installed as part of the work under this section. Provide type as specified under Division 08.

C. Refer to architectural drawings for type of wall and ceiling in each area and for rated construction.

D. Coordinate work of various sections to locate valves, etc. with others to avoid unnecessary duplication of access doors.

3.9 PRODUCT AND EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. All equipment, valves, sensors, etc., shall be installed in strict conformance with the manufacturer's recommendations and all codes.

B. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.

E. Install equipment to allow right-of-way for piping installed at required slope.

F. Do not install any equipment in an application not recommended by the manufacturer.

G. Provide metal box with red-enamel paint or powder coating mounted on wall adjacent to fire sprinkler riser. Provide a minimum of two spare sprinklers of each type installed within the building and wrenches required to replace sprinklers.

H. Provide metal box with red-enamel paint or powder coating mounted on wall adjacent to fire sprinkler riser. Provide a complete set of fire suppression Record Drawings in cabinet.

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3.10 EQUIPMENT SUPPORTS

A. Erection of Metal Supports and Anchorages:

1. Refer to Division 05 for structural steel.
2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment. Neatly fabricate and erect steel work with burrs and welding spatter ground off. Paint after fabrication with a rust-inhibitive primer.
3. Field Welding: Comply with AWS D1.1.

B. Erection of Wood Supports and Anchorages:

1. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support and anchor plumbing materials and equipment.
2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
3. Attach to substrates as required to support applied loads.

C. Where supports, foundations, stands, suspended platforms for machinery, tanks, or other equipment are indicated or specified, perform the following:

1. Locate support members to avoid equipment strains and interference with piping connections and maintenance operations.
2. Where saddles are required, use cast iron or welded steel saddles with curvature to fit the tank shell.
3. Mount power-driven equipment on common base with driver.

D. Concrete Inserts: Furnish and install all concrete inserts required for all materials and equipment specified and/or shown on the drawings for Division 21.

E. Concrete Bases: Work under this section includes coordination of construction of all concrete foundations indicated or required for equipment specified under Division 21. Materials and workmanship shall be described under Division 03. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extends through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

F. Grouting:

1. Grout under all equipment after leveling, filling completely the space between machinery bed plate and foundation surface as specified in Division 03.
2. Mix and install grout for plumbing equipment base bearing surfaces, pumps and other equipment base plates, and anchors.
3. Clean surfaces that will come into contact with grout.
4. Provide forms as required for placement of grout.

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5. Avoid air entrapment during placement of grout.
6. Place grout, completely filling equipment bases.
7. Place grout on concrete bases and provide smooth bearing surface for equipment.
8. Place grout around anchors.
9. Cure placed grout.
10. Finish exposed surface of grout for a neat appearance.

3.11 CLEANUP

A. In addition to cleanup specified under Division 01, thoroughly clean all parts of the equipment. Where exposed parts are to be painted, thoroughly clean off any splattered construction materials and remove all oil and grease spots. Wipe the surface carefully and scrape out all cracks and corners.

B. Thoroughly flush and clean all water systems.

C. During the progress of the work, keep the premises clean and free of debris.

3.12 PAINTING

A. Except as otherwise specified or indicated in the architectural drawings and/or specifications, paint all exposed unfinished metal with one coat of rust-inhibiting primer. Factory painted equipment shall be considered as having primed surface.

B. Damage and Touch-Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

C. Finished painting is specified under Division 09.

3.13 CONNECTIONS TO SERVICES

A. Provide all connections to water lines, except as otherwise specifically designated. Provide all necessary tees, taps and connections required to properly connect to building services. Verify all requirements with civil drawings before making any piping connections to water piping and conform to them during installation.

3.14 WELDING

A. Procedures:

1. All procedures and welders must be qualified in accordance with the requirements of Section IX, ASME Boiler and Pressure Vessel Code and ANSI code for power piping B31.1. Procedure qualification test records and acceptance shall be submitted with the welding procedure prior to the start of fabrication.
2. Architect's inspector or authorized representative will review performance qualification records of individual welders.

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3.15 COMMISSIONING

A. Provide commissioning services as directed in Division 01.

END OF SECTION 21 05 00

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SECTION 21 05 01

DEMONSTRATION & TRAINING FOR FIRE SPRINKLER SYSTEMS & COMPONENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for demonstration of proper operation of equipment and instructing Owner's personnel, including the following:

1. Demonstration of operation of systems and equipment.
2. Training in operation and maintenance of systems and equipment.

1.2 CLOSEOUT SUBMITTALS

A. At completion of training, submit complete training manual(s) for Owner's use.

1.3 QUALITY ASSURANCE

A. Instructor Qualifications: A factory-authorized service representative experienced in operation and maintenance procedures and training.

1.4 COORDINATION

A. Complete demonstrations prior to Substantial Completion.

B. Complete instruction prior to Final Completion.

C. Coordinate demonstration and instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.

D. Coordinate content of training modules with content of approved operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

a. System and equipment descriptions.

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b. Operating standards.
c. Regulatory requirements.
d. Equipment function.
e. Operating characteristics.
f. Limiting conditions.

2. Documentation: Review the following items in detail:

a. Emergency manuals.
b. Operations and Maintenance manuals.
c. Project record documents.
d. Identification systems.
e. Warranties and bonds.
f. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

a. Instructions on meaning of warnings, trouble indications, and error messages.
b. Sequences for electric or electronic systems.
c. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

a. Startup procedures.
b. Routine and normal operating instructions.
c. Regulation and control procedures.
d. Safety procedures.
e. Operating procedures for emergencies.
f. Required sequences for electric or electronic systems.
g. Special operating instructions and procedures.

5. Troubleshooting: Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

6. Maintenance: Include the following:

a. Inspection procedures.
b. Procedures for preventive maintenance.
c. Procedures for routine maintenance.
d. Instruction on use of special tools.

PART 3 - EXECUTION

3.1 PREPARATION

A. Inspect and test each system and piece of equipment prior to demonstration. Confirm proper operation prior to scheduling demonstrations.

1. Replace defective work or material.
2. Repeat inspection and testing until defects are eliminated.

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B. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements for "Operations and Maintenance Data."

3.2 DEMONSTRATION

A. Inspect and operate satisfactorily, in presence of Engineer and Owner, each system and item of equipment, including accessories.

3.3 INSTRUCTION

A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems.

1. Owner will furnish Contractor with names and positions of participants.

B. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of an oral or a demonstration performance-based test.

END OF SECTION 21 05 01

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SECTION 21 05 17

SLEEVES & SLEEVE SEALS FOR FIRE SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded or snap-lock longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. GPT, an EnPro Industries Company.
5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

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2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07.

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07.

3.2 SLEEVE-SEAL SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

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3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade: Cast-iron wall sleeves, Galvanized-steel wall sleeves or Galvanized-steel-pipe sleeves.
2. Exterior Concrete Walls below Grade:

   a. Piping Smaller Than NPS 4: Cast-iron wall sleeves with sleeve-seal system, Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

   b. Piping NPS 4 and Larger: Cast-iron wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

   a. Piping Smaller Than NPS 4: Cast-iron wall sleeves with sleeve-seal system, Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

   b. Piping NPS 4 and Larger: Cast-iron wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade: Galvanized-steel-pipe sleeves.
5. Interior Partitions:

   a. Piping Smaller than NPS 6: Galvanized-steel-pipe sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 21 05 17

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SECTION 21 05 20

ELECTRICAL & CONTROL WIRING FOR FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section is to be used for all low- and line- voltage wiring for fire suppression systems. All line-voltage work shall be performed by a licensed contractor qualified to perform the work and shall comply with the requirements contained in this section, or in Division 26 and Division 28.

B. This Section includes the following:

1. Metal conduits, tubing, and fittings.
2. Metal wireways and auxiliary gutters.
3. Surface raceways.
4. Boxes, enclosures, and cabinets.
5. Low-voltage control cabling.
6. Conductors and cables rated 600 V and less.
7. Connectors, splices, and terminations rated 600 V and less.
8. Identification products.
9. Identification of power and control cables.
10. Identification for conductors.

1.2 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include manufacturer's technical data, materials of construction and listings.

B. Field quality-control test reports.

C. Maintenance data.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

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.

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C. Comply with NFPA 70.

D. Comply with ANSI A13.1 for identification devices.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. GRC: Comply with ANSI C80.1 and UL 6.

C. IMC: Comply with ANSI C80.6 and UL 1242.

D. EMT: Comply with ANSI C80.3 and UL 797.

1. Color: Factory applied color per schedule below.

   a. Fire Alarm System: Red
   b. Power – Normal: Natural
   c. Power – Standby: Orange

E. FMC: Comply with UL 1; zinc-coated steel or aluminum.

F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:

   a. Material: Steel.
   b. Type: Setscrew or compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

H. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250; Type 1, Type 3R, Type 4 or Type 12, as required by location; and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

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B. Fittings and Accessories: Include covers, 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.

2.3 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Where installed in finished spaces, match color of adjacent surfaces.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

C. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

D. Device Box Dimensions: 4 inches square by 2-1/8 inches deep or 4 inches by 2-1/8 inches by 2-1/8 inches deep.

E. Gangable boxes are prohibited.

F. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250; Type 1, Type 3R, Type 4 or Type 12, as required by location; with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

G. Cabinets:

1. NEMA 250; Type 1, Type 3R or Type 12, as required by location; galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.5 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 16 or 18 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

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2.6 CONDUCTORS AND CABLES

A. Copper Conductors: Comply with NEMA WC 70.

B. Conductor Insulation: Comply with the following:

1. NEMA WC 70 for Types THHN-THWN and XHHW.
2. UL 83 for Types TW and TF.

2.7 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.8 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

2.9 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

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PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC or IMC.
2. Concealed Conduit, Aboveground: GRC, IMC or EMT.
3. Connection to Vibrating Equipment (Including Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated.

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Raceway locations include the following but not limited to:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Gymnasiums.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC or IMC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduit, boxes, or fittings in contact with concrete or earth.

F. Install surface raceways only in retrofit applications where indicated.

3.2 RACEWAY INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. 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.

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C. Comply with code requirements for hangers and supports.

D. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

E. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

F. Support conduit within 12 inches of enclosures to which attached.

G. Raceways Embedded in Slabs:

1. 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. Secure raceways to reinforcement at maximum 10-foot intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 1 inch of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

H. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or GRC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

K. 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.

L. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

M. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with 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.

N. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

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O. Expansion-Joint Fittings:

1. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
2. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

P. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 48 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for motors.

1. Use FMC in indoor, dry locations.
2. Use LFMC in all other locations.

Q. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

R. Locate boxes so that cover or plate will not span different building finishes.

S. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

T. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 CONDUCTOR MATERIAL APPLICATIONS

A. All conductors shall comply with the system manufacturer's requirements where they are more stringent than those listed below.

B. Control Circuit Sizing: Minimum sizes are listed below:

1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits, No. 12 AWG.

C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

D. Branch Circuit Sizing: Size conductors for circuits with less than a 20 ampere connected load, maximum of 16 amperes actual load, as follows:

1. For 120V circuits up to 65 feet in length from panel to center of load: Not smaller than No. 12.
2. For 120V circuits up to 110 feet in length from panel to center of load: Not smaller than No. 10.
3. For 120V circuits up to 165 feet in length from panel to center of load: Not smaller than No. 8.
4. For 120V circuits up to 255 feet in length from panel to center of load: Not smaller than No. 6.
5. For 208V circuits up to 110 feet in length from panel to center of load: Not smaller than No. 12.
6. For 208V circuits up to 185 feet in length from panel to center of load: Not smaller than No. 10.
7. For 208V circuits up to 280 feet in length from panel to center of load: Not smaller than No. 8.
8. For 208V circuits up to 440 feet in length from panel to center of load: Not smaller than No. 6.
9. For 277V circuits up to 150 feet in length from panel to center of load: Not smaller than No. 12.
10. For 277V circuits up to 250 feet in length from panel to center of load: Not smaller than No. 10.
11. For 277V circuits up to 380 feet in length from panel to center of load: Not smaller than No. 8.
12. For 277V circuits up to 590 feet in length from panel to center of load: Not smaller than No. 6.

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3.4 CONDUCTOR INSULATION APPLICATIONS AND WIRING METHODS

A. All conductors shall comply with the system manufacturer's requirements where they are more stringent than those listed below.

B. Comply with NECA 1.

C. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN or XHHW, single conductors in raceway.

D. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN or XHHW, single conductors in raceway.

E. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN or XHHW, single conductors in raceway.

F. Class 1 and 2 Control Circuits: Type THHN-THWN or XHHW, in raceway.

1. Final raceway connections for low-voltage control wiring to equipment, actuators and similar devices may be omitted where the devices are located above lay-in ceilings. Length of exposed wire is to be less than 24 inches.

G. Class 3 Control Circuits: Type TW or TF in raceway.

1. Final raceway connections for low-voltage control wiring to equipment, actuators and similar devices may be omitted where the devices are located above lay-in ceilings. Length of exposed wire is to be less than 24 inches.

3.5]INSTALLATION OF CONDUCTORS AND CABLES

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. Identify and color-code conductors and cables.

E. 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.

F. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

3.6 IDENTIFICATION INSTALLATION

A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

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B. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

3.7 IDENTIFICATION SCHEDULE

A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded branch-circuit conductors.

a. Color shall be factory applied.
b. Colors for 208/120-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.
4) Neutral: White.

c. Colors for 480/277-V Circuits:

1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.
4) Neutral: Gray.

B. Control Systems Conductor Identification: Identify field-installed control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

3.8 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables.

3.9 GROUNDING

A. For low-voltage wiring and cabling, comply with requirements in Division 26.

3.10 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 21 "Sleeves and Sleeve Seals for Fire Suppression Piping."

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3.11 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Comply with requirements in Division 07.

3.12 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to paint finishes with matching touchup coating recommended by manufacturer.

3.13 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections: Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. 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.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 21 05 20

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SECTION 21 05 53

IDENTIFICATION FOR FIRE SUPPRESSION PIPING & EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Valve tags.

1.2 SUBMITTAL

A. Product Data: For each type of product indicated.

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: Black.
3. Background Color: White.
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: 1/2 inch. Include secondary lettering 3/8 inch.
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. Coordinate with Owner.

2.2 WARNING SIGNS AND 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: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

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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: 1/2 inch. Include secondary lettering 3/8 inch.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: As indicated on drawings or required by local authority.

2.3 VALVE TAGS

A. Plastic Labels for Valves:

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: Black.
3. Background Color: White.
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: 1/2 inch. Include secondary lettering 3/8 inch.
7. Fasteners: Beaded chain.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean 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 fire suppression system equipment.

B. Locate equipment labels where accessible and visible.

3.3 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in fire suppression piping systems.

B. Valve tags shall include the following information:

1. Piping System: Wet sprinkler riser, pre-action riser, etc.
2. Area Served: First Floor, Data Room, etc.
3. Function: e.g., Inspector's Test, Isolation, etc.

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3.4 ADJUSTING AND CLEANING

A. Relocate fire suppression identification materials and devices that have become visually blocked by other work.

B. Clean faces of plumbing identification devices.

END OF SECTION 21 05 53

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SECTION 21 13 13

WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Fire-department connections.
4. Sprinklers.
5. Alarm devices.
6. Pressure gages.

1.2 SYSTEM DESCRIPTIONS

A. Performance Based Specifications: This section describes requirements necessary to design and install an automatic fire sprinkler system. The licensed Fire Sprinkler Contractor is responsible to design and install the complete fire sprinkler system per NFPA Requirements, per the requirements of the Local Authority Having Jurisdiction (AHJ) and per this specification.

B. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device.

1.3 PERFORMANCE REQUIREMENTS

A. Design and install a complete automatic wet fire sprinkler system as required by national and local codes that meets the requirements of the Authority Having Jurisdiction. Systems shall be full and complete with all components specified for each area protected. The system shall be in accordance with the required edition of the following:

1. Latest Edition of the "Northern Arizona University Fire Life safety Equipment Installation Guidelines."
2. NFPA, Chapter 13 entitled "Sprinkler Systems, Installation."
3. NFPA, Chapter 13R, "Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height."
4. NFPA, Chapter 25 entitled "Inspection, Testing and Maintenance of Water-Based Fire Protection Systems."
5. NFPA, Chapter 1963 entitled "Fire Hose Connections."
6. NFPA, Chapter 14 entitled "Standpipe and Hose Systems."
7. NFPA, Chapter 15 entitled "Water Spray Fixed Systems."
8. NFPA, Chapter 24 entitled "Private Fire Service Mains."
9. NFPA, Chapter 231C entitled "Rack Storage of Materials."
10. Refer to other chapters of the NFPA that are applicable.

B. Provide field verification of all dimensions. No extra charges or compensation will be allowed for any differences between actual dimensions and measurements indicated.

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C. Contractor shall pay for or perform flow tests on systems prior to completing fire sprinkler calculations and shop drawings.

D. Hydraulic design of the system shall be based on the following adjustments being made to the flow test results:

1. When flow test records a static pressure of over 100 psi, the static recorded test pressure shall be reduced to 75 psi and the original slope of the water supply curve shall be maintained.
2. When flow test records a static pressure between 100 psi and 60 psi, both the static and residual pressures shall be reduced by 25%.
3. When flow test records a static pressure between 60 psi and 50 psi, the static pressure shall be reduced to 45 psi and the original slope of the water supply curve shall be maintained.
4. When flow test records a static pressure less than 50 psi, then performance engineering is required and a multi-day pressure recording shall be conducted to verify test results.

E. Water velocity for interior piping should be limited to 10 fps on risers and 27 fps in main and branch line piping.

F. Securing and payment for all necessary permits and inspections.

G. Design and install the sprinkler system to the sprinkler occupancy hazard classifications as defined in NFPA and per the Authority Having Jurisdiction.

H. Minimum Density for Automatic-Sprinkler Piping Design:

1. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
2. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.

I. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Data information is to include pipe material, and manufacturer and model number of all components intended for use on this project.

B. Shop Drawings: For wet-pipe sprinkler systems. Include detailed plans, elevations, sections, details, and attachments to other work. Shop drawing to also include water calculations.

C. Provide a letter of acceptance from the Owner's fire protection insurer and complete printed instructions on operation of system to the Owner.

D. Welding certificates.

E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

F. Field quality-control reports.

G. Operation and maintenance data.

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1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems. Base calculations on results of fire-hydrant flow test and criteria stated herein.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer or NICET Designer.

B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

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

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Underground Piping: Underground piping shall conform to NFPA Standard 24 "Standard for Installation of Private Fire Mains." All pipe and fitting shall be cleaned of all debris, stone and dirt and inspected for cracks and holes before being laid. All underground piping shall be thoroughly flushed in accordance with the requirements of NFPA 13 and 24. The test must be witnessed by a proper authority.

B. Interior Piping: Piping 2" and smaller shall be a minimum of schedule 40 steel pipe. Piping greater than 2" shall be a minimum of schedule 10 steel pipe. All piping shall conform to NFPA 13, Table 2-3.1. All other types of pipe or tube are specifically prohibited. All piping shall be treated to prevent microbial induced corrosion.

2.2 LISTED FIRE-PROTECTION VALVES

A. General Requirements:

1. Valves shall be UL listed or FM approved.
2. Minimum Pressure Rating: 175 psig.

B. Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International, Inc.
b. Clow Valve Company; a division of McWane, Inc.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Crane Co.; Crane Valve Group; Jenkins Valves.
e. Crane Co.; Crane Valve Group; Stockham Division.
f. Kennedy Valve; a division of McWane, Inc.
g. Metraflex, Inc.
h. Milwaukee Valve Company.
i. Mueller Co.; Water Products Division.
j. NIBCO INC.

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k. Potter Roemer.
l. Reliable Automatic Sprinkler Co., Inc.
m. Tyco Fire & Building Products LP.
n. United Brass Works, Inc.
o. Victaulic Company.
p. Viking Corporation.
q. Watts Water Technologies, Inc.

2. Standard: UL 312.
3. Pressure Rating: 250 psig minimum.
4. Type: Swing check.
5. Body Material: Cast iron.
6. End Connections: Flanged or grooved.

C. Bronze OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. United Brass Works, Inc.

2. Standard: UL 262.
3. Pressure Rating: 175 psig.
4. Body Material: Bronze.
5. End Connections: Threaded.

D. Iron OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
b. American Valve, Inc.
c. Clow Valve Company; a division of McWane, Inc.
d. Crane Co.; Crane Valve Group; Crane Valves.
e. Crane Co.; Crane Valve Group; Jenkins Valves.
f. Crane Co.; Crane Valve Group; Stockham Division.
g. Hammond Valve.
h. Milwaukee Valve Company.
i. Mueller Co.; Water Products Division.
j. NIBCO INC.
k. Tyco Fire & Building Products LP.
l. United Brass Works, Inc.
m. Watts Water Technologies, Inc.

2. Standard: UL 262.
3. Pressure Rating: 250 psig minimum.
4. Body Material: Cast or ductile iron.
5. End Connections: Flanged or grooved.

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E. Indicating-Type Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Anvil International, Inc.
   b. Fivalco Inc.
   c. Global Safety Products, Inc.
   d. Kennedy Valve; a division of McWane, Inc.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Tyco Fire & Building Products LP.
   h. Victaulic Company.

2. Standard: UL 1091.
3. Pressure Rating: 175 psig minimum.
4. Valves NPS 2 and Smaller:

   a. Valve Type: Ball or butterfly.
   b. Body Material: Bronze.
   c. End Connections: Threaded.

5. Valves NPS 2-1/2 and Larger:

   a. Valve Type: Butterfly.
   b. Body Material: Cast or ductile iron.
   c. End Connections: Flanged, grooved, or wafer.

6. Valve Operation: Integral electrical, 115-V ac, prewired, two-circuit, supervisory switch indicating device.

2.3 TRIM AND DRAIN VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global listing.
2. Minimum Pressure Rating: 175 psig.

B. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Anvil International, Inc.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. Milwaukee Valve Company.
   d. NIBCO INC.
   e. Tyco Fire & Building Products LP.
   f. Victaulic Company.
   g. Watts Water Technologies, Inc.

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2.4 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global listing.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. AFAC Inc.
    b. Globe Fire Sprinkler Corporation.
    c. Reliable Automatic Sprinkler Co., Inc.
    d. Tyco Fire & Building Products LP.
    e. Victaulic Company.
    f. Viking Corporation.
2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping if retarding chamber is required else pipe drain with check valve to main drain piping.

C. Automatic Ball Drip Drain Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. AFAC Inc.
    b. Reliable Automatic Sprinkler Co., Inc.
    c. Tyco Fire & Building Products LP.
2. Standard: UL 1726.
3. Pressure Rating: 175 psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4.
6. End Connections: Threaded.

2.5 FIRE-DEPARTMENT CONNECTIONS

A. Flush-Type, Fire-Department Connection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. AFAC Inc.
    b. Elkhart Brass Mfg. Company, Inc.

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c. GMR International Equipment Corporation.
d. Guardian Fire Equipment, Inc.
e. Potter Roemer.

2. Standard: UL 405.
3. Type: Flush, for wall mounting.
4. Pressure Rating: 175 psig minimum.
5. Body Material: Corrosion-resistant metal.
6. Inlets: Brass with threads according to NFPA 1963 and matching local fire department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain, or as directed by local fire department.
8. Escutcheon Plate: Rectangular, brass, wall type.
9. Outlet: With pipe threads.
10. Body Style: Horizontal
11. Number of Inlets: Two
12. Outlet Location: Back
13. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."
14. Finish: Polished chrome plated
15. Outlet Size: NPS 4

2.6 SPRINKLER SPECIALTY PIPE FITTINGS

A. Flow Detection and Test Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AGF Manufacturing Inc.
b. Reliable Automatic Sprinkler Co., Inc.
c. Tyco Fire & Building Products LP.
d. Victaulic Company.

2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global listing.
3. Pressure Rating: 175 psig minimum
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

B. Sprinkler Inspector's Test Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AGF Manufacturing Inc.
b. Triple R Specialty.
c. Tyco Fire & Building Products LP.
d. Victaulic Company.
e. Viking Corporation.

2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global listing.
3. Pressure Rating: 175 psig minimum.

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4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

2.7 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire & Building Products LP.
3. Victaulic Company.
4. Viking Corporation.

B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
3. Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Sprinkler Finishes:

1. Chrome plated.
2. Bronze.
3. Painted.

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

F. Sprinkler Guards:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Reliable Automatic Sprinkler Co., Inc.
    b. Tyco Fire & Building Products LP.
    c. Victaulic Company.
    d. Viking Corporation.

2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

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2.8 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Globe Fire Sprinkler Corporation.
   b. Tyco Fire & Building Products LP.
   c. Victaulic Company.
   d. Viking Corporation.

2. Standard: UL 753.
3. Type: Mechanically operated, with Pelton wheel.
4. Alarm Gong: Cast aluminum with red-enamel factory finish.
5. Size: 10-inch diameter.
6. Components: Shaft length, bearings, and sleeve to suit wall construction.
7. Inlet: NPS 3/4.
8. Outlet: NPS 1 drain connection.

C. Water-Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ADT Security Services, Inc.
   b. McDonnell & Miller; ITT Industries.
   c. Potter Electric Signal Company.
   d. System Sensor; a Honeywell company.
   e. Viking Corporation.
   f. Watts Industries (Canada) Inc.

2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

D. Valve Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Fire-Lite Alarms, Inc.; a Honeywell company.
   b. Kennedy Valve; a division of McWane, Inc.
   c. Potter Electric Signal Company.
   d. System Sensor; a Honeywell company.

2. Standard: UL 346.
3. Type: Electrically supervised.

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4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

2.9 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AMETEK; U.S. Gauge Division.
2. Ashcroft, Inc.
3. Brecco Corporation.
4. WIKA Instrument Corporation.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gage Range: 0 to 250 psig minimum.

E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

F. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 WATER-SUPPLY CONNECTIONS

A. Prior to connecting sprinkler piping to interior water distribution piping, verify flushing of piping has been completed.

B. Connect sprinkler piping to building's interior water-distribution piping.

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Piping and sprinkler head locations are to be coordinated in the field with other trades and the final ceiling layout.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Install seismic restraints on piping where required. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 and smaller.

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F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

H. Install sprinkler piping with drains for complete system drainage.

I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install automatic, ball drip, drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

K. Install alarm devices in piping systems.

L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

N. Fill sprinkler system piping with water.

O. Install sleeves for piping penetrations of walls, ceilings, and floors.

P. Install sleeve seals for piping penetrations of concrete walls and slabs.

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors.

R. Install flexible couplings within 24" of building expansion joints.

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

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G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

K. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

L. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves where required in potable-water-supply sources.

D. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

3.5 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

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3.6 FIRE-DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire-department connections.

B. Install automatic, ball drip, drain valve at each check valve for fire-department connection.

3.7 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Start and run excess-pressure pumps.
6. Coordinate with fire-alarm tests. Operate as required.
7. Verify that equipment hose threads are same as local fire-department equipment.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

3.10 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers
2. Non-Public Rooms with suspended hard ceilings.
3. Rooms with Suspended Lay-in Ceilings: Recessed sprinklers.
4. Wall Mounting: Sidewall sprinklers.
5. Spaces Subject to Freezing: Pendent or Sidewall dry sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.

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2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
4. Upright, Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.

END OF SECTION 21 13 13

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SECTION 22 05 00

GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE

A. Provisions of this section apply to all work specified in all sections under Division 22.

B. In addition, work in Division 22 is governed by the provisions of the Bidding Requirements, Contract Forms, General Conditions, and all sections under Division 01, General Requirements.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 EXAMINATION OF PREMISES

A. Visit the site, verify all measurements and job conditions, and pay all costs necessary to perform the work.

1.4 PLUMBING CONTRACTOR

A. The Plumbing Contractor shall be licensed and hold a current contracting license that has been valid for a minimum of two years in the State of Arizona as a plumbing contractor.

1.5 REGULATIONS, PERMITS, FEES, CHARGES, INSPECTIONS

A. Regulations: Comply with all applicable codes, rules and regulations.

B. Fees and Permits: Pay all connection, installation, use, development, etc., fees and/or charges. Obtain and pay for all required permits and licenses. Refer to Division 01.

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C. Inspections: All work must be inspected and approved by local authorities. Prior to final approval, furnish the Architect with certificates of inspections and approvals by the local authorities in accordance with Division 01.

1.6 DRAWINGS AND SPECIFICATIONS

A. Refer to Division 01 for additional information on submittals and shop drawings.

B. If a conflict exists on the drawings or between the drawings and specifications, promptly notify the Architect.

1.7 SUBMITTALS

A. Submittals are for information and coordination only. The Engineer will diligently review the submittals and attempt to verify compliance with the project requirements. Such review, however, does not constitute approval or disapproval of obligation to comply with all project requirements. The submittals are not to be construed to be contract documents. Any failure by the Engineer to note a point of non-compliance shall not be construed to be acceptance or approval of the discrepancy.

B. Product Information Sheets: Provide manufacturer's literature which includes the information required by the Product Data paragraph of the applicable Specification Section. Where Product Information Sheets show multiple models or options, clearly mark the model and options to be provided.

C. Assembly: Assemble all required submittal information for each specification section and submit in PDF format.

1. Assemble PDF submittals in one PDF file for each Division. Separate and order sections within each file by corresponding specification number. Provide bookmarks at the first page of each section and label each bookmark with the specification number and name to allow for easy navigation of the submittal.
2. Partial submittals will be returned without review.

D. Identification and Information:

1. Name the PDF file with the Project name, Division number and sequential submittal number. (I.E. The first submittal shall be No. 1; the second submittal shall be No. 2.)
2. Provide a cover sheet at the front of each submittal with the following information:

    a. Project name.
    b. Date.
    c. Name of Engineer.
    d. Name of Contractor.
    e. Name of subcontractor.

3. Provide a cover sheet at the front of each submittal section with the following information:

    a. Name of supplier.
    b. Name of manufacturer.
    c. Number and title of appropriate Specification Section.
    d. Drawing number and detail references, as appropriate.
    e. Other necessary identification.

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E. Options:

1. Identify options requiring selection by the Engineer.
2. Identify options included with submittal item.

F. Deviations: Identify deviations from the Contract Documents on submittals.

1.8 MATERIAL SAFETY DATA SHEETS

A. Provide current, Material Safety Data Sheets (MSDS), for all hazardous chemicals that are proposed for use at the project site.

1. Provide one complete set to the Owner for review and approval a minimum of one week prior to the delivery of any hazardous chemicals to the site.
2. Maintain a second complete set at the project location, readily accessible by both the Owner's personnel and the contractor's personnel.

1.9 REQUEST FOR INFORMATION

A. Request for Information:

1. A document submitted by the Contractor requesting clarification of a portion of the Contract Documents, hereinafter referred to as RFI.
2. A properly prepared request for information shall include a detailed written statement of the clarification, apparent conflict, or information requested that indicates the specific drawings or specification in need of clarification and the nature of the clarification requested.

    a. Drawings shall be identified by drawing number and location on the drawing sheet.
    b. Specifications shall be identified by section number, page, and paragraph.

3. Include a proposed solution, where appropriate, based upon the field conditions and best knowledge of the Contractor.

B. Improper or Frivolous RFIs: RFIs which are not properly prepared or that request information which is clearly shown in the contract documents will be returned unanswered. Processing time for multiple submissions of improper or frivolous RFIs will be billed at the Engineer's standard hourly rate to the Owner who may deduct an equal amount from the monies due the Contractor.

1.10 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings, Submittals and Shop Drawings.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Include underground and overhead piping. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

    a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.

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b. Include dimensions both horizontally and vertically to permanent points of reference accurate within 6 inches. Include descriptors such as "below slab", "above ceiling", etc.
c. Record data daily or as soon as possible after obtaining it.
d. Record and check the markup before enclosing concealed installations.

2. Mark the Contract Drawings, Submittals and Shop Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of marked-up record prints.
3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Identification: As follows:

a. Project name.
b. Date.
c. Designation "PROJECT RECORD DRAWINGS."
d. Name of Engineer.
e. Name of Contractor.

3. Remove or obscure Engineer's seal from Record Drawings.

1.11 OPERATION AND MAINTENANCE MANUAL

A. Prior to completion of the project, compile a complete equipment, operation and maintenance manual for all equipment supplied under Division 22.

B. Schedule:

1. Submit a preliminary copy of the manual not less than 30 days prior to substantial completion for review and comment.
2. Submit the final version the manual not more than four weeks after substantial completion of the project.

C. Format: Submit manuals in both of the following formats:

1. PDF electronic file. Assemble each manual into a composite electronically-indexed file. Submit on digital media acceptable to Engineer.

a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically-linked operation and maintenance directory.
b. Enable inserted reviewer comments on draft submittals.
c. Provide one final copy to Engineer and two copies to Owner.

2. Three paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. Engineer will return three copies.

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D. Provide operating and maintenance manuals for all systems, subsystems, and equipment that requires operation and regular maintenance, or has replaceable parts.

E. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, product data, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below. In addition to requirements in this Section, include operation and maintenance data required in individual Specification Sections.

F. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

G. Product Data: Include the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Approved submittals.
3. Include the following if not shown on approved submittals:

    a. Product name and model number. Use designations for products indicated on Contract Documents.
    b. Manufacturer's name.
    c. Equipment identification with serial number of each component.
    d. Equipment function.
    e. Operating characteristics.
    f. Limiting conditions.
    g. Performance curves.
    h. Engineering data and tests.

H. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures. Including precautions against improper use.
10. Operating logs.

I. Wiring Diagrams: Diagram of factory installed wiring including any options as well as any field modifications.

J. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

K. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification. Include valve locations and designations.

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L. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

M. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

N. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

O. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

P. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

Q. Licenses: Include copies of any licenses with requirements including inspection and renewal dates.

R. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1.12 WORK AND MATERIALS

A. Unless otherwise specified, all materials must be new and of the quality specified. The workmanship shall be of a quality that is acceptable to the Architect, Engineer, and Owner, and is equal to the standards of the trades. Contractor must staff the project with sufficient skilled workmen, including a fully qualified construction superintendent, to complete the work in the time allotted. The superintendent must be qualified to supervise all of the work in his work category.

B. Uniformity: Unless otherwise specified, provide all equipment and products of same type or classification by the same manufacturer.

C. All piping, fittings, valves, and equipment shall be made in the USA. Documentation shall be supplied with the submittals.

1.13 APPROVALS OF MATERIALS AND EQUIPMENT

A. Refer to Division 01 for description of material and equipment for prior approvals and substitutions.

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1.14 COOPERATIVE WORK

A. Correct without charge any work requiring alteration due to lack of proper supervision or failure to make proper provision in time. Correct without charge any damage to adjacent work caused by the alteration. See Division 01 for additional requirements.

B. Cooperative Work Includes:

1. General supervision and responsibility for proper location, rough-in and size of work related to Division 22 but provided under other divisions of these specifications.
2. Installation of sleeves, inserts and anchors bolts for work under sections in Division 22.

1.15 CONSTRUCTION FACILITIES

A. General: Under this division of the specifications, execute all work in a manner to provide safe and lawful ingress and egress to the Owner's establishment and such facilities shall be kept clear of materials or equipment. Refer to Division 01 for additional requirements.

B. Furnish and maintain from the beginning to the completion of all work all lawful and necessary guards, railings, fences, canopies, lights, and warning signs. Take all necessary precautions required by city and state laws to avoid injury or damage to any and all persons and property.

1.16 GUARANTEE

A. Guarantee all material, equipment, installation and workmanship for all sections under Division 22 in writing to be free from defects of material and workmanship for one year from date of final acceptance as outlined in Division 01. Equipment warranties shall be a minimum of two years from date of substantial completion or as specified elsewhere. Replace without charge any material or equipment proving defective during this period. The guarantee shall include performance of the equipment under all conditions.

1.17 ELECTRICAL WORK

A. Electrical wiring, including power wiring and control wiring, except as otherwise specified under Division 22, all raceways, outlet and junction boxes, and labor for installation of the wiring and equipment shall be included in Division 26 of the specifications.

B. All loose starters and control devices for equipment furnished under Division 22, except as otherwise specified under Division 22, are to be furnished under that particular section of Division 22 and installed under Division 26.

C. Contractor shall be responsible for the checking and testing of all controls and the interlocks for a complete and satisfactory operating system.

D. Before ordering any motors and equipment, verify the available voltage and phase for all motors with the Division 26 Contractor.

E. Submit a complete list of all motors prior to final closeout of job indicating the location, horsepower, voltage, phase, and amperage draw of each motor.

F. All field wiring and equipment must conform to the applicable Division 26 specification sections.

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1.18 COMMISSIONNING

A. This project will be commissioned. See commissioning requirements in Division 01.

PART 2 - PRODUCTS

2.1 EQUIPMENT DESIGN AND INSTALLATION

A. Design: Design all equipment in accordance with latest edition of ASME, AGA, UL and other applicable technical standards as follows:

1. Pressure Vessels: ASME Code constructed and stamped.
2. Electric Appliances: UL labeled.

2.2 GROUT

A. Description: ASTM C1107, Grade B, non-shrink and non-metallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, non-staining, non-corrosive, non-gaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SUBMITTALS

A. Prepare submittals as directed for review by the Contractor, Owner, Architect, and Engineer.

B. Submit one copy of PDF submittals via email, project website or other electronic media.

3.2 RECORD DRAWINGS

A. Recording: Post changes and modifications to project record documents as they occur; do not wait until the end of Project.

B. Maintenance of Record Documents and Samples: Store record documents in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Engineer's reference during normal working hours.

3.3 OPERATION AND MAINTENANCE MANUALS

A. Prepare Operation and Maintenance Manuals as directed for review by the Contractor, Owner, Architect, and Engineer.

B. Make corrections and resubmit as required.

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3.4 VERIFICATION OF DIMENSIONS

A. Scaled and figured dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions at site, and be responsible for properly fitting equipment and materials together and to the structure in spaces provided.

B. Drawings are essentially diagrammatic and many offsets, bends, special fittings and exact locations are not indicated. Carefully study drawings and premises in order to determine best methods, exact locations, routes, building obstructions, and install apparatus and equipment in available locations. Install apparatus and equipment in manner and in locations to avoid obstructions, preserve headroom, and keep openings and passageways clear.

3.5 CUTTING AND PATCHING

A. Cut work and patch per Division 01 as necessary to properly install the new work. As the work progresses, coordinate necessary openings, holes, chases, etc., in their correct location. If the required openings, holes and chases are not in their correct locations, make the necessary corrections at no cost to the Owner. Avoid excessive cutting and do not cut structural members without the consent of the Architect. Include as a part of the work all structural framing required by penetrations through the roof and necessary steel to support ducts and pipes between structural steel unless shown on the structural drawings.

3.6 CLOSING-IN OF UNFINISHED WORK

A. Cover no work until inspected, tested and approved. Where work is covered before inspection and test, uncover it, and when inspected, tested and approved, restore all work to original proper condition.

3.7 EXCAVATION AND BACKFILL

A. Perform all necessary excavation, shoring and backfilling required for the proper laying of all pipes inside the building and premises, and outside as may be necessary. Remove all excess excavated materials from the site or dispose of on site as directed by General Contractor.

B. Excavate all trenches open cut, keep trench banks as nearly vertical as practicable, and sheet and brace trenches where required for stability and safety. Excavate trenches true to line and make bottoms not less than 18" wide but no wider than necessary to provide ample work room. Grade trench bottoms accurately to provide uniform bearing and support for each section of pipe on undisturbed soil along its entire length. Dig "bell" holes after the trench bottom has been graded. Machine grade only to the top line of the pipes, doing the balance by hand. Do not cut any trench near or under footings without first consulting the Architect. Comply with OSHA requirements.

C. Provide not less than 4 inches of granular material as pipe bedding prior to laying pipe in trench to continuously support pipe and maintain required slope. Granular material shall be pea gravel or sand per MAG Standards.

D. Provide backfilling and compaction in accordance with provisions of these specifications and under the direction of the Architect to the required density.

E. Provide not less than 4 inches of granular material, same as piping bedding, all around pipe. Make the first 2 feet of fill in 6 inch layers, each thoroughly compacted as directed, and free from rocks, large clods of earth, leaves, branches, and debris. Compact the rest of the backfill as directed, using in the backfill no rocks larger than 4 inches in diameter, and using no rock in the top 12 inches.

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3.8 ACCESSIBILITY

A. Install valves, thermometers, gauges, traps, cleanouts, control devices or other specialties requiring reading, adjustment, inspection, repairs, removal or replacement conveniently and accessibly throughout the finished building. Where any of these devices are shown on the contract drawings to be installed above any inaccessible ceiling or behind any inaccessible wall, the Plumbing Contractor shall furnish access doors or panels as required.

B. All access doors or panels in walls and ceilings required for access to control devices, traps, valves and similar devices are to be furnished and installed as part of the work under this section. Provide type as specified under Division 08.

C. Refer to architectural drawings for type of wall and ceiling in each area and for rated construction.

D. Coordinate work of various sections to locate valves, traps, etc. with others to avoid unnecessary duplication of access doors.

E. The Contractor, along with the Owner's representative, shall complete the Plumbing Accessibility/Clearance Checklist at the end of this section for all plumbing equipment. The chart shall be submitted to the Architect for approval prior to substantial completion. All conflicts shall be resolved to the Architect's and Owner's satisfaction prior to submission.

3.9 ROOF FLASHINGS

A. Flash and counterflash all piping penetrating roofing membrane with flashing per roofing manufacturer's recommendations. Refer to architectural drawings for detailing of pipe penetrations through roof.

3.10 PRODUCT AND EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. All equipment, valves, sensors, etc., shall be installed in strict conformance with the manufacturer's recommendations and all codes.

B. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.

E. Install equipment to allow right-of-way for piping installed at required slope.

F. Do not install any equipment in an application not recommended by the manufacturer.

3.11 EQUIPMENT ROUGH-IN

A. Rough in all equipment and fixtures as designated on the drawings and in the specifications. The drawings indicate only the approximate location of rough-ins. The exact rough-in locations must be determined from large-scale certified drawings. The Contractor shall obtain all certified rough-in information before progressing with any work for rough-in final connections.

B. Be responsible for providing all outlets and services of proper size at the required locations.

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C. Minor changes in the contract drawings shall be anticipated and provided for under this contract.

1. Rough-in only (unless otherwise designated on the drawings) shall include providing all services as indicated and required, including all piping and valves. Valve and cap all piping stub-outs.

3.12 OWNER-FURNISHED AND OTHER EQUIPMENT

A. Rough-in only for all Owner-furnished equipment see Division 01 and all equipment furnished under other sections of the specifications, except as otherwise specified and/or noted on the drawings.

B. Provide all services designated, valve and cap all piping, and leave in a clean and orderly manner.

3.13 EQUIPMENT FINAL CONNECTIONS

A. Provide all piping final connections for all equipment under Division 22 and as indicated on the drawings.

3.14 EQUIPMENT SUPPORTS

A. Erection of Metal Supports and Anchorages:

1. Refer to Division 05 for structural steel.
2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment. Neatly fabricate and erect steel work with burrs and welding spatter ground off. Paint after fabrication with a rust-inhibitive primer.
3. Field Welding: Comply with AWS D1.1.

B. Erection of Wood Supports and Anchorages:

1. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support and anchor plumbing materials and equipment.
2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
3. Attach to substrates as required to support applied loads.

C. Where supports, foundations, stands, suspended platforms for machinery, tanks, or other equipment are indicated or specified, perform the following:

1. Locate support members to avoid equipment strains and interference with piping connections and maintenance operations.
2. Where saddles are required, use cast iron or welded steel saddles with curvature to fit the tank shell.
3. Mount power-driven equipment on common base with driver.

D. Concrete Inserts: Furnish and install all concrete inserts required for all materials and equipment specified and/or shown on the drawings for Division 22.

E. Concrete Bases: Work under this section includes coordination of construction of all concrete foundations indicated or required for equipment specified under Division 22. Materials and workmanship shall be described under Division 03. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at project.

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1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extends through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

F. Grouting:

1. Grout under all equipment after leveling, filling completely the space between machinery bed plate and foundation surface as specified in Division 03.
2. Mix and install grout for plumbing equipment base bearing surfaces, pumps and other equipment base plates, and anchors.
3. Clean surfaces that will come into contact with grout.
4. Provide forms as required for placement of grout.
5. Avoid air entrapment during placement of grout.
6. Place grout, completely filling equipment bases.
7. Place grout on concrete bases and provide smooth bearing surface for equipment.
8. Place grout around anchors.
9. Cure placed grout.
10. Finish exposed surface of grout for a neat appearance.

3.15 CLEANUP

A. In addition to cleanup specified under Division 01, thoroughly clean all parts of the equipment and fixtures. Where exposed parts are to be painted, thoroughly clean off any splattered construction materials and remove all oil and grease spots. Wipe the surface carefully and scrape out all cracks and corners.

B. Thoroughly flush and clean all water systems.

C. During the progress of the work, keep the premises clean and free of debris.

3.16 PAINTING

A. Except as otherwise specified or indicated in the architectural drawings and/or specifications, paint all exposed unfinished metal with one coat of rust-inhibiting primer. Factory painted equipment shall be considered as having primed surface.

B. Damage and Touch-Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

C. Finished painting is specified under Division 09.

3.17 CONNECTIONS TO SERVICES

A. Provide all connections to sanitary sewer lines, storm water lines, gas lines, and water lines, except as otherwise specifically designated. Provide all necessary tees, taps and connections required to properly

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connect to all building services. Verify all requirements with civil drawings before making any piping connections to sanitary sewer, storm sewer, water or gas piping and conform to them during installation.

3.18 OBJECTIONABLE NOISE AND VIBRATION

A. Construct and brace piping systems to prevent vibration or rattling when systems are in operation. Install connections to equipment so noise and vibration will not reach the conditioned area through piping, conduit, or the building structure.

3.19 WELDING

A. Procedures:

1. All procedures and welders must be qualified in accordance with the requirements of Section IX, ASME Boiler and Pressure Vessel Code and ANSI code for power piping B31.1. Procedure qualification test records and acceptance shall be submitted with the welding procedure prior to the start of fabrication.
2. Architect's inspector or authorized representative will review performance qualification records of individual welders.

3.20 COMMISSIONING

A. Provide commissioning services as directed in Division 01.

END OF SECTION 22 05 00

PLUMBING ACCESSIBILITY / CLEARANCE CHECKLIST
(See Paragraph 3.8.E)

Bldg.	Location	Unit #	Acceptable Access		Conflict	Date	Action	Observer	
			Yes	No				Owner	Contractor

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SECTION 22 05 01

DEMONSTRATION & TRAINING FOR PLUMBING SYSTEMS & COMPONENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for demonstration of proper operation of equipment and instructing Owner's personnel, including the following:

1. Demonstration of operation of systems, subsystems, and equipment.
2. Training in operation and maintenance of systems, subsystems, and equipment.

1.2 CLOSEOUT SUBMITTALS

A. At completion of training, submit complete training manual(s) for Owner's use.

1.3 QUALITY ASSURANCE

A. Instructor Qualifications: A factory-authorized service representative experienced in operation and maintenance procedures and training.

1.4 COORDINATION

A. Complete demonstrations prior to Substantial Completion.

B. Complete instruction prior to Final Completion.

C. Coordinate demonstration and instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.

D. Coordinate content of training modules with content of approved operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system. Include training for all plumbing systems and equipment such as water heaters, water softeners, booster pumps, mixing valves, flush valves, etc. and as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

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1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

    a. System, subsystem, and equipment descriptions.
    b. Operating standards.
    c. Regulatory requirements.
    d. Equipment function.
    e. Operating characteristics.
    f. Limiting conditions.
    g. Performance curves.

2. Documentation: Review the following items in detail:

    a. Emergency manuals.
    b. Operations and Maintenance manuals.
    c. Project record documents.
    d. Identification systems.
    e. Warranties and bonds.
    f. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

    a. Instructions on meaning of warnings, trouble indications, and error messages.
    b. Instructions on stopping.
    c. Shutdown instructions for each type of emergency.
    d. Operating instructions for conditions outside of normal operating limits.
    e. Sequences for electric or electronic systems.
    f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

    a. Startup procedures.
    b. Equipment or system break-in procedures.
    c. Routine and normal operating instructions.
    d. Regulation and control procedures.
    e. Control sequences.
    f. Safety procedures.
    g. Instructions on stopping.
    h. Normal shutdown instructions.
    i. Operating procedures for emergencies.
    j. Operating procedures for system, subsystem, or equipment failure.
    k. Seasonal and weekend operating instructions.
    l. Required sequences for electric or electronic systems.
    m. Special operating instructions and procedures.

5. Adjustments: Include the following:

    a. Alignments.
    b. Checking adjustments.
    c. Noise and vibration adjustments.
    d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

    a. Diagnostic instructions.
    b. Test and inspection procedures.

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7. Maintenance: Include the following:

   a. Inspection procedures.
   b. Types of cleaning agents to be used and methods of cleaning.
   c. List of cleaning agents and methods of cleaning detrimental to product.
   d. Procedures for routine cleaning
   e. Procedures for preventive maintenance.
   f. Procedures for routine maintenance.
   g. Instruction on use of special tools.

8. Repairs: Include the following:

   a. Diagnosis instructions.
   b. Repair instructions.
   c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   d. Instructions for identifying parts and components.
   e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

A. Inspect and test each system, subsystem and piece of equipment prior to demonstration. Confirm proper operation prior to scheduling demonstrations.

   1. Replace defective work or material.
   2. Repeat inspection and testing until defects are eliminated.

B. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements for "Operations and Maintenance Data."

3.2 DEMONSTRATION

A. Inspect and operate satisfactorily, in presence of Engineer and Owner, each system and item of equipment, including accessories.

3.3 INSTRUCTION

A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

   1. Owner will furnish Contractor with names and positions of participants.

B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

   1. Schedule training with Owner with at least seven days' advance notice.

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C. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of an oral or a demonstration performance-based test.

END OF SECTION 22 05 01

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SECTION 22 05 13

COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 104 deg F and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

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D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers:

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 HP shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

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E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 22 05 13

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SECTION 22 05 16

EXPANSION FITTINGS & LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal-bellows packless expansion joints.
2. Alignment guides and anchors.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Maintenance data.

PART 2 - PRODUCTS

2.1 PACKLESS EXPANSION JOINTS

A. Metal-Bellows Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Adsco Manufacturing LLC.
b. Flexicraft Industries.
c. Flex Hose Co., Inc.
d. Flex Pression Ltd.
e. Flex-Weld, Inc.
f. Hyspan Precision Products, Inc.
g. Metraflex, Inc.
h. Mason-Mercer.

2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
3. Type: Circular, corrugated bellows with external tie rods or circular corrugated bellows with braided hose covering.
4. Minimum Pressure Rating: 150 psig unless otherwise indicated.
5. Configuration: Straight, looped or vee class(es) unless otherwise indicated.
6. Expansion Joints for Copper Tubing: Single or multi-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.

a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint.
b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint or brazed.
c. End Connections for Copper Tubing NPS 5 and Larger: Flanged.

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2.2 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

1. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

   a. Stud: Threaded, zinc-coated carbon steel.
   b. Expansion Plug: Zinc-coated steel.
   c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

   a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
   b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
   c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

3.2 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide on each side of pipe expansion fittings. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

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E. Anchor Attachments:

1. Anchor Attachment to Black-Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Anchor Attachment to Galvanized-Steel Pipe: Attach with pipe hangers. Use MSS SP-69, Type 42, riser clamp welded to anchor.
3. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 22 05 16

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SECTION 22 05 17

SLEEVES & SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded or snap-lock longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. GPT, an EnPro Industries Company.
5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.

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3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07.

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07.

3.2 SLEEVE-SEAL SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

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3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade: Cast-iron wall sleeves, Galvanized-steel wall sleeves or Galvanized-steel-pipe sleeves.
2. Exterior Concrete Walls below Grade:

   a. Piping Smaller Than NPS 4: Cast-iron wall sleeves with sleeve-seal system, Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

   b. Piping NPS 4 and Larger: Cast-iron wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

   a. Piping Smaller Than NPS 4: Cast-iron wall sleeves with sleeve-seal system, Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

   b. Piping NPS 4 and Larger: Cast-iron wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade: Galvanized-steel-pipe sleeves.
5. Interior Partitions:

   a. Piping Smaller than NPS 6: Galvanized-steel-pipe sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 22 05 17

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SECTION 22 05 18

ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw and polished chrome-plated finish.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting, Floor Plate Type: Cast-brass with concealed hinge and set screw.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

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1. Escutcheons for New Piping:

    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    b. Insulated Piping: One-piece, stamped-steel type.
    c. Bare Piping: One-piece, cast-brass type.

2. Escutcheons for existing piping shall be split-casting, cast-brass type.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 22 05 18

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SECTION 22 05 19

METERS & GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Water Meters.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product certificates.

C. Operation and maintenance data.

PART 2- PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETER

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Miljoco Corporation.
b. Palmer Wahl Instrumentation Group.
c. Trerise, H.O. Co.
d. Weiss Instruments, Inc.
e. Winters Instruments – U.S.

2. Standard: ASME B40.200.
3. Case: Cast aluminum, 9-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Bare aluminum and of length to suit installation.
9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.

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10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: Copper-nickel (90-10).
4. Material for Use with Steel Piping: Stainless Steel.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

2.3 PRESSURE GAGES

A. Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Marsh Bellofram.
    b. Miljoco Corporation.
    c. Palmer Wahl Instrumentation Group.
    d. Trerice, H. O. Co.
    e. Weiss Instruments, Inc.
    f. Weksler.

2. Standard: ASME B40.100.
3. Case: Liquid-filled Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and surge-dampening device. Include extension for use on insulated piping.

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B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2 ASME B1.20.1 pipe threads.

2.5 WATER METERS

A. Basis of Design: Subject to compliance with requirements, provide the following product:

1. Hersey MVR by Mueller Systems.

B. AWWA C701 Class I, vertical turbine, magnetic-drive, totalization meter.

1. Body: Bronze.

C. Maximum Pressure Loss at Design Flow: 5 psig.

D. Registration: Gallons or cubic feet with sweep hand and low flow leak detector.

E. Display: Remote mounting.

F. Meter shall match size of adjacent piping.

PART 3- EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids.

H. Install thermometers where indicated on drawings and in the following locations:

1. Outlet of each water heater.
2. Two inlets and one outlet of each mixing valve.
3. Inlet and outlet of each thermal-storage tank.

I. Install pressure gages where indicated on drawings and in the following locations:

1. Discharge of each pressure-reducing valve.
2. Each pump. Provide one gage per pump with tubing and valves to allow measurement at strainer inlet, pump inlet and pump discharge.

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J. Install water meters with isolation valve upstream and downstream of meter.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Cold- and Hot-Water Piping: 0 to 150 deg F.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range: 0 to 100 psi.

END OF SECTION 22 05 19

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SECTION 22 05 23

GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball valves.
2. Bronze swing check valves.
3. Iron swing check valves.
4. Iron swing check valves with closure control.
5. Iron gate valves.
6. Chainwheels.

1.2 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.3 QUALITY ASSURANCE

A. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

B. NSF Compliance: NSF 61 for valve materials for potable-water service.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

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

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

D. Valve Actuator Types:

1. Handwheel: For valves other than quarter-turn types.
2. Handlever: For quarter-turn valves NPS 4 and smaller except plug valves.
3. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.

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2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

G. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Jomar Valve.
2. Milwaukee Valve Company.

2.2 BALL VALVES

A. Two-Piece, Full-Port Ball Valves with Bronze Trim:

1. Description:

a. Standard: MSS SP-110.
b. Compliance: ANSI/NSF 372 lead free.
c. SWP Rating: 150 psig.
d. CWP Rating: 600 psig.
e. Body Design: Two piece.
f. Body Material:

1) Valves 2 inches and smaller: Forged bronze.
2) Valves 2-1/2 inches and larger: Forged bronze or brass.

g. Ends: Soldered or threaded as indicated below.
h. Seats: PTFE or TFE.
i. Stem: Bronze or brass to match valve body.
j. Ball: Chrome-plated brass.
k. Port: Full.

B. Two-Piece, Full-Port Cast Iron Ball Valves:

1. Description

a. Standard: ANSI B16.10.
b. Compliance:

1) ANSI/NSF 61-8 drinking water safe.
2) ANSI/NSF 372 lead free.

c. CWP Rating: 200 psig.
d. SWP Rating: 125 psig.
e. Body Design: Two piece.
f. Body Material: Epoxy coated cast iron.
g. Ends: Flanged.
h. Seats: PTFE or TFE.
i. Stem: Stainless steel, blowout proof design.

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j. Ball: Teflon fused cast iron or stainless steel.
k. Port: Full.

2.3 CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Description:

a. Standard: MSS SP-80, Type 3.
b. Compliance: ANSI/NSF 372 lead free.
c. CWP Rating: 200 psig.
d. Body Design: Horizontal flow.
e. Body Material: ASTM B 62, bronze.
f. Ends: Threaded.
g. Disc: Bronze.

B. Class 125, Iron Swing Check Valves with Metal Seats:

1. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.

2.4 CHECK VALVES WITH CLOSURE CONTROL

A. Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:

1. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Gasket: Asbestos free.
h. Closure Control: Factory-installed, exterior lever and weight.

2.5 GATE VALVES

A. Class 125, NRS, Iron Gate Valves:

1. Description:

a. Standard: MSS SP-70, Type I.
b. CWP Rating: 200 psig.

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c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

2.6 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating.
4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

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

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

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

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

E. Install chainwheels on operators for gate valves NPS 2 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install chainwheels operators for all valves located more than 3 feet above a lay-in ceiling. Extend chains to 6 inches above ceiling.

G. Install chainwheels operators for all valves located more than 2 feet above a hard ceiling access opening. Extend chains to 6 inches above ceiling.

H. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

3.2 ADJUSTING

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

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not otherwise indicated, use the following:

1. Shutoff Service: Ball or gate valves.

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2. Throttling Service: Ball valves.
3. Pump-Discharge Check Valves:

    a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
    b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight.
    c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

C. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.4 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 4 and Smaller:

1. Brass and Bronze Valves: NPS 2-1/2 and smaller may be provided with solder-joint ends instead of threaded ends. NPS 3 and larger threaded or flanged ends.
2. Ball Valves: Two piece, full port.
3. Bronze Swing Check Valves: Class 125, bronze disc.

B. Pipe NPS 5 through NPS 8:

1. Ball Valves: Two piece, full-port, cast-iron with flanged ends.
2. Iron Swing Check Valves: Class 125, metal seats.
3. Iron Swing Check Valves with Closure Control: Class 125, lever and weight.

C. Pipe NPS 10 and Larger:

1. Iron Swing Check Valves: Class 125, metal seats.
2. Iron Swing Check Valves with Closure Control: Class 125, lever and weight.
3. Iron Gate Valves: Class 125, NRS.

3.5 SANITARY-WASTE AND STORM-DRAINAGE VALVE SCHEDULE

A. Pipe NPS 4 and Smaller:

1. Brass and Bronze Valves: NPS 2-1/2 and smaller may be provided with solder-joint ends instead of threaded ends. NPS 3 and larger threaded or flanged ends.
2. Ball Valves: Two piece, full port, bronze with bronze trim.
3. Bronze Swing Check Valves: Class 125, bronze disc.

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B. Pipe NPS 5 and Larger:

1. Iron Swing Check Valves: Class 125, metal seats.
2. Iron Swing Check Valves with Closure Control: Class 125, lever and weight.
3. Iron Gate Valves: Class 125, NRS.

END OF SECTION 22 05 23

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SECTION 22 05 29

HANGERS & SUPPORTS FOR PLUMBING PIPING & EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Pipe positioning systems.
6. Equipment supports.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For tapes, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label tapes with appropriate markings of applicable testing agency.

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1. Tape Installed in Return Plenums: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Tape Installed Elsewhere: No testing requirement.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers shall be one of the following unless noted otherwise:

1. Anvil International.
2. B-Line.
3. Elcen.
4. Grinnell.
5. Kin-Ling.
6. Michigan Hanger Co.
7. National Pipe Hanger Corp.
8. Pipe Technology Products.
9. PHD Manufacturing.
10. PHS Industries.
11. Unistrut.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts. Pregalvanized components or hot dip galvanize entire assembly after fabrication where indicated.

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2.4 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Hot or Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

D. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

E. Shield: Shields shall be a minimum of 18 gauge galvanized steel, 12 inches long for piping 6 inches and smaller. Shields shall be a minimum of 16 gauge galvanized steel, 18 inches long for pipe over 6 inches.

2.5 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

B. Bushings: Plastic, flame retardant bushings may be used at penetrations of steel stubs and steel clips.

2.6 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes. Pregalvanized components or hot dip galvanize entire assembly after fabrication where indicated.

2.7 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Tape for Plenum Use:

1. Polypropylene backing with acrylic adhesive, Hart & Cooley part number 011371.
2. Polyethylene coated cloth backing with rubber adhesive, Uline Black Nashua 398 Duct Tape, model number S-17236BL.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

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1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 22 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Insulated Piping:

1. Attach clamps and spacers to piping.
    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

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4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers 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/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

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1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Wrap copper piping with not less than two layers of 10 mil. thick black plastic tape extending a minimum of 1 inch on each side of clamp for electrolytic protection where hangers or supports are in direct contact with copper piping.

D. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications. Provide galvanized coating on all hangers and supports outside the insulated building envelope.

E. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

F. Use padded hangers for piping that is subject to scratching.

G. Use thermal-hanger shield inserts for insulated piping and tubing.

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
5. Single-Pipe Rolls (MSS Type 43): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
6. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
7. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

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2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape. Include retaining clip.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 22 05 29

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SECTION 22 05 33

HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes plumbing piping heat tracing for freeze prevention with self-regulating, parallel resistance electric heating cables.

1.2 SUBMITTALS

A. Product Data: Provide manufacturer's product data for each system indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:

1. Manufacturer and model number.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
3. Equipment dimensions.
4. Required clearances.
5. Electrical data.
    a. Voltage/Phase/Hz
    b. Start-up ampacity, operating ampacity and maximum overcurrent protection device requirements.
    c. Electrical service point(s) of connection.
    d. Wiring diagrams.
6. Materials of construction.
7. Accessories and options.
8. Controls.
9. Assembly details.
10. Installation details particular for this project.

B. Field quality-control test reports.

C. Operation and maintenance data.

D. Warranty: Special warranty specified in this Section.

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.

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1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, provide products from one of the following:

1. BH Thermal Corporation.
2. Chromalox, Inc.; Wiegard Industrial Division; Emerson Electric Company.
3. Delta-Therm Corporation.
4. Easy Heat Inc.
5. Nelson Heat Trace.
6. Pyrotenax; a division of Tyco Thermal Controls.
7. Raychem; a division of Tyco Thermal Controls.
8. Thermon Manufacturing Co.
9. Trasor Corp.

B. Heating Element: Pair of parallel No. 16 AWG, tinned or nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

C. Electrical Insulating Jacket: Flame-retardant polyolefin.

D. Cable Cover: Tinned-copper or Stainless-steel braid, and polyolefin outer jacket with UV inhibitor.

E. Maximum Operating Temperature (Power On): 150 deg F.

F. Maximum Exposure Temperature (Power Off): 185 deg F.

2.2 CONTROLS

A. Pipe-Mounting Thermostats for Freeze Protection:

1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.

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2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Division 22 Section "Identification for Plumbing Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Install the following types of electric heating cable for the applications described:

1. Freeze protection of pipes: Self-regulating, parallel-resistance heating cable where indicated on drawings.
2. Roof Drain and Overflow Drain Bodies: Self-regulating, parallel-resistance heating cable.
3. Roof Drain and Overflow Drain Horizontal Leaders: Self-regulating, parallel-resistance heating cable.
4. Outside Air Intake Enclosure Drain Bodies and Leaders: Self-regulating, parallel-resistance heating cable.

3.2 INSTALLATION

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written recommendations using cable protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.
2. Install electric heating cables according to IEEE 515.1.
3. Install insulation over piping with electric cables according to Division 22 Section "Plumbing Insulation."
4. Install warning tape on piping insulation where piping is equipped with electric heating cables.

C. Set field-adjustable switches and circuit-breaker trip ranges.

D. Protect installed heating cables, including nonheating leads, from damage.

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3.3 FIELD QUALITY CONTROL

A. Testing: Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.

1. Test cables for electrical continuity and insulation integrity before energizing.
2. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounting cables.

C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 22 05 33

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SECTION 22 05 48

VIBRATION CONTROLS FOR PLUMBING PIPING & EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Elastomeric hangers.
3. Spring hangers.
4. Spring hangers with vertical-limit stops.
5. Pipe riser resilient supports.
6. Resilient pipe guides.

1.2 SUBMITTALS

A. Product Data: For each product indicated.

B. Welding certificates.

C. Field quality-control test reports.

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: The following products are based on Mason Industries. Subject to compliance with requirements, provide comparable products by one of the following:

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.
4. Vibration Mountings & Controls, Inc.

B. Neoprene Pad: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.

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C. Style F - Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

D. Style G - Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Elements: Molded, oil-resistant rubber or neoprene.
    a. Minimum 1-1/4 inches thick element at top of hanger with steel-washer-reinforced rod support and bushing projecting through top of frame.
    b. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits.

C. Select vibration isolation elements and deflections in accordance with the following table:

Equipment	Location	Vibration Isolation Element (Minimum Deflection)
Pump	Suspended In-line Type	Style F (1.5 inches)
Piping	Where connected to equipment with spring isolators.	Style G on first 4 hangers (Match equipment deflection)

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3.2 VIBRATION-CONTROL INSTALLATION

A. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

B. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

C. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.3 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 22 05 48

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SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING & EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.

1.2 SUBMITTAL

A. Product Data: For each type of product indicated.

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: Black.
3. Background Color: White.
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: 1/2 inch. Include secondary lettering 3/8 inch.
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. Coordinate with Owner.

2.2 WARNING SIGNS AND 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: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

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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: 1/2 inch. Include secondary lettering 3/8 inch.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: As indicated on drawings or required by local authority.

2.3 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 cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. 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.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved, minimum 2-inch size with 1/4-inch letters for piping system abbreviation and function, i.e., balance, drain, shutoff, stop. Include 1/2-inch identifying number. Provide 5/32-inch hole for fastener.

1. Material: 0.032-inch-thick brass.
2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

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 plumbing equipment.

B. Locate equipment labels where accessible and visible.

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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. 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 25 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
7. Spaced at maximum 10 feet on piping above removable acoustical ceilings.

B. Pipe Label Color Schedule:

1. Domestic Water Piping:

   a. Background Color: Green.
   b. Letter Color: White.

2. Reclaimed Water Piping:

   a. Background Color: Purple.
   b. Letter Color: White.

3. Sanitary Waste and Storm Drainage Piping:

   a. Background Color: Green.
   b. Letter Color: White.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems including piping within refrigeration machinery rooms, boiler rooms, mechanical equipment room, mechanical equipment yards, piping mains, and piping branches serving more than one piece of equipment. Tags are not required on check valves; valves within factory-fabricated equipment units; and similar roughing-in connections of end-use fixtures and units.

B. List tagged valves in a valve schedule. Valve schedule shall indicate the following:

1. Valve Identification Number.
2. Piping System: e.g., CW, DHW, DHWR.
3. Function: e.g., balance, drain, shut-off, stop.
4. Location: e.g., "Above ceiling in Corridor C-01 near Room 117."
5. Equipment/Area Served: e.g., Restroom 121, Breakroom 231.
6. Valve Size.
7. Valve Type: e.g. ball, check, butterfly, etc.
8. Valve Manufacturer and model number.

C. Mount valve schedule under glass in main mechanical room, or elsewhere as directed by Owner. Include copy in O&M Manual.

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3.5 ADJUSTING AND CLEANING

A. Relocate plumbing identification materials and devices that have become visually blocked by other work.

B. Clean faces of plumbing identification devices and glass frames of valve schedules.

END OF SECTION 22 05 53

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SECTION 22 07 16

PLUMBING EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following plumbing equipment:

1. Domestic water heat exchangers.
2. Domestic hot water storage tanks.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include manufacturer's technical data with proposed thickness and r-value indicated as well as proposed application.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that product complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

C. Field quality-control reports.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

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PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

1. Manufacturers: Subject to compliance with requirements, provide product by one of the following manufacturers:

   a. CertainTeed Corp.
   b. Johns Manville.
   c. Knauf Insulation.
   d. Owens Corning.

2.2 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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D. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.5 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.
5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for equipment.

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2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.
3. Factory-fabricated tank heads and tank side panels.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

2.9 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.

B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

   a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   b. Spindle: Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

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2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

   a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   b. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

4. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

2.10 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

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B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

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N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.3 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe, and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

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3.4 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.5 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Heat-Exchanger (Water-to-Water for Domestic Water Heating Service) Insulation:

1. Mineral-Fiber Pipe and Tank: 2 inches thick.

D. Domestic water, domestic chilled-water (potable), and domestic hot-water hydropneumatic tank insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Pipe and Tank: 1 inch thick.
3. Polyolefin: 1 inch thick.

E. Domestic Hot-Water Storage Tank Insulation:

1. Mineral-Fiber Pipe and Tank: Of thickness to provide an R-value of 24.

3.6 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed: None.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. PVC: 30 mils thick.

3.7 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. If more than one material is listed, selection from materials listed is Contractor's option.

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B. Equipment, Concealed:

1. PVC: 30 mils thick.

END OF SECTION 22 07 16

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SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic water piping.
2. Domestic tempered water piping.
3. Domestic hot-water piping.
4. Domestic recirculating hot-water piping.
5. Roof and overflow drains and leaders.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include manufacturer's technical data with proposed thickness and r-value indicated as well as proposed application.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that product complies with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," including 2004 Addenda.

1.3 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

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PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Mineral-Fiber, Preformed Pipe Insulation:

1. Manufacturers: Subject to compliance with requirements, provide product by one of the following manufacturers:

   a. Certainteed Corp.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation.
   d. Owens Corning.

2. Mineral-Fiber, Preformed Pipe Insulation: Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Omit jacket on all but outermost layer where multiple insulation layers are required. Jacket shall comply with the following:

   a. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.2 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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D. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.5 SEALANTS

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.
5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.

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4. Color: To match jacket.
5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: As scheduled below.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

1. Finish and thickness are indicated in field-applied jacket schedules.
2. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
3. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
4. Factory-Fabricated Fitting Covers:

    a. Same material, finish, and thickness as jacket.
    b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    c. Tee covers.
    d. Flange and union covers.
    e. End caps.
    f. Beveled collars.
    g. Valve covers.
    h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.

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5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.9 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

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C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Install insulation continuously through hangers and around anchor attachments.

K. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

L. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

M. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

N. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

O. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

P. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

Q. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

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R. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

S. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends below roof surface. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends inside building. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 07 for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 for firestopping and fire-resistive joint sealers.

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3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

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3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

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3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.7 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping, except tempered water, hot water return and hot water piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.8 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Water Piping: Insulation shall be the following: Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick for piping 1-1/2 inches and smaller, 1-1/2 inches thick for piping larger than 1-1/2 inches.

B. Domestic Hot, Tempered, and Recirculated Hot Water Piping: Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Domestic Chilled Water: Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick for piping 1-1/2 inches and smaller, 1-1/2 inches thick for piping larger than 1-1/2 inches.

D. Roof Drain and Overflow Drain Bodies: Mineral-Fiber Insulation: 1 inch thick.

E. Roof Drain and Overflow Drain Leaders: Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

3.9 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping: Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick for pipe 1-1/2 inches and smaller, 2 inches for pipe larger than 1-1/2 inches.

B. Domestic Hot and Recirculated Hot Water: Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

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3.10 UNDERGROUND PIPING INSULATION SCHEDULE

A. Domestic Hot and Recirculated Hot Water: Flexible Elastomeric: 1 inch thick.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed: None.

D. Piping, Exposed:

1. PVC: 20 mils thick.

a. Color: As selected by Owner.

1) Domestic Cold Water: Green.
2) Domestic Hot Water: Orange.
3) Domestic Hot Water Recirculation: Yellow
4) P-Traps: White.

2. Aluminum, Smooth or Corrugated: 0.016 inch thick.

3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed: None.

D. Piping, Exposed: Aluminum, Smooth or Corrugated with Z-Shaped Locking Seam: 0.020 inch thick.

END OF SECTION 22 07 19

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SECTION 22 08 00

COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes commissioning process requirements for plumbing systems, assemblies, and equipment.

1.2 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.3 INFORMATIONAL SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

1.4 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in plumbing systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.5 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual plumbing systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

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C. Verify testing, adjusting, and balancing of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

1.6 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for plumbing systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of readiness, signed by the Contractor, certifying that plumbing systems, assemblies, equipment, components, and associated controls are ready for testing.
5. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
6. Test and inspection reports and certificates.
7. Corrective action documents.
8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that plumbing control systems have been completed and calibrated, that they are operating according to the Contract Documents.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

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B. Scope of plumbing testing shall include entire plumbing installation, from the water service, water heaters, and distribution systems to each fixture or point of use.

C. The CxA along with the plumbing Contractor shall prepare detailed testing plans, procedures, and checklists for plumbing systems, subsystems, and equipment.

D. Tests will be performed using design conditions whenever possible.

E. If tests cannot be completed because of a deficiency outside the scope of the plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

F. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.3 PLUMBING, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Pipe system cleaning, flushing, hydrostatic tests, and sterilization requirements are specified in plumbing piping Sections. Plumbing Contractor shall prepare a pipe system cleaning, flushing, hydrostatic testing, and sterilization plan. Provide cleaning, flushing, testing, and sterilization plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and sterilization plan.
2. Description of equipment for flushing operations.
3. Minimum flushing water velocity.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and sterilized.

B. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

C. Mixing Valves: Provide technicians, instrumentation, tools, and equipment to test performance of mixing valves under varying flow conditions.

D. Domestic Hot Water Circulation Systems: Provide technicians, instrumentation, tools, and equipment to test performance of domestic hot water recirculation systems.

E. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation devices.

END OF SECTION 22 08 00

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SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Specialty valves.
3. Flexible connectors.

1.2 DEFINITIONS

A. Domestic Water: Includes softened and un-softened domestic hot and cold water.

1.3 SUBMITTALS

A. Product Data: For each type of pipe and joining material, and for method for joining piping intended for the project.

B. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 61 for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

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4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.

1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 TRANSITION FITTINGS

A. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Description:

a. Pressure Rating: 150 psig at 180 deg F.
b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Description:

a. Factory-fabricated, bolted, companion-flange assembly.
b. Pressure Rating: 150 psig.
c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

1. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.

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

2.6 FLEXIBLE CONNECTORS

A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.
2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install piping buried below the building slab a minimum of 24 inches below slab.

D. Install underground piping outside of the building footprint a minimum of 36 inches below finished grade or minimum of 12 inches below the local frostline, whichever is deeper.

E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance.

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install water-pressure-reducing valves downstream from shutoff valves where facility incoming water pressure exceeds 80 psi.

H. Install domestic water piping level and plumb.

I. Rough-in domestic water piping for water-meter installation and install building water meter.

J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

L. Do not install piping within electrical rooms, elevator equipment rooms, MDF or IDF rooms, or stairwells. Exception: Pipe supplying equipment serving the room. Maintain all required clearances to other equipment.

M. Do not install piping above electrical equipment such as transformers, panels, motor control centers, etc. in other rooms

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N. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

O. Install piping adjacent to equipment and specialties to allow service and maintenance.

P. Install piping to permit valve servicing.

Q. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

R. Install piping free of sags and bends.

S. Install fittings for changes in direction and branch connections.

T. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

U. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

V. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.

W. Install thermometers on outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

X. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

Y. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

Z. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

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F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 4 and smaller. Use gate valves for piping NPS 5 and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."

1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

D. Install balancing valve in each hot-water circulation return branch and where indicated on the drawings. Set balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. Dielectric Fittings for NPS 5 to NPS 6: Use dielectric flange kits.

3.6 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible connectors in suction and discharge piping connections to each domestic water booster pump.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

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1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable, steel clevis hangers.
3. Multiple, Straight, Horizontal Piping Runs: Trapeze hangers with pipe clamps.

B. Support vertical piping and tubing at base and at each floor.

C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.8 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.
4. Install automatic trap primers on the cold water supply at the nearest fixture (or where indicated on the drawings) and run drain to trap seal being protected. Provide wall access panel when primers are installed in walls.

3.9 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

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B. Label pressure piping with system operating pressure.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

    a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

1. Fill domestic water piping using clean, potable water. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.11 CLEANING

A. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

B. Clean and disinfect potable domestic water piping prior to putting into service as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before use with clean, potable water.

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2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Submit water samples in sterile bottles to authorities having jurisdiction for testing of piping cleanliness. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities to Architect/Engineer. Include a copy of final report in Operation and Maintenance Manual.

3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Under-ground, domestic water, building service piping shall be:

1. Piping NPS 2 and smaller: Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
2. Piping NPS 2-1/2 and larger: Hard copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.

D. Under-building-slab, domestic water piping shall be:

1. Piping NPS 2 and smaller shall be: Soft copper tube, ASTM B 88, Type K; without joints.
2. Piping NPS 2-1/2 and larger: Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
3. All under slab copper tube shall be protected with 20 mil plastic sleeving. Use blue sleeving on cold water piping and red sleeving for hot water piping. Sleeving shall extend a minimum of 2 inches above slab.

E. Aboveground domestic water piping, NPS 2 and smaller shall be the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.

F. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 shall be the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and brazed soldered joints.

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G. Aboveground domestic water piping, NPS 5 and NPS 6 shall be the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and brazed joints.

3.13 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves for piping NPS 4 and smaller. Use gate valves with flanged ends for piping NPS 5 and larger.
2. Throttling Duty: Use ball valves for piping NPS 4 and smaller. Use butterfly valves with flanged ends for piping NPS 5 and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 22 11 16

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SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated water mixing valves.
6. Strainers.
7. Hose bibbs.
8. Wall hydrants.
9. Drain valves.
10. Water hammer arresters.
11. Trap-seal primer valves.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 SUBMITTALS

A. Product Data: For each type of water piping specialty proposed for this project. Include manufacturer, model number, materials of construction, options and accessories, etc.

1. For thermostatic mixing valves include a copy of the piping diagram.

B. Field quality-control test reports.

C. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

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PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS

A. Basis-of Design: Subject to compliance with requirements, provide products by the following product; Wilkens 375AST by Zurn.

B. Reduced-Pressure-Principle Backflow Preventers:

1. Standard: ASSE 1013.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved, steel with interior lining complying with AWWA C550 or that is FDA approved, or stainless steel for NPS 2-1/2 and larger.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
6. Configuration: Designed for horizontal, straight through flow.
7. Accessories:

    a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.2 WATER PRESSURE-REDUCING VALVES

A. Water Pressure-Reducing Valves: Pilot controlled, hydraulically operated single diaphragm actuated pressure reducing valve.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts ACV Model LFF115 valve or comparable product by one of the following:

    a. Cla-Val.
    b. Conbraco Industries, Inc.
    c. Wilkins.

2. Pressure Rating: Initial working pressure of 150 psig.
3. Design Outlet Pressure Setting: As indicated on drawings.
4. Flow Rate:

    a. Maximum: Flow indicated on drawings.
    b. Minimum: One gallon per minute.
    c. Provide parallel valves where required to achieve specified minimum and maximum flows.

5. Size: As indicated on drawings.
6. Main Valve Body: ASTM A536 ductile iron with NSF listed fusion bonded epoxy liner and coating.
7. Trim: 316 Stainless steel.
8. Elastomers: Buna-N or EPDM.
9. Internal Wetted Parts: Coated ductile iron of stainless steel.
10. Pressure Reducing Pilot Valve: Direct acting type valve. Lead free brass body with Buna-N diaphragm, stainless steel wetted parts, and aluminum spring cage.

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11. Pilot Control Piping and Fittings: Copper tubing with lead free brass fittings. Provide with Y-strainer and isolation cocks.
12. End Connections: Threaded for NPS 1-1/2 and smaller; flanged for NPS 2 and larger.

2.3 BALANCING VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong Pumps, Inc.
    b. Bell & Gossett Domestic Pump; a division of ITT Industries.
    c. Griswold Controls.
    d. NIBCO INC.
    e. Oventrop.
    f. Taco.

2. Body: Brass resistant to dezincification (DZR) or stainless steel, ball, plug or globe type with calibrated orifice or venturi.
3. Ball: Brass resistant to dezincification (DZR) or stainless steel.
4. Seat: PTFE.
5. End Connections: Threaded or socket.
6. Pressure Gage Connections: Two, one on either side of valve with integral seals for portable differential pressure meter.
7. Handle Style: Lever or handwheel, with memory stop to retain set position.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.

2.4 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Point-of-Use, Water-Temperature Limiting Devices:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

    a. Bradley.
    b. Conbraco Industries, Inc.
    c. Lawler Manufacturing Company, Inc.
    d. Powers.
    e. Symmons Industries, Inc.
    f. Watts Industries, Inc.
    g. Wilkins.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded or union inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: 110° F.
9. Tempered-Water Design Flow Rate: .5gpm – 2.5gpm.

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10. Valve Finish: Chrome plated where exposed, (0.3 L/S - .15 L/S) rough bronze where concealed.

B. Primary, Thermostatic, Water Mixing Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

   a. Bradley.
   b. Lawler Manufacturing Company, Inc.
   c. Powers.
   d. Symmons Industries, Inc.
   e. Wilkins.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Cabinet-type, thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
9. Pressure Drop at Design Flow Rate: 25 psig.
10. Valve Finish: Rough bronze.
11. Piping Finish: Copper.
12. Cabinet: Factory-fabricated, stainless steel, for surface mounting and with hinged, stainless-steel door.

2.5 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with AWWA C550 or FDA approved epoxy coating for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:

   a. Strainers NPS 2 and Smaller: 0.020 inch.
   b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
   c. Strainers NPS 5 and Larger: 0.10 inch.

6. Drain: Pipe plug.

2.6 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.

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6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Operating key.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.7 WALL HYDRANTS

A. Basis-of Design: Subject to compliance with requirements, provide products by the following product; Woodford Model 67.

B. Nonfreeze Wall Hydrants:

1. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig.
3. Operation: Loose key.
4. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
5. Inlet: NPS 3/4 or NPS 1.
6. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounting with cover.
8. Box and Cover Finish: Polished nickel bronze.
9. Operating Keys(s): One with each wall hydrant.

2.8 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.9 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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a. MIFAB, Inc.
b. PPP Inc.
c. Sioux Chief Manufacturing Company, Inc.
d. Smith, Jay R. Mfg. Co.
e. Watts Drainage Products Inc.
f. Zurn.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows or Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.10 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. MIFAB, Inc.
b. PPP Inc.
c. Sioux Chief Manufacturing Company, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Watts Industries, Inc.; Water Products Div.

2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.11 ELECTRONIC TRAP PRIMER VALVES

A. Supply Type, electronic trap priming assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. MIFAB, Inc.
b. PPP Inc.
c. Zurn Plumbing Products Group.

2. Standard: ASSE 1044.
3. Pressure Rating: 125 psig minimum.
4. Style: Recessed cabinet in finished locations and new construction. NEMA 1 cabinet in retrofit applications or unfinished areas with masonry walls.
5. Number of openings: As required for application or as noted.
6. Inlet Connections: NPS 3/4 with shutoff valve.
7. Outlet connection: 1/2 inch compression.
8. Backflow Prevention: Anti-siphon atmospheric vacuum breaker, ASSE 1001.
9. Electrical: 120V, 1 phase, circuit breaker, manual override, 24 hour timer, UL listed solenoid valve.

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PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in building at connection points of domestic water system to water-service piping. Comply with authorities having jurisdiction.

B. Install backflow preventers in each water supply to equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.

C. Install water pressure-reducing valves where supply water pressure exceeds 80 psig and where indicated on drawings. Install water pressure-reducing valves with inlet and outlet shutoff valves, and full size bypass with isolation valve. Install pressure gages on inlet and outlet.

D. Install balancing valves in locations where they can easily be adjusted.

E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install thermometers and water regulators if specified.
2. Install cabinet-type units recessed in or surface mounted on wall as specified.

F. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve, solenoid valve, and pump.

G. Install non-freeze wall hydrants in exterior walls and other locations as noted on drawings.

H. Install wall hydrants in interior locations susceptible to vandalism or damage such as student areas in schools, loading docks, etc., and other locations as noted on drawings.

I. Install hose bibs in interior locations not susceptible to vandalism and other locations as noted on drawings.

J. Install water hammer arresters in water piping according to PDI-WH 201.

K. Install trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain or floor-sink body, trap, or inlet fitting. Adjust valve for proper flow.

1. Install trap primer valves at all floor drains or floor sinks, except floor drains in commercial showers.
2. Install supply-type valves where floor drains and floor sinks are in close proximity to flush valves.
3. Install electronic valves where floor drains and floor sinks are not in close proximity to flush valves.

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L. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Reduced-pressure-principle backflow preventers.
2. Water pressure-reducing valves.
3. Primary, thermostatic, water mixing valves.

M. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each reduced-pressure-principle backflow preventer assembly according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.3 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 22 11 19

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SECTION 22 11 23

DOMESTIC HOT WATER RECIRCULATING PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. In-line, sealless centrifugal pumps.
2. In-line, close-coupled centrifugal pumps.

1.2 SUBMITTALS

A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:

1. Manufacturer and model number.
2. Rated capacity based on scheduled conditions.
3. Equipment dimensions.
4. Required clearances.
5. Electrical data.
    a. Motor horsepower
    b. Voltage/Phase/Hz
6. Materials of construction.
7. Accessories and options.
8. Controls.

B. Warranty information.

C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

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

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS

2.1 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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1. Armstrong Pumps Inc.
2. Grundfos Pumps Corp.
3. TACO.

B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

C. Pump Construction:

1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal or vertical.
2. Casing: Bronze or stainless steel with threaded or companion-flange connections.
3. Impeller: Plastic.
4. Motor: Single speed, unless otherwise indicated.

D. Capacities and Characteristics:

1. Minimum Working Pressure: 125 psig.
2. Maximum Continuous Operating Temperature: 220 deg F.
3. Pump Control: Aquastat and timer.
4. Electrical Characteristics:

   a. Volts: 120.
   b. Phases: Single.
   c. Hertz: 60.

2.2 IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Bell & Gossett Domestic Pump; ITT Corporation.

B. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontally or vertically.

C. Pump Construction:

1. Casing: Radially split with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
2. Impeller: Statically and dynamically balanced, closed, and keyed to shaft.
3. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
4. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
5. Bearings: Oil-lubricated; bronze-journal or ball type.
6. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.

D. Motor: Single speed, with grease-lubricated ball bearings; and resiliently or rigidly mounted to pump casing.

E. Capacities and Characteristics:

1. Casing Material: Bronze.

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2. Impeller Material: ASTM B 584, cast bronze or stainless steel.
3. Minimum Working Pressure: 175 psig.
4. Maximum Continuous Operating Temperature: 225 deg F.
5. Pump Control: Aquastat and Timer.
6. Electrical Characteristics:

    a. Volts: 120.
    b. Phases: Single.
    c. Hertz: 60.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Type: Water-immersion temperature sensor or pipe clamp-on, for installation in or on piping.
2. Range: 50 to 125 deg F.
3. Enclosure: NEMA 250, Type 4X.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 24 V, ac or 120 V, ac.
7. Settings: Start pump at 105 deg F and stop pump at 110 deg F.

PART 3 - EXECUTION

3.1 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install in-line, centrifugal pumps per manufacturer's recommendations.

C. Install thermostats in or on hot-water return piping.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

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C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

1. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping" and comply with requirements for strainers specified in Division 22 Section "Domestic Water Piping Specialties."
2. Install a single pressure gage at each pump connected to the suction and discharge of each pump with valves to allow for individual measurement of pump pressures. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Division 22 Section "Meters and Gages for Plumbing Piping."

D. Connect aquastats to pumps that they control.

3.3 ADJUSTING

A. Adjust domestic water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 22 11 23

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SECTION 22 13 16

SANITARY WASTE & VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

1.2 SUBMITTALS

A. Product Data: For each type of pipe and joining material, and for method for joining piping intended for the project.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

1.3 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888.

B. Heavy-Duty, Hubless-Piping Couplings:

1. Product: Subject to compliance with requirements, provide one of the following products:

a. ANACO-Husky, SD 4000.
b. Mission, HeavyWeight Coupling.

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2. Standards: ASTM C 1277 or ASTM C 1540.
3. Description: Type 304 stainless-steel shield with minimum four stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Standard-Duty, Hubless-Piping Couplings:

1. Product: Subject to compliance with requirements, provide one of the following products:

   a. ANACO, No Hub Coupling.
   b. Clamp-All Corp, Hi-Torque 80.
   c. Mission, No Hub Coupling.

2. Standards: ASTM C 1277 or ASTM C 1540.
3. Description: Type 304 stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 GALVANIZED STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53, hot-dipped galvanized, schedule 40 steel with plain ends; welded and seamless, Grade B.

B. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150, galvanized.

C. Malleable-Iron Unions: ASME B16.39; Classes 150, galvanized.

D. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 125; galvanized, raised ground face, and bolt holes spot faced.

E. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, galvanized, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

2.4 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.

1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Solvent Cement: ASTM D 2564.

1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Shielded, Nonpressure Transition Couplings:

a. Standard: ASTM C 1460.
b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. 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.

D. Do not install piping within electrical rooms, elevator equipment rooms, MDF or IDF rooms, or stairwells. Exception: Pipe supplying equipment serving the room. Maintain all required clearances to other equipment.

E. Do not install piping above electrical equipment such as transformers, panels, motor control centers, etc. in other rooms.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees.

J. Use standard pipe increasers and reducers if pipes of different sizes are connected. Do not use bushings. Reducing size of drainage piping in direction of flow is prohibited.

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K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Horizontal Sanitary Drainage Piping: One-fourth inch per foot, 2 percent, downward in direction of flow unless noted otherwise.
2. Vent Piping: One-eight inch per foot, 1 percent, down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

N. Install stainless steel piping in accordance with the manufacturer's written instructions.

O. Install aboveground PVC piping according to ASTM D 2665.

P. Install underground PVC piping according to ASTM D 2321.

Q. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."
2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."

R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

B. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

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2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

C. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

D. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.3 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Non-pressure transition couplings.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable, steel clevis hangers.
7. Multiple, Straight, Horizontal Piping Runs: Trapeze hangers with pipe clamps.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support each section of horizontal piping and tubing within 12 inches of each fitting and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

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G. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 12 feet; minimum rod size, 1/2 inch.
9. NPS 8: Maximum span, 12 feet; minimum rod size, 5/8 inch.

H. Install supports for vertical steel piping every 10 feet.

I. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

J. Install supports for vertical PVC piping every 48 inches.

K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Backwater valves with cleanout cover flush with floor.
6. Comply with requirements for cleanouts and drains specified in Division 22 Section "Sanitary Waste Piping Specialties."
7. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

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E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.6 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. Water level must not drop for 4 hours. Inspect joints for leaks and make all necessary repairs.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection but no less than 30 minutes. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

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3.8 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty, 4-band hubless-piping couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

C. Aboveground vent piping, NPS 4 and smaller shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; standard-duty hubless-piping couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

D. Aboveground, soil, and waste piping NPS 5 and larger shall be the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty, 6-band hubless-piping couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

E. Aboveground vent piping, NPS 5 and larger shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; standard-duty hubless-piping couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

F. Underground, soil, waste, and vent piping, NPS 4 and smaller shall be the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

G. Underground, soil, waste, and vent piping, NPS 5 and larger shall be any of the following:

1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Shielded, non-pressure transition couplings.

H. Pumped waste piping shall be any of the following:

1. Galvanized steel pipe and fittings; and threaded or flanged joints.

END OF SECTION 22 13 16

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SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

1. Cleanouts.
2. Floor drains.
3. Floor sinks.
4. Trench drains.
5. Roof flashing assemblies.
6. Miscellaneous sanitary drainage piping specialties.
7. Flashing materials.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include manufacturer, model number, materials of construction, and options and accessories.

1.3 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Josam Company; Josam Div.
2. Smith, Jay R. Mfr. Co.
3. Watts Drainage Products Inc.
4. Zurn Plumbing Products Group.

2.2 CLEANOUTS

A. Exposed Cast-Iron Cleanouts:

1. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
2. Size: Same as connected drainage piping
3. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk, plastic plug, except provide brass plug in return air plenums.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

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B. Cast-Iron Floor Cleanouts:

1. Standard: ASME A112.36.2M for adjustable housing cleanout.
2. Size: Same as connected branch.
3. Type: Adjustable housing.
4. Body or Ferrule: Cast iron.
5. Clamping Device: Not required.
6. Outlet Connection: Spigot.
7. Closure: Plastic plug.
8. Adjustable Housing Material: Cast iron with threads.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy
10. Frame and Cover Shape: Round in concrete floors, square in tiled floors.
11. Top Loading Classification: Heavy Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping.
3. Body: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk, brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.3 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Standard: ASME A112.6.3.
2. Pattern: Floor drain.
3. Body Material: Gray iron.
4. Seepage Flange: Required for slabs above grade.
5. Anchor Flange: Required for slabs on grade.
6. Clamping Device: Required, where floor has waterproofing membrane.
7. Outlet: Bottom or Side as required.
8. Backwater Valve: Not required.
9. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel when located in equipment rooms.
10. Sediment Bucket: Slotted type when located in equipment rooms.
11. Top or Strainer Material: Gray iron in unfinished floors, Nickel bronze in finished floors.
12. Top of Body and Strainer Finish: Nickel bronze in unfinished floors, polished bronze in finished floors.
13. Top Shape: Round in concrete floors, Square in tiled floors.
14. Top Loading Classification: Extra heavy-duty in areas with vehicle traffic, heavy duty in equipment rooms, light duty in finished areas.
15. Funnel: Required, where indicated on drawings.
16. Trap Material: Cast iron or copper to match adjacent piping.
17. Trap Pattern: Standard P-trap unless noted otherwise.
18. Trap Features: Trap-seal primer valve drain connection, and cleanout where indicated.

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2.4 FLOOR SINKS

A. Cast-Iron Floor Sinks:

1. Standard: ASME A48-83.
2. Pattern: Floor sink.
3. Body Material: Gray iron.
4. Seepage Flange: Required for slabs above grade.
5. Anchor Flange: Required for slabs on grade.
6. Clamping Device: Required, where floor has waterproofing membrane.
7. Outlet: Bottom.
8. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
9. Sediment Bucket: Aluminum slotted type when located in kitchen area
10. Dome Strainer: Anti-splash with acid-resistant enamel coating for non-kitchen areas.
11. Top or Grate Material: Acid-resistant enamel.
12. Grate: Full, 3/4, or half as required for application.
13. Top Shape and Size: Square, 12 inches x 12 inches.
14. Basin Depth: 8 inches unless noted otherwise.
15. Funnel: Required, where indicated on drawings.
16. Trap Material: Cast iron or copper to match adjacent piping.
17. Trap Pattern: Standard P-trap unless noted otherwise.
18. Trap Features: Trap-seal primer valve drain connection.

2.5 TRENCH DRAINS

A. Shower Entry Trench Drains:

1. Standard: ADA Compliance.
2. Body Material: Polypropylene.
3. Flange: Not required.
4. Clamping Device: Molded clips to accommodate vertical rebar for positioning.
5. Outlet: Bottom.
6. Grate Material: Stainless steel, slotted.
7. Dimensions of Frame and Grate: 36" to 42" long x 6" wide or as noted on drawings.
8. Top-Loading Classification: Light Duty.

B. Area Trench Drains:

1. Body Material: High density polypropylene with interlocking ends, radius bottom and .75% built-in slope.
2. Clamping Device: Molded clips to accommodate vertical rebar for positioning and anchoring.
3. Outlet: Bottom.
4. Grate Material: Cast iron, slotted.
5. Dimension: Modular, 80 inch long x 6 inch wide sections.
6. Top Loading Classification: H-20FAA load rating with anchor studs.

2.6 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch- thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

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2. Open-Top Vent Cap: Without cap.

2.7 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

    a. NPS 2: 4-inch minimum water seal.
    b. NPS 2-1/2 and Larger: 5-inch minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

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2.8 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 4.0-lb/sq. ft., 0.0625-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Fasteners: Metal compatible with material and substrate being fastened.

C. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

D. Solder: ASTM B 32, lead-free alloy.

E. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger 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 NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

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4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install floor sinks where indicated on drawings. Set grates of sinks flush with finished floor, unless otherwise indicated.

1. Position floor sinks for easy access and maintenance.
2. Install floor-sink flashing collar or flange so no leakage occurs between sink and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
3. Install individual traps for floor sinks connected to sanitary building drain, unless otherwise indicated.

F. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.

G. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

H. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

I. Assemble open drain fittings and install with top of hub 2 inches above floor.

J. Install deep-seal traps on floor drains and other waste outlets where indicated.

K. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

L. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

M. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

N. Install vent caps on each vent pipe passing through roof.

O. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.

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B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum 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.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07.

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19

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SECTION 22 14 13

STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of pipe and joining material, and for method for joining piping intended for the project.

1.3 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888.

B. Heavy-Duty, Hubless-Piping Couplings:

1. Product: Subject to compliance with requirements, provide one of the following products:

a. ANACO-Husky, SD 4000.
b. Mission, HeavyWeight Coupling.

2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with minimum four stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

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2.3 EPOXY-COATED, HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 coated inside and out with a fusion bonded epoxy coating complying with Section 4.6 and 5.7 of European Standard EN 877.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. NewAge Casting.

B. Liquid Epoxy Coating: Furnished by pipe manufacturer, used to coat uncoated ends of pipe after cutting or to repair damaged epoxy coating.

C. Heavy-Duty, Hubless-Piping Couplings:

1. Product: Subject to compliance with requirements, provide one of the following products:

a. ANACO-Husky, SD 4000.
b. Mission, HeavyWeight Coupling.

2. Standards: ASTM C 1277 or ASTM C 1540.
3. Description: Type 304 stainless-steel shield with minimum four stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Shielded, Nonpressure Transition Couplings:

a. Standard: ASTM C 1460.
b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 – EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. 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.

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D. Do not install piping within electrical rooms, elevator equipment rooms, MDF or IDF rooms, or stairwells. Exception: Pipe supplying equipment serving the room. Maintain all required clearances to other equipment.

E. Do not install piping above electrical equipment such as transformers, panels, motor control centers, etc. in other rooms.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees.

J. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Do not use bushings. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install storm drainage piping at the following minimum slopes unless otherwise indicated:

1. Building Storm Drain: One-fourth inch per foot, 2 percent, downward in direction of flow.
2. Horizontal Storm-Drainage Piping: One-fourth inch per foot, 2 percent downward in direction of flow.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

N. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

O. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."
2. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."

P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

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3.2 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasketed joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

1. After making a cut, dip exposed end of epoxy coated pipe in liquid epoxy to coat exposed cast iron.

C. Join copper tube and fittings with soldered joints according to ASTM B 828 procedure. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

3.3 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, nonpressure transition couplings.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable, steel clevis hangers.
7. Multiple, Straight, Horizontal Piping Runs: Trapeze hangers with pipe clamps.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support each section of horizontal piping and tubing within 12 inches of each fitting and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.

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6. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

H. Install supports for vertical copper tubing every 10 feet.

I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
2. Comply with requirements for cleanouts and drains specified in Section 221423 "Storm Drainage Piping Specialties."

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.6 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

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B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. Water level must not drop for 4 hours. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.8 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping NPS 4 and smaller shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty, 4-band hubless-piping couplings; and coupled joints.
2. Epoxy-coated, hubless, cast-iron soil pipe and fittings; heavy-duty, 4-band hubless-piping couplings; and coupled joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

C. Aboveground storm drainage piping NPS 5 and larger shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty, 6-band hubless-piping couplings; and coupled joints.
2. Epoxy-coated, hubless, cast-iron soil pipe and fittings; heavy-duty, 6-band hubless-piping couplings; and coupled joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

D. Underground storm drainage piping NPS 4 and smaller shall be any of the following:

1. Epoxy-coated, hubless, cast-iron soil pipe and fittings; heavy-duty, 4-band hubless-piping couplings; and coupled joints.

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2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

E. Underground storm drainage piping NPS 5 and larger shall be any of the following:

1. Epoxy-coated, hubless, cast-iron soil pipe and fittings; heavy-duty, 4-band hubless-piping couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

F. Pumped waste piping shall be any of the following:

1. Galvanized steel pipe and fittings; and threaded or flanged joints.
2. Copper tube and fittings; and soldered joints.

END OF SECTION 22 14 13

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SECTION 22 14 23

STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Cleanouts.
4. Flashing materials.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include manufacturer, model number, accessories and options.

1.3 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 METAL ROOF AND OVERFLOW DRAINS

A. Manufacturers: Subject to compliance with requirements. Provide products by one of the following:

1. Jay R. Smith Manufacturing Co.
2. Josam Company; Josam Division.
3. Wade.
4. Watts Drainage Products Inc.
5. Zurn Plumbing Products Group.

B. Cast-Iron, Large-Sump, General-Purpose Roof Drains:

1. Standard: ASME A112.6.4, for general-purpose roof drains.
2. Body Material: Cast iron.
3. Dimension of Body: Nominal 14-inch diameter.
4. Combination Flashing Ring and Gravel Stop: Required.
5. Outlet: Bottom or Side.
6. Extension Collars: Adjustable.
7. Underdeck Clamp: Required.
8. Sump Receiver Plate: Required.
9. Dome Material: Cast iron.
10. Vandal-Proof Dome: Required.
11. Water Dam: 2 inches high, required on overflow drains.

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C. Metal, Parapet Roof Drains:

1. Standard: ASME A112.6.4, for parapet roof drains.
2. Body Material: Cast iron or bronze.
3. Outlet: Back or Angle as required.
4. Grate Material: Bronze or Cast iron.
5. Vandal-Proof Grate: Required.

D. Metal, Large-Sump, Area Drains:

1. Standard: ASME A112.6.4, for area drains.
2. Body Material: Cast iron.
3. Dimension of Body: Nominal 14-inch diameter.
4. Dimension of Frame and Grate: Nominal 14 inches square.
5. Outlet: Bottom.
6. Grate Material: Nickel-bronze alloy.
7. Vandal-Proof Grate: Required.
8. Extension Collars: As required.
9. Sump Receiver: Required.
10. Sediment Bucket: Required.

2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Conductor Nozzles:

1. Description: Nickel bronze body with threaded or hub-less inlet and bronze wall flange with mounting holes. Designed to discharge water away from building and to prevent wall staining.
2. Size: Same as connected conductor.

2.3 CLEANOUTS

A. Floor Cleanouts:

1. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
2. Size: Same as connected branch.
3. Type: Adjustable housing.
4. Body or Ferrule Material: Cast iron.
5. Clamping Device: As required.
6. Outlet Connection: Spigot.
7. Closure: Plastic.
8. Adjustable Housing Material: Cast iron with threads.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
10. Frame and Cover Shape: Round or Square
11. Top-Loading Classification: Medium Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Test Tees:

1. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
2. Size: Same as connected drainage piping.
3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.

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4. Closure Plug: Countersunk, brass.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

C. Wall Cleanouts:

1. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
2. Size: Same as connected drainage piping.
3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or Hubless, cast-iron soil-pipe test tee as required to match connected piping.
4. Closure: Countersunk brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

2.4 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.

1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

C. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:

1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.

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4. Locate cleanouts at base of each vertical soil and waste stack.

D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

F. Install test tees in vertical conductors and near floor.

G. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

H. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with 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.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 14 23

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SECTION 22 14 29

SUMP PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submersible sump pumps.

1.2 SUBMITTALS

A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:

1. Manufacturer and model number.
2. Rated capacity based on scheduled conditions.
3. Equipment dimensions.
4. Required clearances.
5. Electrical data.
    a. Motor horsepower
    b. Voltage/Phase/Hz
    c. Full load ampacity, minimum circuit ampacity and maximum overcurrent protection device requirements.
    d. Electrical service point(s) of connection.
    e. AIC rating of the equipment.
6. Materials of construction.
7. Accessories and options.
8. Controls.

B. Warranty information.

C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

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

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

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PART 2 - PRODUCTS

2.1 SUBMERSIBLE SUMP PUMPS

A. Submersible, Fixed-Position, Single-Seal Sump Pumps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Bell & Gossett Domestic Pump.
    b. Grundfos Pumps Corp.
    c. Little Giant Pump Co.
    d. Weil Pump Company, Inc.
    e. Weinman Division.
    f. Zoeller Company.

2. Description: Factory-assembled and -tested sump-pump unit.
3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
5. Impeller: Statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron or ASTM A 532/A 532M, abrasion-resistant cast iron or ASTM B 584, cast bronze, design for clear wastewater handling, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seal: Mechanical.
8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
9. Controls:

    a. Switch Type: Unit mounted Mechanical-float or pressure type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    b. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float or pressure switch matching control and electric bell; 120-V ac, with transformer and contacts for remote alarm bell.

10. Control-Interface Features:

    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

        1) On-off status of pump.
        2) Alarm status.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."

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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. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and filling are specified in Division 31 Section "Earth Moving."

3.2 INSTALLATION

A. Pump Installation Standard: Comply with HI 1.4 for installation of sump pumps.

END OF SECTION 22 14 29

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SECTION 22 17 16

RECLAIMED WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Under-building slab and aboveground reclaimed water pipes, tubes, fittings, and specialties inside the building.
2. Specialty valves.
3. Flexible connectors.

1.2 SUBMITTALS

A. Product Data: For each type of pipe and joining material, and for method for joining piping intended for the project.

B. Field quality-control reports.

1.3 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic, potable domestic water piping and components.

C. Comply with NSF 61 for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

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B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.

1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
2. Copper Pressure-Seal-Joint Fittings:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Elkhart Products Corporation; Industrial Division.
2) NIBCO INC.
3) Victaulic Company of America.
4) Viega; Plumbing and Heating Systems.

b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.

c. NPS 3 and NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 TRANSITION FITTINGS

A. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Description:

a. Pressure Rating: 150 psig at 180 deg F.
b. End Connections: Solder-joint copper alloy and threaded ferrous.

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C. Dielectric Flanges:

1. Description:

a. Factory-fabricated, bolted, companion-flange assembly.
b. Pressure Rating: 150 psig.
c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

1. 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.

2.6 FLEXIBLE CONNECTORS

A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.
2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

2.7 MARKING TAPE

A. Marking Tape: Mylar tape minimum 0.005 inches thick and 2 inches wide with purple coloring (Pantone #512). Tape shall consist of PVC tape with a synthetic rubber adhesive with a clear polypropylene coating. Tape shall be marked with 1/2 inch high, black uppercase letters "CAUTION: RECLAIMED WATER, DO NOT DRINK" in two parallel lines spaced to remain visible after wrapping of the tape with a 1/2 inch overlap.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of reclaimed water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install piping buried below the building slab a minimum of 24 inches below slab.

D. Install underground piping outside of the building footprint a minimum of 36 inches below finished grade or minimum of 12 inches below the local frostline, whichever is deeper.

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E. Install shutoff valve with locking device, hose-end drain valve with locking device, strainer, pressure gage, and test tee with valve, inside the building at each reclaimed water service entrance.

F. Install shutoff valve with locking device immediately upstream of each dielectric fitting.

G. Install water-pressure-reducing valves downstream from shutoff valves where facility incoming water pressure exceeds 80 psi.

H. Install reclaimed water piping level and plumb.

I. Rough-in reclaimed water piping for water-meter installation and install meter.

J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

L. Do not install piping within electrical rooms, elevator equipment rooms, MDF or IDF rooms, or stairwells. Exception: Pipe supplying equipment serving the room. Maintain all required clearances to other equipment.

M. Do not install piping above electrical equipment such as transformers, panels, motor control centers, etc. in other rooms

N. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

O. Install piping adjacent to equipment and specialties to allow service and maintenance.

P. Install piping to permit valve servicing.

Q. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

R. Install piping free of sags and bends.

S. Install fittings for changes in direction and branch connections.

T. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

U. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

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3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for reclaimed water service. Join flanges with gasket and bolts according to ASME B31.9.

H. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.3 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations. Provide locking device on all valves except fixture supply valves.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 4 and smaller. Use gate valves for piping NPS 5 and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Reclaimed Water Piping Specialties."

1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

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B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. Dielectric Fittings for NPS 5 to NPS 6: Use dielectric flange kits.

3.6 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible connectors in suction and discharge piping connections to each reclaimed water booster pump.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: MSS Type 1, adjustable, steel clevis hangers.
3. Multiple, Straight, Horizontal Piping Runs: Trapeze hangers with pipe clamps.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.8 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect reclaimed water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect reclaimed water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Reclaimed Water Booster Pumps: Cold-water suction and discharge piping.

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2. Plumbing Fixtures: Cold-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
3. Equipment: Cold-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.
4. Install automatic trap primers on the cold water supply at the nearest fixture (or where indicated on the drawings) and run drain to trap seal being protected. Provide wall access panel when primers are installed in walls.

3.9 IDENTIFICATION

A. Identify reclaimed water piping systems by wrapping all pipe and fittings with marking tape with 1/2 inch overlap.

B. Paint equipment connected to the reclaimed water system purple to match the marking tape.

C. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

D. Label pressure piping with system operating pressure.

E. Provide room entrance sign with minimum 1/2" letters in a highly visible color on a contrasting background with the following, "TO CONSERVE WATER, THIS BUILDING USES RECLAIMED WATER TO FLUSH TOILETS AND URINALS" at the entrance to each restroom or other location where reclaimed water is used. Coordinate the color and location of the signs with the architect and the authorities having jurisdiction. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for materials.

F. Provide an equipment room entrance sign with minimum 1" high white letters on a purple background, "CAUTION RECLAIMED WATER, DO NOT DRINK. DO NOT CONNECT TO DRINKING WATER SYSTEM. NOTICE CONTACT BUILDING MANAGEMENT BEFORE PERFORMING ANY WORK ON THIS WATER SYSTEM" at the entrance to each mechanical or equipment room, or other location where reclaimed water is located. Provide one additional sign adjacent to each piece of equipment. Coordinate location of the signs with the architect and authorities having jurisdiction. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for materials.

G. Provide a 6 inch by 6 inch access door sign with 1/2 inch high white letters on a purple background, "CAUTION RECLAIMED WATER, DO NOT DRINK. DO NOT CONNECT TO DRINKING WATER SYSTEM. NOTICE CONTACT BUILDING MANAGEMENT BEFORE PERFORMING ANY WORK ON THIS WATER SYSTEM" at each access door or panel that conceals and valve or other appurtenance connected to the reclaimed water system. The sign shall be hung behind the access panel or door in the center of the access door frame. Coordinate location of the signs with the architect and authorities having jurisdiction. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for materials.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

    a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

1. Fill reclaimed water piping using clean, potable water. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced reclaimed water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

D. Reclaimed water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.11 CLEANING

A. Clean interior of reclaimed water piping system. Remove dirt and debris as work progresses.

B. Clean and disinfect potable reclaimed water piping prior to putting into service as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before use with clean, potable water.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.

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b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Submit water samples in sterile bottles to authorities having jurisdiction for testing of piping cleanliness. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities to Architect/Engineer. Include a copy of final report in Operation and Maintenance Manual.

D. Contractor will be responsible for cleaning and repair of system if microbial induced corrosion is detected within warranty period.

3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Under-ground, reclaimed water, building service piping shall be:

1. Piping NPS 2 and Smaller: Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
2. Piping NPS 2-1/2 and Larger: Hard copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.

D. Under-building-slab, reclaimed water piping shall be:

1. Piping NPS 2 and Smaller shall be: Soft copper tube, ASTM B 88, Type K; without joints.
2. Piping NPS 2-1/2 and Larger: Hard copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.
3. All under slab copper tube shall be protected with 20 mil plastic sleeving. Use purple sleeving on cold and hot water piping. Sleeving shall extend a minimum of 2 inches above slab.

E. Aboveground reclaimed water piping, NPS 2 and smaller shall be the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.

F. Aboveground reclaimed water piping, NPS 2-1/2 to NPS 4 shall be the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.

G. Aboveground reclaimed water piping, NPS 5 and NPS 6 shall be the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and brazed joints.

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3.13 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves for piping NPS 4 and smaller. Use gate valves with flanged ends for piping NPS 5 and larger.
2. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
3. Drain Duty: Hose-end drain valves with locking device.

B. Use check valves to maintain correct direction of reclaimed water flow to and from equipment.

END OF SECTION 22 17 16

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SECTION 22 17 19

RECLAIMED WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following reclaimed water piping specialties:

1. Backflow preventers.
2. Water pressure-reducing valves.
3. Strainers.
4. Drain valves.
5. Water hammer arresters.
6. Trap-seal primer valves.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Reclaimed Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 SUBMITTALS

A. Product Data: For each type of water piping specialty proposed for this project. Include manufacturer, model number, materials of construction, options and accessories, etc.

1. For thermostatic mixing valves include a copy of the piping diagram.

B. Field quality-control test reports.

C. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic reclaimed water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS

A. Basis-of Design: Subject to compliance with requirements, provide the following product: Wilkens 375AST by Zurn.

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B. Reduced-Pressure-Principle Backflow Preventers:

1. Standard: ASSE 1013.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved, steel with interior lining complying with AWWA C550 or that is FDA approved, or stainless steel for NPS 2-1/2 and larger.
5. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
6. Configuration: Designed for horizontal, straight through flow.
7. Accessories:

    a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.2 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Conbraco Industries, Inc.
    b. Watts Industries, Inc.
    c. Wilkins.

2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Design Outlet Pressure Setting: As indicated on drawings.
5. Body: Bronze for NPS 2 and smaller; cast iron for NPS 2-1/2 and NPS 3.
6. Valves for Booster Heater Water Supply: Include integral bypass.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.3 STRAINERS FOR RECLAIMED WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:

    a. Strainers NPS 2 and Smaller: 0.020 inch.
    b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
    c. Strainers NPS 5 and Larger: 0.10 inch.

6. Drain: Pipe plug.

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2.4 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel with locking device.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.5 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. MIFAB, Inc.
    b. PPP Inc.
    c. Sioux Chief Manufacturing Company, Inc.
    d. Smith, Jay R. Mfg. Co.
    e. Watts Drainage Products Inc.
    f. Zurn.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows or Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.6 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. MIFAB, Inc.
    b. PPP Inc.
    c. Sioux Chief Manufacturing Company, Inc.
    d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
    e. Watts Industries, Inc.; Water Products Div.

2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

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2.7 ELECTRONIC TRAP PRIMER VALVES

A. Supply Type, electronic trap priming assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. MIFAB, Inc.
b. PPP Inc.
c. Zurn Plumbing Products Group.

2. Standard: ASSE 1044.
3. Pressure Rating: 125 psig minimum.
4. Style: Recessed cabinet in finished locations and new construction. NEMA 1 cabinet in retrofit applications or unfinished areas with masonry walls.
5. Number of openings: As required for application or as noted.
6. Inlet Connections: NPS 3/4 with shutoff valve.
7. Outlet connection: 1/2 inch compression.
8. Backflow Prevention: Anti-siphon atmospheric vacuum breaker, ASSE 1001.
9. Electrical: 120V, 1 phase, circuit breaker, manual override, 24 hour timer, UL listed solenoid valve.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in building at connection points of reclaimed water system to water-service piping. Comply with authorities having jurisdiction.

B. Install backflow preventers in each water supply to equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.

C. Install water pressure regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

D. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve, solenoid valve, and pump.

E. Install water hammer arresters in water piping according to PDI-WH 201.

F. Install trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain or floor-sink body, trap, or inlet fitting. Adjust valve for proper flow.

1. Install trap primer valves at all floor drains or floor sinks, except floor drains in commercial showers.

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2. Install supply-type valves where floor drains and floor sinks are in close proximity to flush valves.
3. Install electronic valves where floor drains and floor sinks are not in close proximity to flush valves.

G. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Reduced-pressure-principle backflow preventers.
2. Water pressure-reducing valves.
3. Primary, thermostatic, water mixing valves.

H. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports: Test each reduced-pressure-principle backflow preventer assembly according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning reclaimed water piping specialties and retest as specified above.

3.3 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 22 17 19

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SECTION 22 31 00

DOMESTIC WATER SOFTENERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commercial water softeners.
2. Chemicals.
3. Water-testing sets.

1.2 SUBMITTALS

A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:

1. Manufacturer and model number.
2. Equipment dimensions.
3. Required clearances.
4. Electrical data.

    a. Voltage/Phase/Hz
    b. Full load ampacity, minimum circuit ampacity and maximum overcurrent protection device requirements.
    c. Electrical service point(s) of connection.

5. Materials of construction.
6. Accessories and options.
7. Controls.

B. Operation and maintenance data.

C. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE

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

B. ASME Compliance for Steel Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, where indicated.

C. UL Compliance: Fabricate and label water softeners to comply with UL 979, "Water Treatment Appliances."

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1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of water softeners that fail in materials or workmanship within specified warranty period.

1. Commercial Water Softeners, Warranty Period: From date of Substantial Completion.

a. Mineral Tanks: Five years.
b. Brine Tanks: 10 years.
c. Control Valve: One year.

1.5 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Salt for Brine Tanks: Furnish in same form as and at least four times original load, but not less than 200 lb.
2. Store salt on raised platform where directed by Owner. Do not store in contact with concrete floor.

PART 2 - PRODUCTS

2.1 COMMERCIAL WATER SOFTENERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following: Water King.

B. Description: Factory-assembled, pressure-type water softener.

1. Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects."
2. Configuration: Twin unit with two mineral tanks and one brine tank.
3. Mounting: On skids.
4. Wetted Components: Suitable for water temperatures from 40 to at least 100 deg F.
5. Mineral Tanks: Fiberglass Reinforced Polyester, Steel or Stainless steel, electric welded; pressure-vessel quality.

a. Working Pressure Rating: 100 psig minimum.
b. Freeboard: 50 percent minimum for backwash expansion above normal resin bed level.
c. Support Legs or Skirt: Constructed of structural steel, welded to tank or molded polypropylene base for FRP tanks.
d. Finish (Steel Tanks): Hot-dip galvanized on exterior and interior of tank after fabrication unless tank is stainless steel.
e. Finish: Exterior of tank spray-painted with rust-resistant prime coat, 2- to 3-mil dry film thickness. Interior sandblasted and lined with epoxy-polyamide coating, 8- to 10-mil dry film thickness.
f. Upper Distribution System: Single, point type, fabricated from galvanized-steel pipe and fittings.
g. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging PE strainers, and arranged for even flow distribution through resin bed.
h. Liner: Epoxy, PE, ABS, or other material suitable for potable water.

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6. Controls: Fully automatic; factory wired and factory mounted on unit.

   a. Indicator lights for each resin tank to indicate service and regeneration.
   b. Adjustable duration of various regeneration steps.
   c. Push-button start and complete manual operation.
   d. Electric time clock and switch for fully automatic operation, adjustable to initiate regeneration at any hour of day and any day of week or at fixed intervals.
   e. Sequence of Operation: Multiport pilot-control valve automatically pressure-actuates main operating valve through steps of regeneration and return to service.
   f. Pointer on pilot-control valve shall indicate cycle of operation.
   g. Includes means of manual operation of pilot-control valve if power fails.
   h. Regeneration shall be initiated by a volumetric meter.

7. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:

   a. Slow opening and closing, nonslam operation.
   b. Isolated, dissimilar metals within valve.
   c. Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
   d. Valve shall have second tank adapter and bypass.
   e. Sampling cocks for soft water.
   f. Special tools are not required for service.

8. Flow Control: Automatic, to control backwash and flush rates over wide variations in operating pressure; does not require field adjustments.

   a. Demand-Initiated Control: Each mineral tank of twin mineral-tank unit is equipped with automatic-reset-head water meter that electrically activates cycle controllers to initiate regeneration at preset total in gallons. Head automatically resets to preset total in gallons for next service run. Electrical lockout prevents simultaneous regeneration of both tanks.

9. Brine Tank: Combination measuring and wet-salt storing system.

   a. Tank and Cover Material: Fiberglass, 3/16 inch thick; or molded PE, 3/8 inch thick.
   b. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawal and freshwater refill.
   c. Size: Large enough for at least four regenerations at full salting.

10. Factory-Installed Accessories:

   a. Piping, valves, tubing, and drains.
   b. Sampling cocks.
   c. Main-operating-valve position indicators.
   d. Water meters.

C. Capacities and Characteristics: The Contractor shall obtain a sample of the water and get an analysis.

2.2 CHEMICALS

A. Mineral: High-capacity, non-phenolic resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock.

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1. Exchange Capacity: 30,000 grains/cu. ft. of calcium carbonate of resin when regenerated with 15 lbs. of salt.
2. Resin:

    a. R.B.C.
    b. Purolite C100X10.
    c. Rohm & Haas I.R. 122/IR-132.
    d. Down Hor/Hg-W2.
    e. Ionac C-250/C299.
    f. Durolite C20 X 10 C255 x 1.

B. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are unacceptable.

1. Form: Processed, plain salt pellets.

2.3 WATER-TESTING SETS

A. Description: Manufacturer's standard water-hardness testing apparatus and chemicals with testing procedure instructions. Include metal container suitable for wall mounting.

PART 3 - EXECUTION

3.1 WATER SOFTENER INSTALLATION

A. Equipment Mounting: Install residential water softeners on floor.

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.

B. Equipment Mounting: Install commercial water softeners on concrete base.

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to supported equipment.
7. Anchor water softener and brine tanks to substrate.

C. Install brine lines and fittings furnished by equipment manufacturer but not specified to be factory installed.

D. Prepare mineral-tank distribution system and under bed for minerals and place specified mineral into mineral tanks.

E. Install water-testing sets mounted on wall, unless otherwise indicated, and near water softeners.

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3.2 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to equipment, allow space for service and maintenance of equipment.

C. Install shutoff valves on raw-water inlet and soft-water outlet piping of each mineral tank.

1. Metal general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
2. Plastic valves are specified in Division 22 Section "Domestic Water Piping."
3. Exception: Water softeners with factory-installed shutoff valves at locations indicated.

D. Install pressure gages on raw-water inlet and soft-water outlet piping of each mineral tank. Pressure gages are specified in Division 22 Section "Meters and Gages for Plumbing Piping."

1. Exception: Water softeners with factory-installed pressure gages at locations indicated.

E. Install valved bypass in water piping around water softeners.

1. Metal general-duty valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
2. Plastic valves are specified in Division 22 Section "Domestic Water Piping."
3. Water piping is specified in Division 22 Section "Domestic Water Piping."

F. Install drains as indirect wastes to spill into open drains or over floor drains.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

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B. Add water to brine tanks and fill with the following form of salt:

1. Commercial Water Softeners: Processed, plain salt pellets.

C. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:

1. ASTM D 859, "Test Method for Silica in Water."
2. ASTM D 1067, "Test Methods for Acidity or Alkalinity of Water."
3. ASTM D 1068, "Test Methods for Iron in Water."
4. ASTM D 1126, "Test Method for Hardness in Water."
5. ASTM D 1129, "Terminology Relating to Water."
6. ASTM D 3370, "Practices for Sampling Water from Closed Conduits."

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water softeners.

END OF SECTION 22 31 00

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SECTION 22 35 00

DOMESTIC WATER HEAT EXCHANGERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Coil-in-tank, storage, domestic-water heat exchangers.
2. Domestic-water, heat-exchanger accessories.

1.2 SUBMITTALS

A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:

1. Manufacturer and model number.
2. Rated capacity based on scheduled conditions.
3. Equipment dimensions.
4. Required clearances.
5. Electrical data.
    a. Voltage/Phase/Hz
    b. Full load ampacity, minimum circuit ampacity and maximum overcurrent protection device requirements.
    c. Electrical service point(s) of connection.
6. Materials of construction.
7. Accessories and options.
8. Controls.

B. Product certificates.

C. Domestic-Water, Heat-Exchanger Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

D. Operation and maintenance data.

E. Warranty: Sample of special warranty.

1.3 QUALITY ASSURANCE

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

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/ IESNA 90.1.

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C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label heat-exchanger storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of domestic-water heat exchangers that fail in materials or workmanship within specified warranty period.

1. Warranty Periods: From date of Substantial Completion.

a. Coil-in-tank, Domestic-Water Heat Exchangers:

1) Storage Tank: Five years.
2) Tube Coil: Five years.
3) Controls and Other Components: Three years.

b. Compression Tanks: One year(s).

PART 2 - PRODUCTS

2.1 COIL-IN-TANK, DOMESTIC-WATER HEAT EXCHANGERS

A. Coil-In-Tank, Storage, Domestic-Water Heat Exchangers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cemline.
b. Thermaflo Engineering Co.

2. Description: Assembly of hot-water storage tanks with separate heat-exchanger coils, controls, and specialties for heating domestic water with steam in coil.
3. Storage-Tank Construction: ASME-code steel with 150-psig working-pressure rating. Include nozzle and head for heat-exchanger tube coil.

a. Configuration: Horizontal or Vertical.

b. Manhole: 11 by 15 inches in sidewall of vertical storage-tank shell.
c. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing and labeling.

1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

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d. Lining: Glass, nickel plate, phenolic coating, cement or sheet copper complying with NSF 61 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
e. Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire storage tank and nozzle except connections and controls.
f. Anode Rods: Factory installed, magnesium.

4. Heat-Exchanger Coil: Vented double-wall, copper or copper-alloy spiral or U tubes with tube sheet and supporting baffles. Include heat-exchanger pressure rating equal to or greater than heating-fluid supply pressure.
5. Temperature Control: Adjustable temperature aquastat, mounted in storage-tank shell head, unless otherwise indicated.
6. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into storage tank.

2.2 DOMESTIC-WATER, HEAT-EXCHANGER ACCESSORIES

A. Domestic-Water Compression Tanks:

1. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
2. Construction:

a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
c. Air-Charging Valve: Factory installed.

3. Capacity and Characteristics:

a. Working-Pressure Rating: 150 psig.
b. Capacity Acceptance: As shown on drawings.
c. Air Precharge Pressure: 12 psig.

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

C. Heat-Trap Fittings: ASHRAE 90.2.

D. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than heat-exchanger working-pressure rating. Select relief valves with sensing element that extends into storage tank.

E. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than heat-exchanger working-pressure rating.

F. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

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2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heat exchangers specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test domestic-water heat exchangers to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heat exchangers will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 for retesting and reinspecting requirements and requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER, HEAT-EXCHANGER INSTALLATION

A. Domestic-Water, Heat-Exchanger Mounting: Install domestic-water heat exchangers on concrete base. Comply with requirements for concrete bases specified in Division 03.

1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Anchor heat exchangers to substrate.

B. Install domestic-water heat exchangers level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to heat exchangers and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
2. Install shutoff valves on heating hot-water piping to heat exchangers. Comply with requirements for shutoff valves specified in Division 23 Section "General-Duty Valves for HVAC Piping."
3. Install shutoff valves on steam and condensate piping to heat exchangers. Comply with requirements for shutoff valves specified in Division 23 Section "General-Duty Valves for HVAC Piping."

C. Install temperature and pressure relief valves in top portion of storage-tank shells of domestic-water heat exchangers with domestic-water storage. Use relief valves with sensing elements that extend into shells. Extend relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install heat-exchanger drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heat exchangers that do not have tank drains. Comply with requirements for hose-end drain valves specified in Division 22 Section "Domestic Water Piping Specialties."

E. Install thermometer on each domestic-water, heat-exchanger, outlet piping, and install thermometer on each domestic-water, heat-exchanger, heating-fluid inlet and outlet piping. Comply with requirements for thermometers specified in Division 22 Section "Meters and Gages for Plumbing Piping."

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F. Install pressure gages on domestic-water, heat-exchanger, heating-fluid piping. Comply with requirements for pressure gages specified in Division 22 Section "Meters and Gages for Plumbing Piping."

G. Fill domestic-water heat exchangers with water.

H. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section "Domestic Water Piping."

B. Comply with requirements for steam and condensate piping specified in Division 23 Section "Steam and Condensate Heating Piping."

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Where installing piping adjacent to domestic-water heat exchangers, allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of domestic-water heat exchangers.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heat exchangers will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain shell-and-tube domestic-water heat exchangers.

END OF SECTION 22 35 00

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SECTION 22 40 00

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following: Standard plumbing fixtures and accessories.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. FRP: Fiberglass-reinforced plastic.

D. PMMA: Polymethyl methacrylate (acrylic) plastic.

E. PVC: Polyvinyl chloride plastic.

F. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include manufacturer, model number, options and accessories. Label each data submittal with fixture designation shown on drawings.

B. LEED Submittal:

1. Product Data for Credit WE 2 3.1 3.2 2 and 3.1 2, 3.1, and 3.2: Documentation indicating flow and water consumption requirements.

C. Warranty information.

D. Operation and maintenance data.

1.4 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. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

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C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

F. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Plastic Laundry Trays: ANSI Z124.6.
3. Plastic Shower Enclosures: ANSI Z124.2.
4. Plastic Sinks: ANSI Z124.6.
5. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
6. Slip-Resistant Bathing Surfaces: ASTM F 462.
7. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
8. Stainless-Steel Residential Sinks: ASME A112.19.3.
9. Vitreous-China Fixtures: ASME A112.19.2M.
10. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
11. Water-Closet, Flushometer Tank Trim: ASSE 1037.

G. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
4. Faucets: ASME A112.18.1.
5. Hose-Connection Vacuum Breakers: ASSE 1011.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
8. NSF Potable-Water Materials: NSF 61.
9. Pipe Threads: ASME B1.20.1.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Supply Fittings: ASME A112.18.1.
12. Brass Waste Fittings: ASME A112.18.2.
13. Components shall be lead free as defined by the Safe Drinking Water Act Amendments of 1986 and the Lead Contamination Control Act of 1988.

H. Comply with the following applicable standards and other requirements specified for shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1070.
3. Faucets: ASME A112.18.1.
4. Hand-Held Shower Backflow Prevention Devices: ASSE 1014.
5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Manual-Control Antiscald Faucets: ASTM F 444.
8. Pipe Threads: ASME B1.20.1.
9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1070.
10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
11. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1070.

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I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Brass and Copper Supplies: ASME A112.18.1.
3. Dishwasher Air-Gap Fittings: ASSE 1021.
4. Manual-Operation Flushometers: ASSE 1037.
5. Plastic Tubular Fittings: ASTM F 409.
6. Brass Waste Fittings: ASME A112.18.2.
7. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.
2. Dishwasher Air-Gap Fittings: ASSE 1021.
3. Flexible Water Connectors: ASME A112.18.6.
4. Grab Bars: ASTM F 446.
5. Hose-Coupling Threads: ASME B1.20.7.
6. Hot-Water Dispensers: ASSE 1023 and UL 499.
7. Off-Floor Fixture Supports: ASME A112.6.1M.
8. Pipe Threads: ASME B1.20.1.
9. Plastic Toilet Seats: ANSI Z124.5.
10. Supply & Drain Protective Shielding Guards: ICC A117.1, ASTM E 84-07.

PART 2 - PRODUCTS

2.1 LAVATORY AND SINK FAUCETS

A. Standard Lavatory and Sink Faucets:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by the following:

a. Delta Commercial Faucet Company.

B. Metering Lavatory Faucets:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by the following:

a. Delta Commercial Faucet Company.

2.2 BATHTUB AND SHOWER FAUCETS

A. Bathtub and Shower Faucets:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by the following:

a. Delta Commercial Faucet Company.

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2.3 FLUSH VALVES FOR URINALS AND WATER CLOSETS

A. Flush Valves for Urinals and Water Closets:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by the following:

a. Sloan Valve Company.

2.4 TOILET SEATS

A. Toilet Seats:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by one of the following:

a. American Standard Brands.
b. Bemis Manufacturing Company.
c. Church Seats.
d. Kohler Co.
e. Olsonite Corp.
f. Sanderson Plumbing Products, Inc.; Beneke Div.
g. Sperzel.
h. Zurn Plumbing Products Group; Commercial Brass Operation.

2.5 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. TRUEBRO, Inc.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot-, cold-, and tempered water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements. Product shall meet ADA and ICC/ANSI A117.1. Insulation material shall comply with ASTM E 84-07 / UL 723 Class A and shall be listed and meet UPC/IAPMO.

2.6 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Josam Company.
2. MIFAB Manufacturing Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Zurn Plumbing Products Group; Specification Drainage Operation.
6. Watts Drainage Products; a division of Watts Water Technologies.

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2.7 DISHWASHER AIR-GAP FITTINGS

A. Dishwasher Air-Gap Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Dearborn Brass; a div. of Moen, Inc.
    b. Geberit Manufacturing, Inc.
    c. Sioux Chief Manufacturing Company, Inc.
    d. Watts Brass & Tubular; a division of Watts Water Technologies.

2.8 DISPOSERS

A. Disposers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by one of the following:

    a. In-Sink-Erator; a div. of Emerson Electric Co.
    b. KitchenAid.
    c. Maytag Co.

2.9 HOT-WATER DISPENSERS

A. Hot-Water Dispensers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by one of the following:

    a. Anaheim Manufacturing, Inc.; a Subsidiary of Western Industries, Inc.
    b. Franke Consumer Products, Inc.; Kitchen Systems Div.
    c. In-Sink-Erator; a div. of Emerson Electric Co.
    d. Just Manufacturing Company.

2. Description: Gooseneck spout with lever-handle, twist-knob or push-button, flow control, household-type dispenser with instant on-off control; insulated, corrosion-resistant-metal storage tank that is open to atmosphere; electric heating element; chrome-plated faucet or spout; removable strainer; thermostat control for water temperature up to 190 deg F; and thermal-overload protection.

    a. Storage Tank Capacity: 0.5 gal.
    b. Heating Element: 750 W minimum, 115-V ac.

2.10 LAVATORIES, WATER CLOSETS, AND URINALS

A. Lavatories, Water Closets, and Urinals:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by one of the following:

    a. American Standard Brands.

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b. Kohler Co.
c. Zurn Plumbing Products Group.

2.11 INDIVIDUAL SHOWERS

A. Individual Showers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by one of the following:

a. Kohler Co.
b. American Standard Brands.

2.12 STAINLESS STEEL SINKS

A. Kitchen Sinks:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by one of the following:

a. Elkay Manufacturing Company.
b. American Standard Brands.

2.13 SERVICE SINKS

A. Service Sinks:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by one of the following:

a. American Standard Companies, Inc.
b. Kohler Co.

2.14 MOP SINKS

A. Mop Sinks:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by one of the following:

a. Crane Plumbing, L.L.C./Fiat Products.
b. Florestone Inc.
c. Zurn Plumbing Products Group.
d. American Standard Brands.
e. Just Manufacturing Company.
f. Willoughby Industries, Inc.

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PART 3 - EXECUTION

3.1 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install fixtures level and plumb according to roughing-in drawings.

G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

H. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

I. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

J. Install flush valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

K. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

L. Install toilet seats on water closets.

M. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

N. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

O. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

P. Install shower flow-control fittings with specified maximum flow rates in shower arms.

Q. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

R. Install disposer in outlet of each sink indicated to have disposer.

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S. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Connect inlet hose to dishwasher and outlet hose to disposer.

T. Install hot-water dispensers in back top surface of sink or in countertop with spout over sink as indicated.

U. Install escutcheons at piping wall and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Escutcheons for Plumbing Piping."

V. Set bathtubs and showers in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."

W. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07.

X. Install protective shielding guards per the manufacturer's written instructions to cover all exposed piping and valves below handicap accessible sinks and lavatories.

3.2 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.3 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.4 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 40 00

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SECTION 22 47 00

DRINKING FOUNTAINS & WATER COOLERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes drinking fountains and water coolers.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include manufacturer, model number, options and accessories.

B. Operation and maintenance data.

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. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for fixtures for people with disabilities.

C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

D. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.

E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.

F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants" for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.

PART 2 - PRODUCTS

2.1 DRINKING FOUNTAINS AND WATER COOLERS

A. Drinking Fountains and Water Coolers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated or a comparable product by one of the following:

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a. Acorn Engineering Company
b. Elkay Manufacturing.
c. Halsey Taylor.
d. Oasis Corporation.
e. Sunroc Corp.

2.2 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Josam Co.
2. MIFAB Manufacturing, Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.

1. Type I: Hanger-type carrier with two vertical uprights.
2. Type II: Bilevel, hanger-type carrier with three vertical uprights.
3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

B. Set freestanding and pedestal drinking fountains on floor.

C. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view.

3.2 INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.

C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball valve unless otherwise indicated. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

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E. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section "Escutcheons for Plumbing Piping."

F. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07.

3.3 CONNECTIONS

A. Connect fixtures with water supplies, traps, and risers, and with soil, waste, and vent piping. Use size fittings required to match fixtures.

3.4 FIELD QUALITY CONTROL

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.

1. Remove and replace malfunctioning units and retest as specified above.
2. Report test results in writing.

3.5 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

END OF SECTION 22 47 00

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SECTION 23 05 00

GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE

A. Provisions of this section apply to all work specified in all sections under Division 23.

B. In addition, work in Division 23 is governed by the provisions of the Bidding Requirements, Contract Forms, General Conditions, and all sections under Division 01.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and utility tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations and mechanical yards.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 EXAMINATION OF PREMISES

A. Visit the site, verify all measurements and job conditions, and pay all costs necessary to perform the work.

1.4 MECHANICAL CONTRACTOR

A. The Mechanical Contractor shall be licensed and hold a current contracting license that has been valid for a minimum of three years in the State of Arizona as a mechanical contractor.

1.5 REGULATIONS, PERMITS, FEES, CHARGES, INSPECTIONS

A. Regulations: Comply with all applicable codes, rules and regulations.

B. Fees and Permits: Pay all connection, installation, use, development, etc., fees and/or charges. Obtain and pay for all required permits and licenses. Refer to Division 01.

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C. Inspections: All work must be inspected and approved by local authorities. Prior to final approval, furnish the Architect with certificates of inspections and approvals by the local authorities in accordance with Division 01.

1.6 DRAWINGS AND SPECIFICATIONS

A. If a conflict exists on the drawings or between the drawings and specifications, promptly notify the Architect.

1.7 SUBMITTALS

A. Submittals are for information and coordination only. The Engineer will diligently review the submittals and attempt to verify compliance with the project requirements. Such review, however, does not constitute approval or disapproval of obligation to comply with all project requirements. The submittals are not to be construed to be contract documents. Any failure by the Engineer to note a point of non-compliance shall not be construed to be acceptance or approval of the discrepancy.

B. Product Information Sheets: Provide manufacturer's literature which includes the information required by the Product Data paragraph of the applicable Specification Section. Where Product Information Sheets show multiple models or options, clearly mark the model and options to be provided.

C. Assembly: Assemble all required submittal information for each specification section and submit in PDF format.

1. Assemble PDF submittals in one PDF file for each Division. Separate and order sections within each file by corresponding specification number. Provide bookmarks at the first page of each section and label each bookmark with the specification number and name to allow for easy navigation of the submittal.
2. Partial submittals will be returned without review. Submittals for Building Automation System may be submitted separately.

D. Identification and Information:

1. Name the PDF file with the Project name, Division number and sequential submittal number. (I.E. The first submittal shall be No. 1; the second submittal shall be No. 2.)
2. Provide a cover sheet at the front of each submittal with the following information:

    a. Project name.
    b. Date.
    c. Name of Engineer.
    d. Name of Contractor.
    e. Name of subcontractor.

3. Provide a cover sheet at the front of each submittal section with the following information:

    a. Name of supplier.
    b. Name of manufacturer.
    c. Number and title of appropriate Specification Section.
    d. Drawing number and detail references, as appropriate.
    e. Other necessary identification.

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E. Options:

1. Identify options requiring selection by the Engineer.
2. Identify options included with submittal item.

F. Deviations: Identify deviations from the Contract Documents on submittals.

1.8 MATERIAL SAFETY DATA SHEETS

A. Provide current, Material Safety Data Sheets (MSDS), for all hazardous chemicals that are proposed for use at the project site.

1. Provide one complete set to the Owner for review and approval a minimum of one week prior to the delivery of any hazardous chemicals to the site.
2. Maintain a second complete set at the project location, readily accessible by both the Owner's personnel and the contractor's personnel.

1.9 SHOP DRAWINGS

A. Provide shop drawings for each mechanical equipment room such as air handler rooms, heat exchanger rooms, and other rooms containing mechanical equipment.

1. Each drawing shall be to scale and show all equipment to be located within the room, including piping, ductwork, control and electrical panels.
2. Show manufacturer and code required maintenance clearance.
3. Submit shop drawings for review and approval by the Engineer and Owner prior to beginning construction.

1.10 REQUEST FOR INFORMATION

A. Request for Information:

1. A document submitted by the Contractor requesting clarification of a portion of the Contract Documents, hereinafter referred to as RFI.
2. A properly prepared request for information shall include a detailed written statement of the clarification, apparent conflict, or information requested that indicates the specific drawings or specification in need of clarification and the nature of the clarification requested.

    a. Drawings shall be identified by drawing number and location on the drawing sheet.
    b. Specifications shall be identified by section number, page, and paragraph.

3. Include a proposed solution, where appropriate, based upon the field conditions and best knowledge of the Contractor.

B. Improper or Frivolous RFIs: RFIs which are not properly prepared or that request information which is clearly shown in the contract documents will be returned unanswered. Processing time for multiple submissions of improper or frivolous RFIs will be billed at the Engineer's standard hourly rate to the Owner who may deduct an equal amount from the monies due the Contractor.

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1.11 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings, Submittals and Shop Drawings.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Include underground and overhead piping. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

   a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
   b. Include dimensions both horizontally and vertically to permanent points of reference accurate within 6 inches. Include descriptors such as "below slab", "above ceiling", etc.
   c. Record data daily or as soon as possible after obtaining it.
   d. Record and check the markup before enclosing concealed installations.

2. Mark the Contract Drawings, Submittals and Shop Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of marked-up record prints.
3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Identification: As follows:

   a. Project name.
   b. Date.
   c. Designation "PROJECT RECORD DRAWINGS."
   d. Name of Engineer.
   e. Name of Contractor.

3. Remove or obscure Engineer's seal from Record Drawings.

1.12 OPERATION AND MAINTENANCE MANUAL

A. Prior to completion of the project, compile a complete equipment, operation and maintenance manual for all equipment supplied under Division 23.

B. Schedule:

1. Submit a preliminary copy of the manual not less than 30 days prior to substantial completion for review and comment.
2. Submit the final version the manual not more than four weeks after substantial completion of the project.

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C. Format: Submit manuals in both of the following formats:

1. PDF electronic file. Assemble each manual into a composite electronically-indexed file. Submit on digital media acceptable to Engineer.

    a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically-linked operation and maintenance directory.
    b. Enable inserted reviewer comments on draft submittals.
    c. Provide one final copy to Engineer and two copies to Owner.

2. Three paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. Engineer will return three copies.

D. Provide operating and maintenance manuals for all systems, subsystems, and equipment that requires operation and regular maintenance, or has replaceable parts.

E. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, product data, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below. In addition to requirements in this Section, include operation and maintenance data required in individual Specification Sections.

F. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

G. Product Data: Include the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Approved submittals.
3. Include the following if not shown on approved submittals:

    a. Product name and model number. Use designations for products indicated on Contract Documents.
    b. Manufacturer's name.
    c. Equipment identification with serial number of each component.
    d. Equipment function.
    e. Operating characteristics.
    f. Limiting conditions.
    g. Performance curves.
    h. Engineering data and tests.

H. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures. Including precautions against improper use.

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10. Operating logs.

I. Wiring Diagrams: Diagram of factory installed wiring including any options as well as any field modifications.

J. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

K. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification. Include valve locations and designations.

L. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

M. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

N. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

O. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

P. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

Q. Licenses: Include copies of any licenses with requirements including inspection and renewal dates.

R. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

S. Test and Balance Report: Include a final, approved copy of the Test and Balance Report.

1.13 WORK AND MATERIALS

A. Unless otherwise specified, all materials must be new and of the quality specified. The workmanship shall be of a quality that is acceptable to the Architect, Engineer, and Owner, and is equal to the standards of the trades. Contractor must staff the project with sufficient skilled workmen, including a fully qualified construction superintendent, to complete the work in the time allotted. The superintendent must be qualified to supervise all of the work in his work category.

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B. Uniformity: Unless otherwise specified, provide all equipment and products of same type or classification by the same manufacturer.

1.14 APPROVALS OF MATERIALS AND EQUIPMENT

A. Refer to Division 01 for description of material and equipment for prior approvals and substitutions.

1.15 COOPERATIVE WORK

A. Correct without charge any work requiring alteration due to lack of proper supervision or failure to make proper provision in time. Correct without charge any damage to adjacent work caused by the alteration. See Division 01 for additional requirements.

B. Cooperative Work Includes:

1. General supervision and responsibility for proper location, rough-in and size of work related to Division 23 but provided under other divisions of these specifications.
2. Installation of sleeves, inserts and anchors bolts for work under sections in Division 23.
3. Sealing of penetrations through fire and smoke barriers caused by work installed as part of Division 23.

1.16 CONSTRUCTION FACILITIES

A. General: Under this division of the specifications, execute all work in a manner to provide safe and lawful ingress and egress to the Owner's establishment and such facilities shall be kept clear of materials or equipment. Refer to Division 01 for additional requirements.

B. Furnish and maintain from the beginning to the completion of all work all lawful and necessary guards, railings, fences, canopies, lights, and warning signs. Take all necessary precautions required by city and state laws to avoid injury or damage to any and all persons and property.

1.17 GUARANTEE

A. Guarantee all material, equipment, installation and workmanship for all sections under Division 23 in writing to be free from defects of material and workmanship for one year from date of final acceptance as outlined in Division 01. Equipment warranties shall be a minimum of two years from date of substantial completion or as specified elsewhere. Replace without charge any material or equipment proving defective during this period. The guarantee shall include performance of the equipment under all conditions of load, installing any additional items of control and/or protective devices as required and the replacing of any refrigerant lost.

1.18 MECHANICAL WIRING

A. Provide all temperature control wiring, interlock wiring, and equipment control wiring for the equipment that is to be provided under Division 23 unless wiring is specifically shown on electrical drawings.

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B. The following schedule is intended to summarize the division of work material responsibilities between the Mechanical Contractor, Controls Contractor and the Electrical Contractor.

Item	Furn. By	Set By	Power Wiring	Control Wiring
Equipment Motors	MC	MC	EC	--
Motor Control Center	EC	EC	EC	CC
Motor Starters, Controllers, Contactors and Overload Heaters	MC*	EC**	EC	CC
Fused and Non-Fused Disconnect Switches	EC	EC	EC	--
Manual Operating Switches, Multispeed Switches, Pushbutton Stations and Pilot Lights	CC	CC	CC	CC
Control Relays and Transformers	CC	CC	CC	CC
Line Voltage Thermostats and Time Switches***	MC	MC	EC	EC
Low Voltage Thermostats	MC	MC	-	MC
Temperature Control Panels	MC	MC	EC	CC
Smoke Detectors (Duct Mounted)	EC	MC	EC	MC or CC
Motor and Solenoid Valves, Damper Motors, PE and EP Switches	CC	MC	CC	CC
Water Treatment Equipment	MC	MC	EC	CC

MC = Mechanical Contractor
CC = Controls Contractor
EC = Electrical Contractor

*Except where such devices are located in MCC's.

**Unless required by these specifications to be provided as part of a factory furnished assembly (i.e. fan coils, air handlers, chillers, etc.).

***Motor-drive units which are controlled from line voltage automatic controls such as line voltage thermostats, float switches or time switches which conduct full load current of the motor shall be wired for both power and control circuit under the electrical contract.

1.19 COMMISSIONNING

A. This project will be commissioned. See commissioning requirements in Division 01.

PART 2 - PRODUCTS

2.1 MACHINERY DRIVES

A. Unless otherwise specified in Division 23 equipment sections, use V-belts designed for 150% of capacity for all belt drives. For multiple belt drives, use matched sets, so marked at the factory.

B. On drives with not more than two belts, provide adjustable pitch motor sheaves with the midpoint of the adjustment range equal to that required to achieve the specified fan capacity.

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C. On motors with drives with more than two belts, furnish non-adjustable sheaves, providing the specified fan capacity.

2.2 MACHINERY ACCESSORIES

A. Guards: Provide totally-enclosed OSHA type belt guards for all rotating equipment. Design guards to be readily removable for access to belt drives.

2.3 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.

B. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SUBMITTALS

A. Prepare submittals as directed for review by the Contractor, Owner, Architect, and Engineer.

B. Submit one copy of PDF submittals via email, project website or other electronic media.

3.2 REFRIGERANT HANDLING AND DOCUMENTATION

A. Refrigerant Handling: Handle, contain and dispose of refrigerant in compliance with local, federal, and EPA regulations and requirements.

B. Documentation: Maintain documentation for all refrigerant brought onto or removed from project location in compliance with local, federal, and EPA regulations and requirements. Submit documentation to Owner and Architect.

3.3 RECORD DRAWINGS

A. Recording: Post changes and modifications to project record documents as they occur; do not wait until the end of Project.

B. Maintenance of Record Documents and Samples: Store record documents in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Engineer's reference during normal working hours.

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3.4 OPERATION AND MAINTENANCE MANUALS

A. Prepare Operation and Maintenance Manuals as directed for review by the Contractor, Owner, Architect, and Engineer.

B. Make corrections and resubmit as required.

3.5 VERIFICATION OF DIMENSIONS

A. Scaled and figured dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions at site, and be responsible for properly fitting equipment and materials together and to the structure in spaces provided.

B. Drawings are diagrammatic and many offsets, bends, special fittings and exact locations are not indicated. Carefully study drawings and premises in order to determine best methods, exact locations, routes, building obstructions, and install apparatus and equipment in available locations. Install apparatus and equipment in manner and in locations to avoid obstructions, preserve headroom, and keep openings and passageways clear.

3.6 CUTTING AND PATCHING

A. Cut work and patch per Division 01 as necessary to properly install the new work. As the work progresses, coordinate necessary openings, holes, chases, etc., in their correct location. If the required openings, holes and chases are not in their correct locations, make the necessary corrections at no cost to the Owner. Avoid excessive cutting and do not cut structural members without the consent of the Architect. Include as a part of the work all structural framing required by penetrations through the roof and necessary steel to support ducts and pipes between structural steel unless shown on the structural drawings.

3.7 CLOSING-IN OF UNFINISHED WORK

A. Cover no work until inspected, tested and approved. Where work is covered before inspection and test, uncover it, and when inspected, tested and approved, restore all work to original proper condition.

3.8 EXCAVATION AND BACKFILL

A. Perform all necessary excavation, shoring and backfilling required for the proper laying of all pipes, ducts, and conduits inside the building and premises, and outside as may be necessary. Remove all excess excavated materials from the site or dispose of on site as directed by General Contractor.

B. Excavate all trenches open cut, keep trench banks as nearly vertical as practicable, and sheet and brace trenches where required for stability and safety. Excavate trenches true to line and make bottoms not less than 18" wide but no wider than necessary to provide ample work room. Grade trench bottoms accurately to provide uniform bearing and support for each section of pipe on undisturbed soil along its entire length. Dig "bell" holes after the trench bottom has been graded. Machine grade only to the top line of the pipes, doing the balance by hand. Do not cut any trench near or under footings without first consulting the Architect. Comply with OSHA requirements.

C. Provide not less than 4 inches of granular material as pipe bedding prior to laying pipe in trench to continuously support pipe and maintain required slope. Granular material shall be pea gravel or sand per MAG Standards.

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D. Provide backfilling and compaction in accordance with provisions of these specifications and under the direction of the Architect to the required density.

E. Provide not less than 4 inches of granular material, same as piping bedding, all around pipe. Make the first 2 feet of fill in 6 inch layers, each thoroughly compacted as directed, and free from rocks, large clods of earth, leaves, branches, and debris. Compact the rest of the backfill as directed, using in the backfill no rocks larger than 4 inches in diameter, and using no rock in the top 12 inches.

3.9 ACCESSIBILITY

A. Install valves, dampers, thermometers, gauges, traps, cleanouts, control devices or other specialties requiring reading, adjustment, inspection, repairs, removal or replacement conveniently and accessibly throughout the finished building. Where any of these devices are shown on the contract drawings to be installed above any inaccessible ceiling or behind any inaccessible wall, the Mechanical Contractor shall furnish access doors or panels as required.

B. All access doors or panels in walls and ceilings required for access to control devices, traps, valves and similar devices are to be furnished and installed as part of the work under this section. Provide type as specified under Division 08.

C. Refer to architectural drawings for type of wall and ceiling in each area and for rated construction.

D. Coordinate work of various sections to locate valves, traps, and dampers with others to avoid unnecessary duplication of access doors.

E. The Contractor, along with the Owner's representative, shall complete the Mechanical Accessibility/Clearance Checklist at the end of this section for all mechanical equipment. The chart shall be submitted to the Architect for approval prior to substantial completion. All conflicts shall be resolved to the Architect's and Owner's satisfaction prior to submission.

3.10 ROOF FLASHINGS

A. Flash and counterflash all piping, conduits and ductwork penetrating roofing membrane with flashing per roofing manufacturer's recommendations. Refer to architectural drawings for detailing of duct and pipe penetrations through roof.

3.11 PRODUCT AND EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. All equipment, valves, sensors, dampers, detectors, etc., shall be installed in strict conformance with the manufacturer's recommendations and all codes.

B. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment to allow right-of-way for piping installed at required slope.

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F. Do not install any equipment in an application not recommended by the manufacturer.

3.12 EQUIPMENT ROUGH-IN

A. Rough in all equipment and fixtures as designated on the drawings and in the specifications. The drawings indicate only the approximate location of rough-ins. The exact rough-in locations must be determined from large-scale certified drawings. The Contractor shall obtain all certified rough-in information before progressing with any work for rough-in final connections.

B. Be responsible for providing all outlets and services of proper size at the required locations.

C. Minor changes in the contract drawings shall be anticipated and provided for under this contract.

1. Rough-in only (unless otherwise designated on the drawings) shall include providing all services as indicated and required, including all ductwork, piping and valves. Valve and cap all piping stub-outs. Cap all ductwork stub-outs in a manner suitable for future extension.

3.13 OWNER-FURNISHED AND OTHER EQUIPMENT

A. Rough-in only for all Owner-furnished equipment see Division 01 and all equipment furnished under other sections of the specifications, except as otherwise specified and/or noted on the drawings.

B. Provide all services designated, valve and cap all piping, cap all ductwork and leave in a clean and orderly manner.

3.14 EQUIPMENT FINAL CONNECTIONS

A. Provide all piping and duct final connections for all equipment under Division 23 and as indicated on the drawings.

3.15 MACHINERY DRIVES

A. After tests have been performed on the air conditioning and air handling systems, make without cost, not more than one change in the size of non-adjustable sheaves to obtain the required air quantities.

3.16 EQUIPMENT SUPPORTS

A. Erection of Metal Supports and Anchorages:

1. Refer to Division 05 for structural steel.
2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment. Neatly fabricate and erect steel work with burrs and welding spatter ground off. Paint after fabrication with a rust-inhibitive primer.
3. Field Welding: Comply with AWS D1.1.

B. Erection of Wood Supports and Anchorages:

1. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support and anchor mechanical materials and equipment.

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2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
3. Attach to substrates as required to support applied loads.

C. Where supports, foundations, stands, suspended platforms for machinery, tanks, or other equipment are indicated or specified, perform the following:

1. Locate support members to avoid equipment strains and interference with piping connections, tube pulling or other maintenance operations.
2. Where saddles are required, use cast iron or welded steel saddles with curvature to fit the tank shell.
3. Mount power-driven equipment on common base with driver.

D. Concrete Inserts: Furnish and install all concrete inserts required for all materials and equipment specified and/or shown on the drawings for Division 23.

E. Concrete Bases: Work under this section includes coordination of construction of all concrete foundations indicated or required for equipment specified under Division 23. Materials and workmanship shall be described under Division 03. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extends through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

F. Grouting:

1. Grout under all equipment after leveling, filling completely the space between machinery bed plate and foundation surface as specified in Division 03.
2. Mix and install grout for mechanical equipment base bearing surfaces, pumps and other equipment base plates, and anchors.
3. Clean surfaces that will come into contact with grout.
4. Provide forms as required for placement of grout.
5. Avoid air entrapment during placement of grout.
6. Place grout, completely filling equipment bases.
7. Place grout on concrete bases and provide smooth bearing surface for equipment.
8. Place grout around anchors.
9. Cure placed grout.
10. Finish exposed surface of grout for a neat appearance.

3.17 CLEANUP

A. In addition to cleanup specified under Division 01, thoroughly clean all parts of the equipment. Where exposed parts are to be painted, thoroughly clean off any splattered construction materials and remove all oil and grease spots. Wipe the surface carefully and scrape out all cracks and corners.

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B. Thoroughly flush and clean out all water circulating systems. Remove, clean and replace all strainer elements.

C. During the progress of the work, keep the premises clean and free of debris.

3.18 PAINTING

A. Except as otherwise specified or indicated in the architectural drawings and/or specifications, paint all exposed unfinished metal with one coat of rust-inhibiting primer. Galvanized ductwork and factory painted equipment shall be considered as having primed surface.

B. Damage and Touch-Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

C. Finished painting is specified under Division 09.

3.19 FIRESTOPPING

A. Coordinate with the firestopping installer for sealing of all penetrations of fire and smoke barriers and other rated assemblies created during the installation of the Division 23 work.

3.20 OBJECTIONABLE NOISE AND VIBRATION

A. Construct and brace the metal partitions, ducts and sheet metal housings to prevent vibration or rattling when systems are in operation. Install connections to equipment so noise and vibration will not reach the conditioned area through ducts, piping, conduit, sheet metal work, or the building structure.

3.21 WELDING

A. Procedures:

1. All procedures and welders must be qualified in accordance with the requirements of Section IX, ASME Boiler and Pressure Vessel Code and ANSI code for power piping B31.1. Procedure qualification test records and acceptance shall be submitted with the welding procedure prior to the start of fabrication.
2. Architect's inspector or authorized representative will review performance qualification records of individual welders.

3.22 COMMISSIONING

A. Provide commissioning services as directed in Division 01.

END OF SECTION 23 05 00

MECHANICAL ACCESSIBILITY / CLEARANCE CHECKLIST (See Paragraph 3.8.E)									
			Acceptable Access					Observer	
Bldg.	Location	Unit #	Yes	No	Conflict	Date	Action	Owner	Contractor

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SECTION 23 05 01

DEMONSTRATION & TRAINING FOR HVAC SYSTEMS & COMPONENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for demonstration of proper operation of equipment and instructing Owner's personnel, including the following:

1. Demonstration of operation of systems, subsystems, and equipment.
2. Training in operation and maintenance of systems, subsystems, and equipment.

1.2 CLOSEOUT SUBMITTALS

A. At completion of training, submit complete training manual(s) for Owner's use.

1.3 QUALITY ASSURANCE

A. Instructor Qualifications: A factory-authorized service representative experienced in operation and maintenance procedures and training.

1.4 COORDINATION

A. Complete demonstrations prior to Substantial Completion.

B. Complete instruction prior to Final Completion.

C. Coordinate demonstration and instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.

D. Coordinate content of training modules with content of approved operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system. Include training for all HVAC systems and equipment such as heat pumps, air-conditioners, heating and ventilating units, evaporative coolers, make-up air units, chillers, cooling towers, pumps, fans, air handlers, etc. and as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

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1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

    a. System, subsystem, and equipment descriptions.
    b. Operating standards.
    c. Regulatory requirements.
    d. Equipment function.
    e. Operating characteristics.
    f. Limiting conditions.
    g. Performance curves.

2. Documentation: Review the following items in detail:

    a. Emergency manuals.
    b. Operations and Maintenance manuals.
    c. Project record documents.
    d. Identification systems.
    e. Warranties and bonds.
    f. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

    a. Instructions on meaning of warnings, trouble indications, and error messages.
    b. Instructions on stopping.
    c. Shutdown instructions for each type of emergency.
    d. Operating instructions for conditions outside of normal operating limits.
    e. Sequences for electric or electronic systems.
    f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

    a. Startup procedures.
    b. Equipment or system break-in procedures.
    c. Routine and normal operating instructions.
    d. Regulation and control procedures.
    e. Control sequences.
    f. Safety procedures.
    g. Instructions on stopping.
    h. Normal shutdown instructions.
    i. Operating procedures for emergencies.
    j. Operating procedures for system, subsystem, or equipment failure.
    k. Seasonal and weekend operating instructions.
    l. Required sequences for electric or electronic systems.
    m. Special operating instructions and procedures.

5. Adjustments: Include the following:

    a. Alignments.
    b. Checking adjustments.
    c. Noise and vibration adjustments.
    d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

    a. Diagnostic instructions.
    b. Test and inspection procedures.

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7. Maintenance: Include the following:

   a. Inspection procedures.
   b. Types of cleaning agents to be used and methods of cleaning.
   c. List of cleaning agents and methods of cleaning detrimental to product.
   d. Procedures for routine cleaning
   e. Procedures for preventive maintenance.
   f. Procedures for routine maintenance.
   g. Instruction on use of special tools.

8. Repairs: Include the following:

   a. Diagnosis instructions.
   b. Repair instructions.
   c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   d. Instructions for identifying parts and components.
   e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

A. Inspect and test each system, subsystem and piece of equipment prior to demonstration. Confirm proper operation prior to scheduling demonstrations.

   1. Replace defective work or material.
   2. Repeat inspection and testing until defects are eliminated.

B. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements for "Operations and Maintenance Data."

3.2 DEMONSTRATION

A. Inspect and operate satisfactorily, in presence of Engineer and Owner, each system and item of equipment, including accessories.

3.3 INSTRUCTION

A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

   1. Owner will furnish Contractor with names and positions of participants.

B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

   1. Schedule training with Owner with at least seven days' advance notice.

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C. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of an oral or a demonstration performance-based test.

END OF SECTION 23 05 01

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SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Motors 3/4 HP and larger, except as otherwise noted shall be designed for 3 phase, 60 hertz power supply.

D. Motors 1/2 HP and smaller, except as otherwise noted, shall be designed for 120 volt, single phase, 60 hertz power supply.

E. Motors not directly exposed to weather and located in nonhazardous spaces shall be in drip-proof enclosures or as indicated on drawings.

F. Motors shall be totally enclosed, fan cooled where directly exposed to weather or as indicated on drawings.

G. High-starting torque, totally enclosed or explosion-proof motors to be used in all hazardous areas or as indicated on drawings.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 104 deg F and at altitude of 7000 feet above sea level.

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B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers:

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

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2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Arrange and set motors.

B. Line up motors on direct drive equipment using dial type gauges.

C. Connections and testing of motor for proper rotation/phasing shall be under Division 26.

END OF SECTION 23 05 13

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SECTION 23 05 14

VARIABLE FREQUENCY MOTOR DRIVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes separately enclosed, pre-assembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.2 DEFINITIONS

A. BAS: Building automation system.

B. CE: Conformite Europeene (European Compliance).

C. CPT: Control power transformer.

D. EMI: Electromagnetic interference.

E. IGBT: Insulated-gate bipolar transistor.

F. LAN: Local area network.

G. LED: Light-emitting diode.

H. MCP: Motor-circuit protector.

I. NC: Normally closed.

J. NO: Normally open.

K. OCPD: Overcurrent protective device.

L. PID: Control action, proportional plus integral plus derivative.

M. PWM: Pulse-width modulated.

N. RFI: Radio-frequency interference.

O. VFD: Variable-frequency motor drive.

1.3 SUBMITTALS

A. Product Data: For each type and rating of VFD indicated.

B. LEED Submittals:

1. Product Data for Credit EA 5: For continuous metering equipment for energy consumption.

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C. Shop Drawings: For each VFD indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings.
2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

D. Product certificates.

E. Source quality-control reports.

F. Field quality-control reports.

G. Operation and maintenance data.

1.4 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion or beneficial use.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide ABB ACH drive.

B. General Requirements for VFDs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

C. Application: variable torque.

D. VFD Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."

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3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

F. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

G. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 20 and minus 20 percent of VFD input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 5 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFD frequency rating.
4. Minimum Efficiency: 97 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.
7. Ambient Temperature Rating: Not less than 0 deg F and not exceeding 122 deg F.
8. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F
9. Humidity Rating: Less than 95 percent (noncondensing).
10. Altitude Rating: Not exceeding 3300 feet.
11. Vibration Withstand: Comply with IEC 60068-2-6.
12. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.3 times the base load current for two seconds.
13. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

H. Inverter Logic: Microprocessor based, 16 or 32 bit, isolated from all power circuits.

I. Isolated Control Interface: Allows VFDs to follow remote-control electrical signal over a minimum 40:1 speed range.

J. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

K. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFD and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
6. Critical frequency rejection, with three selectable, adjustable deadbands.

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7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor overtemperature fault.

L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

M. Bidirectional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Integral Input Disconnecting Means and OCPD: NEMA AB 1, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.

2.2 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicator displaying unit status.

1. Power on.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

a. Control Authority: Supports at least four conditions: Off, local manual control at VFD, local automatic control at VFD, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Running log of total power versus time.
2. Total run time.
3. Fault log, maintaining last three faults with time and date stamp for each.

D. Indicating Devices: Digital display mounted flush in VFD door and connected to display VFD parameters including, but not limited to:

1. Output frequency (Hz).

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2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

   a. A minimum of two programmable analog inputs: Selectable 0- to 10-V dc or 4- to 20-mA dc.
   b. A minimum of six multifunction programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:

   a. 0- to 10-V dc.
   b. 4- to 20-mA dc.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.

3. Output Signal Interface: A minimum of two programmable analog output signals (4- to 20-mA dc), which can be configured for any of the following:

   a. Output frequency (Hz).
   b. Output current (load).
   c. DC-link voltage (V dc).
   d. Motor torque (percent).
   e. Motor speed (rpm).
   f. Set point frequency (Hz).

4. Remote Indication Interface: A minimum of three programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

   a. Motor running.
   b. Set point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: Two.

G. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFD status and alarms and energy usage. Allows VFD to be used with an external system within a multidrop LAN configuration; settings retained within VFD's nonvolatile memory.

1. Network Communications Ports: RS-422/485.

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2. Embedded BAS Protocols for Network Communications: BACnet, Johnson Metasys N2, Modbus/Memobus, Siemens Building Technologies FLN; protocols accessible via the communications ports. Provide optional, add-on, protocol if required for BAS interface.

2.3 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Internal 5% impedance reactors. Reactors shall be dual positive and negative DC bus reactors, or AC line reactors.

B. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.4 OPTIONAL FEATURES

A. Damper control circuit with end of travel feedback capability where indicated on drawings or needed for proper system operation.

B. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.5 ENCLOSURES

A. VFD Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.
2. Outdoor Locations: Type 3R.
3. Kitchens or Wash-Down Areas: Type 4X, stainless steel.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFD as "Plenum Rated."

2.6 ACCESSORIES

A. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

B. Cooling Fan and Exhaust System: For NEMA 250, Type 1 or Type 12; UL 508 component recognized: Supply fan, with composite intake and exhaust grills; 120 -V ac; obtained from integral CPT.

C. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4X and Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

D. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 3R, Type 4X and Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

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2.7 SOURCE QUALITY CONTROL

A. VFDs will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wall-Mounting Controllers: Install VFDs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

D. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

E. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

F. Comply with NECA 1.

3.2 IDENTIFICATION

A. Identify VFDs, components, and control wiring. Comply with requirements for identification specified in Division 23 Section "Identification for HVAC Piping and Equipment."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFD with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and remote devices and facility's central-control system. Comply with requirements in Division 23 Section "Electrical and Control Wiring for Mechanical Systems."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.

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2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency or manufacturer's representative to perform tests and inspections.

B. Perform tests and inspections.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Inspect VFD, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. VFDs will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies the VFD and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

G. Provide on-site harmonic distortion testing, if required by Owner or Engineer.

3.5 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable circuit-breaker trip ranges as specified.

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3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFDs. Provide minimum of four hours of on-site training at time of project closeout.

END OF SECTION 23 05 14

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SECTION 23 05 15

ENCLOSED MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following enclosed controllers rated 600 V and less:

1. Full-voltage manual.
2. Full-voltage magnetic.
3. Multispeed.

1.2 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. OCPD: Overcurrent protective device.

1.3 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include dimensions, required clearances, and wiring diagrams for power, signal, and control wiring.

B. Operation and maintenance data.

1.4 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

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B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   c. Rockwell Automation, Inc.; Allen-Bradley brand.
   d. Siemens Energy & Automation, Inc.
   e. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing or two speed as required.
3. Surface mounting.
4. Green and red pilot lights.

C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Allen-Bradley Bulletin 600 or comparable product by one of the following:

   a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   c. Siemens Energy & Automation, Inc.
   d. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing or two speed as required.
3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
4. Surface mounting.
5. Green and Red Pilot lights.

D. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   c. Siemens Energy & Automation, Inc.
   d. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing or two speed as required.
3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button; bimetallic type.
4. Surface mounting.
5. Pilot lights.

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E. Definite Purpose Contactors: For remote control of single-phase motors.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Square D, Type DPA, Class 8910 or comparable product by one of the following:

   a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   c. Siemens Energy & Automation, Inc.
   d. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing, double break contacts.
3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
4. Surface mounting.

F. Magnetic Controllers: Full voltage, across the line, electrically held, NEMA device.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Square D Class 8536 Type S or comparable product by one of the following:

   a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   c. Siemens Energy & Automation, Inc.
   d. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing.
3. Contactor Coils: Pressure-encapsulated type.

   a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
5. Control Circuits: 24-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

6. Bimetallic Overload Relays:

   a. Inverse-time-current characteristic.
   b. Class 20 tripping characteristic.
   c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

7. Solid-State Overload Relay:

   a. Switch or dial selectable for motor running overload protection.
   b. Sensors in each phase.
   c. Class 20 or class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

8. External overload reset push button.

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2.2 MULTISPEED MAGNETIC CONTROLLERS

A. General Requirements for Multispeed Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Multispeed Magnetic Controllers: Multispeed, full voltage, across the line, electrically held, NEMA device.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Square D Class 8810 Type S or comparable product by one of the following:

    a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
    c. Siemens Energy & Automation, Inc.
    d. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing; consequent pole or two winding as required.
3. Contactor Coils: Pressure-encapsulated type.

    a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.

4. Power Contacts: Totally enclosed, double break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
5. Control Circuits: 24-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
6. Accelerating timer relays shall ensure properly timed acceleration through speeds lower than that selected.
7. Bimetallic Overload Relays:

    a. Inverse-time-current characteristic.
    b. Class 20 tripping characteristic.
    c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

8. Solid-State Overload Relay:

    a. Switch or dial selectable for motor running overload protection.
    b. Sensors in each phase.
    c. Class 20 or class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

9. External overload reset push button.

2.3 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.
2. Outdoor Locations: Type 3R.
3. Kitchen Wash-Down Areas: Type 4X, stainless steel.
4. Other Wet or Damp Indoor Locations: Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

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2.4 ACCESSORIES

A. Push Buttons, Pilot Lights, and Selector Switches: NEMA ICS 5; heavy-duty type; factory installed in controller enclosure cover unless otherwise indicated.

B. Control Relays: Auxiliary and adjustable time-delay relays.

C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

PART 3 - EXECUTION

3.1 GENERAL

A. Controllers: Furnish controllers for all single-phase and polyphase motors provided as part of the Division 23 Work. Controllers shall be installed by Division 26 Contractor. Controllers are not required for the following:

1. Motors controlled by a variable frequency drive.
2. Motors that are provided with controllers as part of packaged equipment.
3. Motors controlled through a motor control center. Motor control centers are specified in Division 26.

B. Accessories: Furnish controllers with the required accessories, auxiliary contacts, holding coils, etc. as required to achieve the sequence of controls, interlocking, etc. indicated on the drawings and as required for a fully functioning system.

1. All definite purpose contactors and magnetic controllers shall be furnished with a hand-off-auto (HOA) switch.
2. All single-phase controllers shall be provided with undervoltage and overvoltage relays.
3. All polyphase controllers shall be provided with phase-failure, phase-reversal, and undervoltage and overvoltage relays.

3.2 APPLICATION

A. Manual Operation: Where only manual operation is indicated.

1. Fractional Horsepower Motors with Internal Overload Protection: Provide with motor-starting switches.
2. Fractional Horsepower Motors without Internal Overload Protection: Provide with fractional horsepower manual controllers.
3. Integral Horsepower Motors up to 10 Horsepower: Provide with integral horsepower manual controllers.

B. Automatic and/or Manual Operation: Where a motor is to be controlled manually or automatically by the building automation system, or other control scheme.

1. Fractional Horsepower Motors: Provide with definite purpose contactors or magnetic controllers.
2. Integral Horsepower Motors: Provide with magnetic controllers.
3. Multispeed Motors: Multispeed magnetic controller selected to match motor type.

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3.3 INSTALLATION

A. Installation shall be by the Division 26 Contractor.

B. Installation of power wiring shall be by the Division 26 Contractor.

C. Install control wiring.

D. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26.

E. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

F. Comply with NECA 1.

3.4 IDENTIFICATION

A. Identification of controllers, line-voltage components, and power wiring shall be done by the Division 26 Contractor.

B. Identify low-voltage components and control wiring.

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices and facility's building automation system. Comply with requirements in Division 23.

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
2. Test continuity of each control circuit.

C. Tests and Inspections:

1. Inspect controllers, control wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test continuity of each control circuit.

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3. Test each motor for proper phase rotation.
4. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
5. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed controllers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports. Reports shall be on the Contractor's letterhead and shall include, at a minimum, the following information:

1. Testing technician's name and signature.
2. Data and time testing was performed.
3. Ambient temperature and weather conditions.
4. Manufacturer, model number, and other pertinent data of the test equipment.
5. Statement of "As Left" condition.
6. Pass/Fail statement relative to NETA Chapter 10 recommendations.
7. Deficiencies detected.
8. Remedial action taken.
9. Observations after remedial action.
10. Recommendations, if any.

F. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 ADJUSTING

A. Set field-adjustable switches and overload-relay pickup and trip ranges.

B. Adjust the settings of adjustable motor overloads to match the motor full-load amperes.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 23 05 15

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SECTION 23 05 16

EXPANSION FITTINGS & LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Expansion-compensator packless expansion joints.
2. Flexible-hose packless expansion joints.
3. Pipe loops and swing connections.
4. Alignment guides and anchors.

1.2 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated including materials of construction, dimensions, listings and ratings.

B. Welding certificates.

C. Maintenance Data: For expansion joints to include in maintenance manuals.

1.4 QUALITY ASSURANCE

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

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 PACKLESS EXPANSION JOINTS

A. Metal, Externally Pressurized Expansion-Compensator Packless Expansion Joints:

1. Basis-of-Design: Subject to compliance with requirements, provide Hyspan 3500 or comparable product by one of the following:

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a. Adsco Manufacturing LLC.
b. Flexicraft Industries.
c. Flex Pression Ltd.
d. Flex-Weld, Inc.
e. Hyspan Precision Products, Inc.
f. Metraflex, Inc.
g. Mason-Mercer.

2. Minimum Pressure Rating: 150 psig at 250°F unless otherwise indicated.

3. Configuration for Steel Piping: Minimum three-ply, ASTM A240 type 321 stainless steel with carbon steel flanged ends, steel guide rings, ASME A53 steel pipe housing.

a. Minimum Compression 2 inch minimum extension 1/2 inch unless noted otherwise on Drawings.
b. Drain Port: 1/2 inch.

B. Flexible-Hose Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Flex-Hose Co., Inc.
b. Flexicraft Industries.
c. Flex Pression Ltd.
d. Mason-Mercer.
e. Metraflex, Inc.

2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend, 60-degree vee or center section of flexible hose.
3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.

a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.

5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with silver solder or threaded end connections.

a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.

6. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.

a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.

7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged or weld end connections.

a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.

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8. Expansion Joints for Steel Piping NPS 8 to NPS 12: Carbon-steel fittings with flanged or weld end connections.

   a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.

9. Expansion Joints for Steel Piping NPS 14 and Larger: Carbon-steel fittings with flanged or weld end connections.

   a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.

2.2 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Adsco Manufacturing LLC.
   b. Advanced Thermal Systems, Inc.
   c. Flex-Hose Co., Inc.
   d. Flexicraft Industries.
   e. Flex-Weld, Inc.
   f. Hyspan Precision Products, Inc.
   g. Mason-Mercer.
   h. Metraflex, Inc.

2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

   a. Stud: Threaded, zinc-coated carbon steel.
   b. Expansion Plug: Zinc-coated steel.
   c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

   a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
   b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
   c. Washer and Nut: Zinc-coated steel.

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PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

C. Install flexible-hose packless expansion joints where indicated on the drawings or where piping systems cross building expansion joints.

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Do not install pipe loops cold-sprung.

B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.

D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

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G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 23 05 16

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SECTION 23 05 17

SLEEVES & SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. GPT, an EnPro Industries Company.
5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

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2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07.

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves at building seismic joints and in exterior, above and below grade, concrete walls and slabs-on-grade at service piping entries into building.

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B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

   a. Piping Smaller than NPS 4: Cast-iron wall sleeves, Galvanized-steel wall sleeves or Galvanized-steel-pipe sleeves.
   b. Piping NPS 4 and Larger: Cast-iron wall sleeves or Galvanized-steel-pipe sleeves.

2. Exterior Concrete Walls below Grade:

   a. Piping Smaller than NPS 4: Cast-iron wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

   b. Piping NPS 4 and Larger: Cast-iron wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade: Cast-iron wall sleeves with sleeve-seal system.

   a. Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade: Galvanized-steel-pipe sleeves.
5. Interior Partitions:

   a. Piping Smaller than NPS 6: Galvanized-steel-pipe sleeves.
   b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 23 05 17

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SECTION 23 05 18

ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-casting, Cast-brass Type: With concealed hinge and set screw and polished chrome-plated finish.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting, Floor Plate Type: Cast-brass with concealed hinge and set screw.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

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1. Escutcheons for New Piping:

    a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    b. Insulated Piping: One-piece, stamped-steel type.
    c. Bare Piping: One-piece, cast-brass type.

2. Escutcheons for existing piping shall be split-casting, cast-brass type.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-late type,
2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 23 05 18

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SECTION 23 05 19

METERS & GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Electromagnetic flowmeters.
6. Vortex flowmeters.
7. Thermal-energy meters.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Wiring Diagrams: For power, signal, and control wiring.

C. Product certificates.

D. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Miljoco Corporation.
b. Palmer Wahl Instrumentation Group.
c. Trerice, H.O. Co.
d. Weiss Instruments, Inc.
e. Winters Instruments – U.S.

2. Standard: ASME B40.200.
3. Case: Cast aluminum, 9-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.

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8. Stem: Aluminum and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Solar Powered Digital Thermometers

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Miljoco Corporation.
    b. Trerice, H.O. Co.
    c. Winters Instruments.

2. Case: High impact ABS plastic.
3. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
4. Stem: Metal for thermowell installation and of length to suit installation, or sampling tube with flange for air duct application.
5. Accuracy: Maximum of 1 degree or 1% of reading.
6. Range: Negative 50 degrees to positive 300 degrees F.
7. Display: LCD with 1/2 inch tall black characters on a gray background, updated at 10 second intervals.
8. Illuminance: Front mounted or bi-directional solar collectors. Maximum required ambient lighting: 35 Lux.

2.2 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: Brass.
4. Material for Use with Steel Piping: Stainless Steel.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

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2.4 PRESSURE GAGES

A. Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Marsh Bellofram.
    b. Miljoco Corporation.
    c. Palmer Wahl Instrumentation Group.
    d. Trerice, H. O. Co.
    e. Weiss Instruments, Inc.
    f. Weksler.

2. Standard: ASME B40.100.
3. Case: Cast aluminum or drawn steel; 6-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 or NPS 1/2 pipe threads.

C. Valves: Bronze or stainless steel ball, with NPS 1/4 or NPS 1/2 ASME B1.20.1 pipe threads.

2.6 FLOWMETERS

A. Electromagnetic Flowmeters:

1. Basis-of-Design Product: Subject to compliance with requirements, provide ONICON Incorporated, model F-3500 or comparable product by one of the following:

    a. Data Industrial Corp.
    b. Hoffer Flow Controls, Inc.
    c. ISTEC Corporation.
    d. ONICON Incorporated

2. Description: Flowmeter with sensor and indicator.
3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.

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4. Sensor: Electromagnetic for inserting into pipe fitting or installing in piping and measuring flow directly in gallons per minute.

    a. Design: Device or pipe fitting with electromagnetic sensor and integral transmitter.
    b. Construction: Type 316 stainless steel wetted parts with polystyrene sensor head.
    c. Minimum Pressure Rating: 200 psig.
    d. Minimum Temperature Rating: 200 deg F.

5. Indicator/Transmitter: Integral part of sensor or a separate component as indicated on drawings or recommended by manufacturer.
6. Accuracy: Plus or minus 1 percent.
7. Display: Shows rate of flow and alarms.
8. Operating Instructions: Include complete instructions with each flowmeter.
9. Building Automation System Interface: 4-20mA signal for flow rate, and two programmable pulse outputs. Include MODBUS connection.

B. Vortex Flowmeters:

1. Basis-of-Design Product: Subject to compliance with requirements, provide ONICON Incorporated, model F-2500 or comparable product by one of the following:

    a. Data Industrial Corp.
    b. Hoffer Flow Controls, Inc.
    c. ISTEC Corporation.
    d. ONICON Incorporated

2. Description: Flowmeter with sensor and indicator.
3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
4. Sensor: Vortex type for installing in piping and measuring flow directly.

    a. Design: Pipe spool piece fitted with sensors and display device.
    b. Construction: Flanged type 316 stainless steel pipe section with ANSI flanges and stainless steel sensor.
    c. Minimum Pressure Rating: 400 psig.
    d. Minimum Temperature Rating: 400 deg F.

5. Compensating: Pressure and temperature compensating.
6. Indicator/Transmitter: Integral part of sensor or a separate component as indicated on drawings or recommended by manufacturer.
7. Flow Straightener: Type 304/A 351 CF8 stainless steel for wafer style mounting.
8. Accuracy:

    a. Plus or minus 3/4 percent for volumetric measurement of liquids.
    b. Plus or minus 1 percent for volumetric measurement of steam and gasses.
    c. Plus or minus 1.5 percent for mass measurement of steam and gasses.

9. Display: Shows rate of flow and alarms.
10. Totalizer: D-100 totalizing display with BAS interface.
11. Operating Instructions: Include complete instructions with each flowmeter.
12. Building Automation System Interface: 4-20mA signal for flow rate, and two programmable pulse outputs. Include MODBUS connection.

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2.7 THERMAL-ENERGY METERS

A. Thermal-Energy Meters:

1. Basis-of-Design Product: Subject to compliance with requirements, provide ONICON Incorporated, model System-10 or comparable product by one of the following:

    a. Data Industrial Corp.
    b. Hoffer Flow Controls, Inc.
    c. ISTEC Corporation.
    d. ONICON Incorporated.

2. Description: System with flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.

3. Flow Sensor: Electromagnetic as specified above.
4. Temperature Sensors: Insertion-type transducer.
5. Indicator: Solid-state, integrating-type meter with integral battery pack; for wall mounting.

    a. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.
    b. Battery Pack: Five-year lithium battery.

6. Accuracy: Plus or minus 1 percent.
7. Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.
8. Strainer: Full size of main line piping.
9. Operating Instructions: Include complete instructions with each thermal-energy meter system.
10. Building Automation System Interface: Output compatible with building automation system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install valve and snubber in piping for each pressure gage for fluids (except steam).

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I. Install valve and syphon fitting in piping for each pressure gage for steam.

J. Assemble and install connections, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

K. Install flowmeter elements in accessible positions in piping systems.

L. Install flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

M. Install permanent indicators on walls or brackets in accessible and readable positions.

N. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

O. Install thermometers and pressure gages where indicated on drawings and in the following locations:

1. Supply and return connections to each site utility.
2. Inlet and outlet of each hydronic coil in air-handling units.
3. Two inlets and two outlets of each hydronic heat exchanger.

P. Install pressure gages where indicated on drawings and in the following locations:

1. Discharge of each pressure-reducing valve.
2. Each hydronic pump. Provide one gage per pump with tubing and valves to allow measurement at strainer inlet, pump inlet and pump discharge.
3. Campus chilled water supply and return connection. Provide one gauge with tubing and valves across supply and return piping.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

B. Connect flowmeter-system elements or transmitters to meters.

C. Connect thermal-energy elements or transmitters to meters.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 deg F.

B. Scale Range for Heating, Hot-Water Piping: 20 to 240 deg F.

C. Scale Range for Steam and Steam-Condensate Piping: 0 to 250 deg F.

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3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 psi.

B. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.

C. Scale Range for Steam Piping: 0 to 100 psi.

D. Scale Range for Gages Serving Vacuum Piping: 0 to 30" HG.

END OF SECTION 23 05 19

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SECTION 23 05 20

ELECTRICAL & CONTROL WIRING FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section is to be used for all low- and line- voltage wiring for mechanical controls. All line-voltage work shall be performed by a licensed contractor qualified to perform the work and shall comply with the requirements contained in this section or in Division 26.

B. This Section does not apply to plenum rated cables used for electrically activated remote damper operators.

C. This Section includes the following:

1. Metal conduits, tubing, and fittings.
2. Nonmetallic conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Surface raceways.
5. Boxes, enclosures, and cabinets.
6. Low-voltage control cabling.
7. Conductors and cables rated 600 V and less.
8. Connectors, splices, and terminations rated 600 V and less.
9. Identification products.
10. Identification of power and control cables.
11. Identification for conductors.
12. Underground-line warning tape.

1.2 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include manufacturer's technical data, materials of construction and listings.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

C. Field quality-control test reports.

D. Maintenance data.

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1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

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.

D. Comply with ANSI A13.1 for identification devices.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. GRC: Comply with ANSI C80.1 and UL 6.

C. IMC: Comply with ANSI C80.6 and UL 1242.

D. EMT: Comply with ANSI C80.3 and UL 797.

1. Color: Factory applied color per schedule below.

a. HVAC Control Wiring: White
b. Power – Normal: Natural
c. Power – Standby: Orange

E. FMC: Comply with UL 1; zinc-coated steel or aluminum.

F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:

a. Material: Steel.
b. Type: Setscrew or compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

H. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

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2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

C. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

D. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250; Type 1, Type 3R, Type 4 or Type 12, as required by location; and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fittings and Accessories: Include covers, 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.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Where installed in finished spaces, match color of adjacent surfaces.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

C. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

D. Device Box Dimensions: 4 inches square by 2-1/8 inches deep or 4 inches by 2-1/8 inches by 2-1/8 inches deep.

E. Gangable boxes are prohibited.

F. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250; Type 1, Type 3R, Type 4 or Type 12, as required by location; with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

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G. Cabinets:

1. NEMA 250; Type 1, Type 3R or Type 12, as required by location; galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.6 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 16 or 18 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 16 or 18 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.7 CONDUCTORS AND CABLES

A. Copper Conductors: Comply with NEMA WC 70.

B. Conductor Insulation: Comply with the following:

1. NEMA WC 70 for Types THHN-THWN and XHHW.
2. UL 83 for Types TW and TF.

2.8 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

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2.9 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

2.10 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.11 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and control lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: CONTROL CABLE.

C. Tag: Type ID:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Overall Thickness: 5 mils
3. Foil Core Thickness: 0.35 mil
4. Weight: 28 lb/1000 sq. ft.
5. 3-Inch Tensile According to ASTM D 882: 70 lbf and 4600 psi.

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PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC or IMC.
2. Concealed Conduit, Aboveground: GRC, IMC or EMT.
3. Underground Conduit: RNC, Type EPC-40-PVC or Type EPC-80-PVC, direct buried or concrete encased.
4. Connection to Vibrating Equipment (Including Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated.

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Raceway locations include the following but not limited to:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Gymnasiums.

4. Concealed in Interior Walls and Partitions: EMT.
5. Concealed Above or In Ceilings: EMT.
6. Connection to Vibrating Equipment (Including Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
7. Damp or Wet Locations: GRC or IMC.
8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduit, boxes, or fittings in contact with concrete or earth.

F. Install surface raceways only in retrofit applications where indicated.

3.2 RACEWAY INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

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B. 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.

C. Comply with requirements in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment" for hangers and supports.

D. Arrange stub-ups so curved portions of bends are not visible above finished slab.

E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

G. Support conduit within 12 inches of enclosures to which attached.

H. Raceways Embedded in Slabs:

1. 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. Secure raceways to reinforcement at maximum 10-foot intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 1 inch of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.

I. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or GRC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

K. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

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. Cap underground raceways designated as spare above grade alongside raceways in use.

M. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

N. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with 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.

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O. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

P. Expansion-Joint Fittings:

1. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
2. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Q. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 48 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for motors.

1. Use FMC in indoor, dry locations.
2. Use LFMC in all other locations.

R. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

S. Locate boxes so that cover or plate will not span different building finishes.

T. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

U. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Division 31.
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31.
4. Install manufactured rigid steel conduit elbows for stub-ups at equipment and at building entrances through floor.

    a. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

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3.4 CONDUCTOR MATERIAL APPLICATIONS

A. Control Circuit Sizing: Minimum sizes are listed below:

1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits, No. 12 AWG.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Branch Circuit Sizing: Size conductors for circuits with less than a 20 ampere connected load, maximum of 16 amperes actual load, as follows:

1. For 120V circuits up to 65 feet in length from panel to center of load: Not smaller than No. 12.
2. For 120V circuits up to 110 feet in length from panel to center of load: Not smaller than No. 10.
3. For 120V circuits up to 165 feet in length from panel to center of load: Not smaller than No. 8.
4. For 120V circuits up to 255 feet in length from panel to center of load: Not smaller than No. 6.
5. For 208V circuits up to 110 feet in length from panel to center of load: Not smaller than No. 12.
6. For 208V circuits up to 185 feet in length from panel to center of load: Not smaller than No. 10.
7. For 208V circuits up to 280 feet in length from panel to center of load: Not smaller than No. 8.
8. For 208V circuits up to 440 feet in length from panel to center of load: Not smaller than No. 6.
9. For 277V circuits up to 150 feet in length from panel to center of load: Not smaller than No. 12.
10. For 277V circuits up to 250 feet in length from panel to center of load: Not smaller than No. 10.
11. For 277V circuits up to 380 feet in length from panel to center of load: Not smaller than No. 8.
12. For 277V circuits up to 590 feet in length from panel to center of load: Not smaller than No. 6.

3.5 CONDUCTOR INSULATION APPLICATIONS AND WIRING METHODS

A. Comply with NECA 1.

B. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN or XHHW, single conductors in raceway.

C. Branch Circuits Concealed in Walls, and Partitions: Type THHN-THWN or XHHW, single conductors in raceway.

D. Branch Circuits Concealed above or in Ceilings: Type THHN-THWN or XHHW, single conductors in raceway.

E. Branch Circuits Concealed above Lay-in Ceilings: Type THHN-THWN or XHHW, single conductors in raceway.

F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN or XHHW, single conductors in raceway.

G. Class 1 and 2 Control Circuits: Type THHN-THWN or XHHW, in raceway unless noted otherwise.

1. Final raceway connections for low-voltage control wiring to equipment, actuators and similar devices may be omitted where the devices are located above lay-in ceilings. Length of exposed wire is to be less than 24 inches.

H. Class 3 Control Circuits: Type TW or TF in raceway unless noted otherwise.

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1. Final raceway connections for low-voltage control wiring to equipment, actuators and similar devices may be omitted where the devices are located above lay-in ceilings. Length of exposed wire is to be less than 24 inches.

3.6 INSTALLATION OF CONDUCTORS AND CABLES

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 23 Sections "Hangers and Supports for HVAC Piping and Equipment."

F. Identify and color-code conductors and cables.

G. 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.

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.

3.7 IDENTIFICATION INSTALLATION

A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

C. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

3.8 IDENTIFICATION SCHEDULE

A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded branch-circuit conductors.

a. Color shall be factory applied.

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b. Colors for 208/120-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.
4) Neutral: White.

c. Colors for 480/277-V Circuits:

1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.
4) Neutral: Gray.

B. Control Systems Conductor Identification: Identify field-installed control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

C. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.
2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

3.9 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables.

3.10 GROUNDING

A. For low-voltage wiring and cabling, comply with requirements in Division 26.

3.11 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 23 "Sleeves and Sleeve Seals for HVAC Piping."

3.12 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Comply with requirements in Division 07.

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3.13 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to paint finishes with matching touchup coating recommended by manufacturer.

3.14 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections: Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. 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.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 23 05 20

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SECTION 23 05 23

GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball valves.
2. Iron, butterfly valves.
3. Bronze swing check valves.
4. Iron swing check valves.
5. Bronze globe valves.
6. Iron globe valves.
7. Chainwheels.

B. Related Sections:

1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.2 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.3 QUALITY ASSURANCE

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

B. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

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

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

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.

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3. Handlever: For quarter-turn valves NPS 6 and smaller.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
2. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

G. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Conbraco Industries; Apollo Valves.
2. FNW Grinnell.
3. Hammond Valve.
4. Milwaukee Valve Company.
5. Nibco Inc.
6. Watts.

2.2 BALL VALVES

A. Two-Piece, Full-Port Ball Valves:

1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psi.
d. Body Design: Two piece.
e. Body Material:

1) Valves 2 inches and smaller: Forged bronze.
2) Valves 2-1/2 inches and larger: Forged bronze or brass.

f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel, blowout proof with adjustable packing nut.
i. Ball: Stainless steel.
j. Port: Full.

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2.3 BUTTERFLY VALVES

A. Iron, Lug Body Butterfly Valves:

1. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 150 psig, bubble tight.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron, epoxy coated.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze or stainless steel.

2.4 CHECK VALVES

A. Bronze Swing Check Valves:

1. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE OR TFE.

B. Iron Swing Check Valves:

1. Description:

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12CWP Rating: 200 psig.
c. NPS 14 to NPS 24CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged or grooved.
g. Trim: Bronze.
h. Gasket: Asbestos free.
i. Seat Rings: Bronze.
j. Disc: Bronze.
k. Closure Control: Factory installed exterior lever and weight.

2.5 GLOBE VALVES

A. Bronze Globe Valves:

1. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.

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d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.
h. Disc: PTFE or TFE.

B. Class 125, Iron Globe Valves:

1. Description:

a. Standard: MSS SP-85, Type I.
b. CWP Rating: 500 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.

2.6 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to butterfly valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

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

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

3.2 VALVE INSTALLATION

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

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

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

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

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

F. Install chainwheels operators for all valves located more than 3 feet above a lay-in ceiling. Extend chains to 6 inches above ceiling.

G. Install chainwheels operators for all valves located more than 2 feet above a hard ceiling access opening. Extend chains to 6 inches above ceiling.

H. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not otherwise indicated and except as specified in piping system sections, use the following:

1. Shutoff Service: Ball or butterfly valves.
2. Throttling Service, Except Steam: Ball or butterfly valves.
3. Throttling Service, Steam: Globe valves.
4. Pump-Discharge Check Valves:

    a. NPS 2 and Smaller: Bronze swing check valves with nonmetallic disc.
    b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves with the following end connections:

1. For Copper Tubing, NPS 2-1/2 and Smaller: Threaded ends.
2. For Steel Piping, NPS 2 and Smaller: Threaded ends.
3. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
4. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 CHILLED-WATER, HEATING WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Ball Valves.
2. Bronze Swing Check Valves.

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

1. Ball Valves, NPS 2-1/2 to NPS 4: On all pump connections.
2. Iron, Butterfly Valves, NPS 2-1/2 to NPS 24.
3. Iron Swing Check Valves.

3.6 STEAM VALVE SCHEDULE (15 PSIG OR LESS)

A. Pipe NPS 2 and Smaller:

1. Ball Valves.
2. Bronze Swing Check Valves.
3. Bronze Globe Valves.

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

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Swing Check Valves.
3. Iron Globe Valves, NPS 2-1/2 to NPS 12.

3.7 HIGH-PRESSURE STEAM VALVE SCHEDULE (MORE THAN 15 PSIG)

A. Pipe NPS 2 and Smaller:

1. Ball Valves.
2. Bronze Swing Check Valves.

B. Pipe Sizes NPS 2-1/2 and Larger:

1. Iron Swing Check Valves.
2. Iron Butterfly Valves, NPS 2-1/2 to NPS 12.

3.8 STEAM-CONDENSATE VALVE SCHEDULE

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

1. Ball Valves.
2. Bronze Swing Check Valves.

END OF SECTION 23 05 23

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SECTION 23 05 29

HANGERS & SUPPORTS FOR HVAC PIPING & EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Equipment supports.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Welding certificates.

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1.4 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Surface-Burning Characteristics: For tapes, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label tapes with appropriate markings of applicable testing agency.

1. Tape Installed in Return Plenums: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Tape Installed Elsewhere: No testing requirement.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers shall be one of the following unless noted otherwise:

1. Anvil International.
2. B-Line Systems.
3. Elgen.
4. Grinnell.
5. Kin-Line.
6. Michigan Hanger Co.
7. National Pipe Hanger Corp.
8. Pipe Technology and Products.
9. PHD manufacturing.
10. PHS Industries.
11. Unistrut.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

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C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, pipe clamps, and U-bolts.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Hot or Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

D. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

E. Shield: Shields shall be a minimum of 18 gauge galvanized steel, 12 inches long for piping 6 inches and smaller. Shields shall be a minimum of 16 gauge galvanized steel, 18 inches long for pipe over 6 inches.

2.5 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

C. Tape for Plenum Use:

1. Polypropylene backing with acrylic adhesive, Hart & Cooley part number 011371.
2. Polyethylene coated cloth backing with rubber adhesive, Uline Black Nashua 398 Duct Tape, model number S-17236BL.

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PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation: Install fasteners in strict accordance with manufacturer's written instructions.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Insulated Piping: Thermal-hanger shield inserts shall be used. Install with insulation same thickness as piping insulation. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

M. Conduit Support Installation:

1. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
2. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

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3. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead, or to support equipment above floor or roof.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers 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/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

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3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

D. Use hangers and supports with galvanized metallic coatings for piping and equipment that is exposed to weather and that will not have field-applied finish.

E. Use stainless-steel pipe hangers and stainless-steel attachments for corrosive atmospheres.

F. Wrap copper piping with not less than two layers of 10 mil. thick black plastic tape extending a minimum of 1 inch on each side of clamp for electrolytic protection where hangers or supports are in direct contact with copper piping.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 1-1/2 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
5. Single-Pipe Rolls (MSS Type 43): For suspension of pipes NPS 1 to NPS 30, with one rod if longitudinal movement caused by expansion and contraction might occur.
6. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
7. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Conduit Support Applications:

1. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical conduit.

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2. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where it's Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
3. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

    a. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape. Include retaining clip.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes. Include retaining clip.
7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

END OF SECTION 23 05 29

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SECTION 23 05 34

DE-ICING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes electric de-icing systems roofs, eaves, gutters and downspouts using self-regulating, parallel resistance electric heating cables.

1.2 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.

1. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
2. Shop Drawings: For electric heating cable. Include plans, sections, details, and attachments to other work.
3. Wiring Diagrams: Power, signal, and control wiring.

B. Field quality-control test reports.

C. Operation and maintenance data.

D. Warranty: Special warranty specified in this Section.

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.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DE-ICING SYSTEM

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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1. BH Thermal Corporation.
2. Chromalox, Inc.
3. Delta-Therm Corporation.
4. Easy Heat Inc.
5. Nelson Heat Trace.
6. Pyrotenax.
7. Raychem.
8. Thermon Manufacturing Co.
9. Trasor Corp.

B. Description: UL Listed, self-regulating electric heating cable designed for exposed mounting on roofs, eaves, gutters and downspouts for de-icing duty. System is to be complete with all controls and sensors required for proper operation.

1. Heating Element: Pair of parallel No. 16 AWG, tinned, or nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself without overheating.
2. Electrical Insulating Jacket: Flame-retardant polyolefin.
3. Cable Cover: Fluoropolymer outer jacket with UV inhibitor.
4. Maximum Operating Temperature (Power On): 150 deg F.

C. Controls: Provide the following sensors and controls for the system:

1. Gutter Ice Sensor: Temperature and moisture sensor design to be mounted in downspout or gutter. Sensor activates de-icing system when ice is present.
2. Snow Sensor: Solid state sensor with aluminum housing designed for mast or roof mounting. Sensor detects outside air temperature and precipitation to activate de-icing system prior to accumulation.
3. Controller: Controller design to operate de-icing systems only when precipitation is present in the air or in the gutter. Includes inputs for both snow and gutter ice sensors, output for building automation system monitoring, and high limit temperature sensor and control. Controller shall be capable of controlling multiple de-icing melt circuits.

2.2 CONTROLS

A. Provide all de-icing controls in a single cabinet complete with all controls, wiring, contactors, and breakers.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all cable in accordance with the manufacturer's written instructions.

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B. Install de-icing cable in gutters, downspouts, and on roof using clips or hangers as recommended by the cable manufacturer.

C. Locate power connection and junction seal box above grade to prevent water entry.

D. Install electric heating cable across expansion joints according to manufacturer's written recommendations using slack cable to allow movement without damage to cable.

E. Set field-adjustable switches and circuit-breaker trip ranges.

F. Protect installed heating cables, including non-heating leads, from damage.

3.2 FIELD QUALITY CONTROL

A. Testing: Perform tests after cable installation but before application concrete or other finishes.

1. Test cables for electrical continuity and insulation integrity before energizing.
2. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests after construction is complete.

C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 23 05 34

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SECTION 23 05 48.13

VIBRATION CONTROLS FOR HVAC PIPING & EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Freestanding spring isolators.
2. Spring hangers.
3. Spring hangers with vertical-limit stops.
4. Thrust restraints.
5. Floating concrete bases.
6. Wall, floor, and ceiling seals.

1.2 DEFINITIONS

A. Sound Critical: Assembly spaces such as classrooms, auditoriums, etc.; normally occupied rooms such as offices, call centers, etc.; vibration critical areas such as data rooms, technical manufacturing areas, etc.; or other areas as indicated.

B. Non-sound Critical: Not normally occupied areas such as storage rooms, electrical rooms, mechanical yards, commercial kitchens, scullery areas, etc.

1.3 SUBMITTALS

A. Product Data: For each product indicated.

B. Welding certificates.

C. Field quality-control test reports.

1.4 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: The following products are based on Mason Industries. Subject to compliance with requirements, provide comparable products by one of the following:

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.

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3. Mason Industries.
4. Vibration Mountings & Controls, Inc.

B. Style B - Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

C. Style F - Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Elements: Molded, oil-resistant rubber or neoprene.
    a. Minimum 1-1/4 inch thick element at top of hanger with steel-washer-reinforced rod support and bushing projecting through top of frame.
    b. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

D. Style G - Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Elements: Molded, oil-resistant rubber or neoprene.
    a. Minimum 1-1/4 inch thick element at top of hanger with steel-washer-reinforced rod support and bushing projecting through top of frame.
    b. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

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7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

E. Style H - Spring Hangers with Vertical-Limit Stop: Coil-spring compression hanger with a vertical-limit stop.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Elements: Molded, oil-resistant rubber or neoprene, steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

F. Style I – Thrust Restraint: Open-spring thrust restraint.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Attachments: Factory drilled, steel angles with backing plates for attachment to both duct and equipment or structure.
6. Adjustable Precompression and Stop Nut: Adjustable nut to set spring precompression and limit travel when fan is off.

G. Style L – Floating Concrete Base: Rectangular, welded or bolted, structural or formed, steel pouring form for field provided concrete. The depth of the base shall be a minimum of 1/12th the longest dimension of the base but no less than 6 inches. The maximum base depth is not required to be more than 12 inches. Bases shall include 1/2-inch reinforcing bars running in both directions welded in place at 6" centers located 1-1/2 inches above the bottom of the base. Forms shall be furnished with steel templates to secure the anchor bolts and anchor bolt sleeves during pouring activities. Bases shall be provided with height saving brackets to maintain a 1-inch clearance below the base. Bases for pumps shall be sized to support the suction and discharge elbows.

H. Style Q – Wall, Floor, and Ceiling Seals: Minimum 3/4-inch-thick neoprene sponge cemented to inner face of split pipe halves. Seals shall extend 1" beyond both faces of the element being penetrated.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application.

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B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits.

C. Select vibration isolation elements and deflections in accordance with the following table:

Equipment	Location	Vibration Isolation Element (Minimum Deflection)
Pump	Slab On-Grade (Sound Critical) or Slab Not On-Grade Suspended In-Line Type	Style B or L (1.5 inches ≤ 60 HP) (2.5 inches > 60 HP) Style F (1.5 inches)
Ceiling Mounted Equipment Fan Coil Units Inline Fans	Suspended	Style F (0.75 inches ≤ 5 HP) (1.5 inches ≥ 7.5 HP)
Piping	Where connected to equipment with spring isolators. Building element penetrations between central plants and sound critical spaces.	Style G on first 4 hangers (match equipment deflection) Style Q
Air Moving Equipment	External Static Pressure >2 inches	Style I
Duct	Where connected to equipment with Style I thrust restraints.	Style H on first 4 hangers (match equipment deflection)

3.2 VIBRATION-CONTROL INSTALLATION

A. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

B. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

C. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

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3.3 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 23 05 48.13

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SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING & EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.

1.2 SUBMITTAL

A. Product Data: For each type of product indicated.

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: Black.
3. Background Color: White.
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: 1/2 inch. Include secondary lettering 3/8 inch.
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. Coordinate with Owner.

2.2 WARNING SIGNS AND 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: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

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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: 1/2 inch. Include secondary lettering 3/8 inch.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: As indicated on drawings or required by local authority.

2.3 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 cover full 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.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved, minimum 2-inch size with 1/4-inch letters for piping system abbreviation and function, i.e., balance, drain, shutoff, stop. Include 1/2-inch identifying number. Provide 5/32-inch hole for fastener.

1. Material: 0.032-inch-thick brass.
2. Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.

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.

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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 25 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
7. Spaced at maximum 10 feet on piping above removable acoustical ceilings.

B. Pipe Label Color Schedule:

1. Chilled-Water Piping:

   a. Background Color: Green.
   b. Letter Color: White.

2. Condensate Drain Piping:

   a. Background Color: Green.
   b. Letter Color: White.

3. Heating Hot Water Piping:

   a. Background Color: Yellow.
   b. Letter Color: Black.

4. Make-up (Non-Potable) Water Piping:

   a. Background Color: Green.
   b. Letter Color: White.

5. Refrigerant Piping:

   a. Background Color: Yellow.
   b. Letter Color: Black.

6. Low-Pressure Steam Piping:

   a. Background Color: Yellow.
   b. Letter Color: Black.

7. High-Pressure Steam Piping:

   a. Background Color: Yellow.
   b. Letter Color: Black.

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8. Steam Condensate Piping:

   a. Background Color: Yellow.
   b. Letter Color: Black.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems including piping within refrigeration machinery rooms, boiler rooms, mechanical equipment room, mechanical equipment yards, piping mains, and piping branches serving more than one piece of equipment. Tags are not required on check valves; valves within factory-fabricated equipment units; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units.

B. List tagged valves in a valve schedule. Valve schedule shall indicate the following:

1. Valve Identification Number.
2. Piping System: e.g., CHWS, HWHS, CWS.
3. Function: e.g., balance, drain, shut-off, stop.
4. Location: e.g., "Above ceiling in Corridor C-01 near Room 117."
5. Equipment/Area Served: e.g., AH-1, CH-1, West Wing.
6. Valve Size.
7. Valve Type: Ball, butterfly, check, etc.
8. Valve manufacturer and model number.

C. Mount valve schedule under glass in main mechanical room, or elsewhere as directed by Owner. Include copy in O&M Manual.

3.5 ADJUSTING AND CLEANING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

B. Clean faces of mechanical identification devices and glass frames of valve schedules.

END OF SECTION 23 05 53

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SECTION 23 05 93

TESTING, ADJUSTING & BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems.
2. Balancing Hydronic Systems.
3. Balancing HVAC Equipment.
4. Testing and Certifying the Proper Operation of Fire and Smoke Control Devices.

1.2 APPROVED CONTRACTORS

A. Approved Contractors: Owner will select and directly contract with the Test and Balance Contractor.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

A. Contractor Qualifications: Include AABC or NEBB certificates for proposed personnel, test instrument certifications.

B. Special Inspection Form: Provide a completed, project specific Special Inspection Form to be stamped and signed by the Engineer of Record and submitted to the Authority having Jurisdiction.

C. LEED Submittal:

1. Air-Balance Report for LEED Prerequisite IEQ 1: Documentation of work performed for ASHRAE 62.1, Section 7.2.2, "Air Balancing."

D. Certified TAB reports.

E. Sealed special inspection reports.

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1.5 QUALITY ASSURANCE

A. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the TAB plan and the procedures specified and referenced in this Specification.

B. TAB Report Forms: Use standard TAB contractor's forms.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

D. Perform special inspections as required herein and by Authorities Having Jurisdiction.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents and approved submittals for the HVAC systems and equipment to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment or inefficient operation. Report findings and recommendations directly to the Engineer within thirty days of document review.

B. Examine ceiling plenums used for return or relief air to verify that there is a proper path for return and relief air from all areas of the building. Verify that penetrations through walls between plenum and non-plenum areas are sealed.

C. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

D. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

E. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

F. Examine placement of the Hydronic differential pressure sensor and confirm it is installed where indicated on the drawings.

G. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

H. Examine system pumps to ensure absence of entrained air in the suction piping.

I. Examine operating safety interlocks and controls on HVAC equipment.

J. Report deficiencies discovered before and during performance of TAB procedures directly to Engineer and Mechanical Contractor. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

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K. The General or Mechanical Contractor shall not in any way prohibit the TAB Contractor from communicating directly and freely with the Engineer. The TAB Contractor is required to copy the Engineer on all communications to the Contractor.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing Adjusting and Balancing of Environmental Systems," and in this Section.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2, "Air Balancing."

B. Cut insulation and ducts for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts airtight.
2. Coordinate with mechanical contractor to restore insulation, coverings, vapor barrier, and finish according to Division 23 Sections.

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes. Correct variations that exceed plus or minus three (3) percent per NAU requirements.

B. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

C. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

D. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

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E. Verify that motor starters are equipped with properly sized thermal protection.

F. Check dampers for proper position to achieve desired airflow path.

G. Check for airflow blockages.

H. Check condensate drains for proper connections.

I. Check for proper sealing of air-handling-unit components.

J. Verify that joints and seams in air duct systems are sealed as specified in Division 23 Sections.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

    a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
    b. Measure static pressure directly at the fan outlet or through the flexible connection.
    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment. Exception: Individual component measurement is not required for unitary equipment 5-tons and less in capacity. Provide external static pressure measurement across unit only.

    a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
7. Instruct Mechanical Contractor to replace fan and motor sheaves and belts as required to achieve design airflow or pressurization.

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B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

   a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at minimum set-point airflow with the remainder at maximum airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units from the terminal units closest to the air handling unit.

B. Pressure-Independent, Variable-Air-Volume Systems: Adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum-minimum, and set return- and relief-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total terminal unit airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

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a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Measure static pressure at the most critical terminal unit and set the supply duct static-pressure control setpoint in the building control system to ensure that adequate static pressure is maintained at the most critical unit. Set and record maximum speed of supply fan VFD to not exceed this speed.
7. With supply fan operating at scheduled airflow, adjust the relief fan speed to scheduled airflow. On ducted return systems, balance the return-air ducts and inlets as described for constant-volume air systems. Set and record maximum speed of return fan VFD to not exceed this speed.
8. Confirm that the outdoor-air damper minimum-minimum and maximum-minimum positions are properly set and maintained throughout the operating range of the supply fan.
9. Measure and record the following airflows and airflow measuring station readings with supply fan operating at 100 percent and 50 percent speeds: Supply air, return air, outdoor air.
10. Calibrate misreading airflow measuring stations.
11. Record final supply and return fan-performance data.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check pressure in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
5. Set differential-pressure control valves as directed by the valve manufacturer to maintain the required downstream differential pressure.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

a. Impeller sizes must be adjusted to achieve pump performance, if the flow exceeds 130% of the design flow. Impeller is to be trimmed by the pump manufacturer at no additional cost to the Owner.

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2. Check system resistance. With all valves open and pump at full speed, read pressure differential across the pump and mark pump manufacturer's head-capacity curve.

   a. Pumps with VFD: Adjust VFD speed until indicated water flow is achieved.

      1) Set maximum VFD output for indicated pump flow.
      2) Set minimum VFD output at 18 Hz.
      3) Place label on VFD stating, "Do not adjust maximum or minimum VFD speed settings. These were set by Test and Balance Contractor for proper pump flow on (mm/dd/yyyy)."
      4) Do not use pump discharge valve to balance pumps with VFD.

   b. Pump without VFD: Adjust pump discharge valve until indicated water flow is achieved.

   c. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure and record the differential-pressure-control-valve settings at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

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3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Determine if the system has diversity. If the sum of the flows through the motorized control valves is greater than the flow of the pump, the system has diversity.

B. Systems Without Diversity: Balance as specified above for constant volume system.

C. Systems With Diversity:

1. Compensating for Diversity:

   a. When the total flow of all motorized control valves is more than the indicated flow of the pump, close a selected number of motorized control valves with the remainder of the valves fully open until the total flow of the open valves equals the indicated flow of the pump. Select the closed valves so they farthest from the pump.
   b. Balance the components connected to the open valves as specified above for constant volume hydronic systems.
   c. Fully open the closed control valves. Close a different group of motorized control valves until the total flow of the open valves equals the indicated flow of the pump. Select the closed valves so they are closest to the pump.
   d. Balance the components connected to the open valves as specified above for constant volume hydronic systems.

2. Determine the system differential pressure (DP setpoint).

   a. After balancing all the components but prior to opening the closed valves, reduce the pump speed until the flow through the most hydraulically remote valve falls to 5% below design. Increase pump speed until valve reaches design flow and record reading at system differential pressure sensor. Set the building automation system to maintain this differential pressure.

3.10 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Set minimum motor speed to 20 percent. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.11 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.

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2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Air pressure drop.
4. Inlet steam pressure.

3.12 PROCEDURES FOR TESTING FIRE AND SMOKE CONTROL DEVICES

A. Record manufacturer and model number for each fire damper, smoke detector, smoke damper, combination fire/smoke damper, and damper actuator.

B. Confirm access door has been installed at each damper location and is properly labeled.

C. Fire Dampers:

1. Disconnect the fusible link and confirm that damper closes smoothly and completely.
2. Reset the damper and replace the fusible link.

D. Duct Mounted Smoke Detectors:

1. Verify the proper operation of the smoke detector using a test gas, "canned smoke", acceptable to the Authorities Having Jurisdiction or Engineer. (Magnets are not acceptable.)
2. Verify activation of the smoke detector closes the appropriate smoke or combination fire/smoke damper(s) and/or de-energizes the appropriate air-moving device(s).
3. Verify activation of the smoke detector is shown by the fire alarm system where monitoring of the detector is required.

E. Smoke and Combination Fire/Smoke Dampers: Verify dampers controlled by a Total Coverage Smoke Detection System operate correctly on a signal from the system.

F. Air-Moving Device Shut-down: Verify air-moving device(s) that are to be de-energized by a Total Coverage Smoke Detection System de-energize on a signal from the system.

G. After all smoke control devices have been successfully tested, the TAB firm shall engage the services of a Professional Mechanical Engineer, registered in the State of Arizona, to submit a signed and sealed report attesting to the proper operation of the smoke control devices and air-moving device shut-downs.

3.13 TOLERANCES

A. Set HVAC system's air flow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus three (3) percent per NAU requirements.
2. Air Outlets and Inlets: Plus or minus three (3) percent per NAU requirements.
3. Heating-Water Flow Rate: Plus or minus 10 percent.

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4. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.14 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.15 OUTDOOR AIR SUMMARY REPORT

A. Outdoor Air Summary Report: Prepare a summary report for review by the Authorities Having Jurisdiction that lists each supply- air system on the project. The report shall indicate the system or equipment designation, the scheduled outdoor- air flow rate and the balanced outdoor- air flow rate.

3.16 SPECIAL INSPECTIONS

A. Prepare special inspection reports, signed and sealed by a professional engineer, as required by the Authority Having Jurisdiction or as required above.

3.17 FINAL REPORT

A. General: Prepare certified reports in both paper and PDF format; tabulate and divide the report into separate sections for tested systems and balanced systems. Submit four (4) copies of paper reports and one (1) copy of report in PDF format.

1. Assemble paper reports in 3-ring binders. Separate and order sections within each binder. Provide labeled tabs at each section with a table of contents at the front of the binder. The table of contents shall indicate the tab number and the information contained at that tab.
2. Assemble PDF report in one PDF file. Separate and order sections within the file to match the paper copy. Provide bookmarks at the first page of each section and label each bookmark with the information contained in that section.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.

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9. Signature of TAB supervisor who certifies the report.
10. Certification sheet signed and sealed by the certified testing and balancing engineer.
11. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
12. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

13. Nomenclature sheets for each item of equipment.
14. Data for terminal units, including manufacturer's name, type, size, and fittings.
15. Notes to explain why certain final data in the body of reports vary from indicated values.
16. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Variable frequency drive settings including maximum and minimum setpoints.
    g. Inlet vane settings for variable-air-volume systems.
    h. Settings for supply-air, static-pressure controller.
    i. Other system operating conditions that affect performance.

17. Include a list of instruments used for procedures, along with proof of calibration.

3.18 ADDITIONAL TESTS

A. TAB Report Verification: The TAB Agency may be required to recheck, in the presence of the Owner's representative, specific or random selections of data recorded in the certified report. Points and areas for recheck shall be selected by the Owner's representative. Measurements and test procedures shall be the same as approved for the initial work for the certified report. Selections for verification, specific plus random, will not exceed 10 percent of the total number of measurements tabulated in the report. If the values measured during the verification process exceed plus or minus 10 percent of the values recorded in the report, the TAB Agency may be required to re-perform the TAB work outlined above.

END OF SECTION 23 05 93

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SECTION 23 07 13

DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes duct exterior insulation systems.

B. Related Sections:

1. Division 23 Section "Metal Ducts" for duct liner.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include manufacturer's technical data with proposed thickness and R-value indicated, and application.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.

1.3 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule" article for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

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D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. All materials shall conform to NFPA 90A and NFPA 90B, ASHRAE 90.1 and the International Energy Construction Code (IECC).

F. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket composed of aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. CertainTeed Corp.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Manson Insulation Products Ltd.; Alley Wrap.
   e. Owens Corning; SOFTR All-Service Duct Wrap.
   f. Bonded Logic Ultra-touch.

H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB with factory-applied ASJ or FSK jacket.

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
3. Products: Subject to compliance with requirements, provide one of the following:

   a. CertainTeed Corp.; Commercial Board.
   b. Johns Manville; 800 Series Spin-Glas.
   c. Knauf Insulation; Insulation Board.
   d. Owens Corning; Fiberglas 700 Series.
   e. Bonded Logic Ultra-touch.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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D. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below and above ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.5 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.

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C. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

1. Sheet and roll stock ready for shop or field sizing or Factory cut and rolled to size.
2. Finish and thickness are indicated in field-applied jacket schedules.
3. Moisture Barrier: 3-mil- thick, heat-bonded polyethylene and kraft paper or 2.5-mil- thick polysurlyn.

D. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco-embossed aluminum-foil facing.

2.6 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

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2.7 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch-thick, 1/2-inch-wide with wing seal or closed seal.

B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030-inch-thick by 2 inches square.
   b. Spindle: Copper- or zinc-coated, low carbon steel, or stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Metal, Capacitor-Discharge-Weld Pin, Insulation Hangers: Copper-coated, low carbon steel, or stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated. May be provided with base.
3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

4. Metal, Cupped-Head, Capacitor-Discharge-Weld Pins:

   a. Head: Galvanized, carbon-steel or stainless steel sheet, minimum of 0.016-inch-thick with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   b. Spindle: Copper- or zinc-coated, low carbon steel, or stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

2.8 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040-inch-thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

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PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

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4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends below roof surface. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends inside building. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 07 for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07.

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3.4 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either adhesively attached or capacitor-discharge-weld pins and speed washers, or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either adhesively attached or capacitor-discharge-weld pins and speed washers, or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

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a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.
e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

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3.6 DUCT INSULATION SCHEDULE

A. Duct, Plenums and Accessories Not Requiring Insulation:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1. See Section "Metal Ducts" for duct lining requirements.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

B. Duct and Plenum Insulation: Insulate ducts and plenums in accordance with the Duct and Plenum Insulation Schedule Table.

Duct & Plenum Insulation Schedule Table

Duct/Plenum System	Duct Type	Duct Location**	Insulation Type	Minimum Insulation Density (PCF)	Minimum Insulation R-Value (Thickness)
Supply	Round	Interior, Concealed	Mineral-Fiber Blanket	0.75	R-6 (2 inches)
Supply	Rectangular	Interior, Concealed	Duct Lining*	--	--
Supply & Return (Within Room it Serves)	Round	Interior, Exposed	None	--	--
Supply & Return (Within Room it Serves)	Rectangular	Interior, Exposed	Duct Lining*	--	--
Supply & Return (Within Mechanical Rooms)	Round	Interior, Exposed	Mineral-Fiber Blanket	0.75	R-6 (2 inches)
Supply & Return (Within Mechanical Rooms)	Rectangular	Interior, Exposed	Duct Lining*	--	--
Return	Round	Interior, Concealed	Mineral-Fiber Blanket	0.75	R-6 (2 inches)
Return & Exhaust	Rectangular	Interior, Concealed	Duct Lining*	--	--
Exhaust	Round	Interior, Concealed	None	--	--
Outside Air	Round/ Rectangular	Interior, Concealed or Exposed	Mineral-Fiber Blanket	0.75	R-8 (3 inches)
Supply & Return	Round/ Rectangular	Exterior, Concealed or Exposed	Duct Lining*	--	--
Outside Air	Round/ Rectangular	Exterior, Concealed	Mineral-Fiber Blanket	0.75	R-6 (2 inches)

* See Division 23 Section "Metal Ducts" for liner requirements.

** Interior means within the insulated building envelope.
Exterior means outside the building envelope.

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3.7 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed: None.

3.8 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed: None.

D. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Aluminum, Stucco Embossed: 0.020 inch thick.

E. Ducts and Plenums, Exposed, Larger than 48 Inches in Diameter or with Flat Surfaces Larger than 72 Inches:

1. Aluminum, stucco embossed with 1-1/4-inch-deep corrugations 0.040 inch thick.

END OF SECTION 23 07 13

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SECTION 23 07 16

HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following HVAC equipment that is not factory insulated:

1. Heat exchangers.
2. Heating, hot-water pumps.
3. Expansion/compression tanks.
4. Air separators.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include manufacturer's technical data with proposed thickness and R-value indicated, and application.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.

1.3 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

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D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Armstrong.
b. Halstead-Nomalco.
c. Imcoa.
d. Nomaco.
e. Rubatex.

F. Mineral-Fiber Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I or Type II with factory-applied vinyl jacket.

1. Products: Subject to compliance with requirements provide one of the following:

a. CertainTeed Corp.; SoftTouch Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Friendly Feel Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR All-Service Duct Wrap.

G. High-Temperature, Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Industrial Insulation Group (IIG); MinWool-1200 Flexible Batt.
b. Johns Manville; HTB 26 Spin-Glas.
c. Roxul Inc.; Roxul RW.

H. Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation with factory-applied ASJ. ASJ shall be white, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

1. Products: Subject to compliance with requirements provide one of the following:

a. CertainTeed Corp.; CertaPro Commercial Board.
b. Fibrex Insulations Inc.; FBX.
c. Johns Manville; 800 Series Spin-Glas.
d. Knauf Insulation; Insulation Board.
e. Manson Insulation Inc.; AK Board.
f. Owens Corning; Fiberglas 700 Series.

I. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Fibrex Insulations Inc.; FBX.
b. Industrial Insulation Group (IIG); MinWool-1200 Industrial Board.
c. Rock Wool; Delta Board.

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d. Roxul Inc.; RHT and RockBoard.
e. Thermafiber, Inc.; Thermafiber Industrial Felt.

J. Mineral-Fiber Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. ASJ shall be white, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; CrimpWrap.
b. Johns Manville; MicroFlex.
c. Knauf Insulation; Pipe and Tank Insulation.
d. Manson Insulation Inc.; AK Flex.
e. Owens Corning; Fiberglas Pipe and Tank Insulation.

K. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Armacell LLC.
b. Imcoa.
c. Nomaco.

2.2 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

D. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

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2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.5 SEALANTS

A. Joint Sealants:

1. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.

B. Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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2.6 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for equipment.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: To match adjacent surfaces.
3. Factory-fabricated tank heads and tank side panels.

D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

1. Sheet and roll stock ready for shop or field sizing or Factory cut and rolled to size.
2. Finish and thickness are indicated in field-applied jacket schedules.
3. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
4. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
5. Factory-Fabricated Fitting Covers:

    a. Same material, finish, and thickness as jacket.
    b. Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    c. Tee covers.
    d. Flange and union covers.
    e. End caps.
    f. Beveled collars.
    g. Valve covers.
    h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco-embossed aluminum-foil facing.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

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B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.9 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   b. Spindle: Copper- or zinc-coated, low carbon steel, or stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Metal, Capacitor-Discharge-Weld Pin, Insulation Hangers: Copper-coated, low carbon steel, or stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated. May be provided with base.
3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

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a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

4. Metal, Cupped-Head, Capacitor-Discharge-Weld Pins:

a. Head: Galvanized, carbon-steel or stainless steel sheet, minimum of 0.016-inch-thick with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

b. Spindle: Copper- or zinc-coated, low carbon steel, or stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

2.10 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: .040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

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G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

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3.3 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.

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2. Fabricate boxes from aluminum, at least 0.040 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.4 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.5 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Heating-hot water service pump insulation: Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.

D. Heat-Exchanger (Water-to-Water for Heating Service) Insulation: Mineral-fiber pipe and tank, 2 inches thick.

E. Heat-Exchanger (Shell and Tube Type, Steam-to-Water for Heating Service) Insulation: Mineral-fiber pipe and tank, 2 inches thick.

F. Heating hot water expansion/compression tank insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-fiber pipe and tank, 1 inch thick.
3. Polyolefin: 1 inch thick.

G. Heating-Hot-Water air-separator insulation: Mineral-fiber pipe and tank, 2 inches thick.

3.6 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed: None.

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D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. PVC 30 mils thick.
2. Aluminum, Stucco Embossed: 0.020 inch thick.

E. Equipment, Exposed, Larger than 48 Inches in Diameter or with Flat Surfaces Larger than 72 Inches:

1. Aluminum, Stucco Embossed with 1-1/4-Inch-Deep Corrugations: 0.032 inch thick.

3.7 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.024 inch thick.

D. Equipment, Exposed, Larger than 48 Inches in Diameter or with Flat Surfaces Larger than 72 Inches:

1. Aluminum, Stucco Embossed with 1-1/4-Inch-Deep Corrugations 0.040 inch thick.

END OF SECTION 23 07 16

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SECTION 23 07 19

HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Chilled-water piping.
2. Heating hot-water piping.
3. Refrigerant piping.
4. Steam and condensate piping.
5. Condensate drain piping.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include manufacturer's technical data with proposed thickness and R-value indicated, and application.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content and chemical components.

1.3 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. All insulating materials shall conform to NFPA 90A and NFPA 90b, ASHRAE 90.1 and the International Energy Construction Code (IECC).

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

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D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Manufacturers: Subject to compliance with requirements, provide product by one of the following manufacturers:

a. Armacell LLC.
b. Halstead-Nomalco.
c. Imcoa.
d. Nomaco.
e. Rubatex.

G. Mineral-Fiber Insulation:

1. Manufacturers: Subject to compliance with requirements, provide product by one of the following manufacturers:

a. CertainTeed Corp.
b. Johns Manville.
c. Knauf Insulation.
d. Manson Insulation Products Ltd.
e. Owens Corning.

2. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 1290, Type I.
3. Mineral-Fiber, Preformed Pipe Insulation: Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or with factory-applied ASJ-SSL. Omit jacket on all but outermost layer where multiple insulation layers are required. Jacket shall comply with the following:

a. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
b. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.2 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

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C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

D. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.5 SEALANTS

A. Joint Sealants:

1. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.

B. Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

C. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.

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4. Color: To match jacket.

2.6 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.
2. Color: Color-code jackets based on system within mechanical rooms, white in all other areas.
3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, traps, and mechanical joints.

C. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

1. Sheet and roll stock ready for shop or field sizing, or factory cut and rolled to size.
2. Finish and thickness are indicated in field-applied jacket schedules.
3. Moisture Barrier for Indoor and Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
4. Factory-Fabricated Fitting Covers:

a. Same material, finish, and thickness as jacket.
b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
c. Tee covers.
d. Flange and union covers.
e. End caps.
f. Beveled collars.
g. Valve covers.
h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco-embossed aluminum-foil facing.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.

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5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.9 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

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E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Install insulation continuously through hangers and around anchor attachments.

K. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

L. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

M. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

N. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

O. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

P. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

Q. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

R. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

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S. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends below roof surface. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends inside building. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 07 for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 for firestopping and fire-resistive joint sealers.

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G. Installation of Pipe Hangers and Rollers:

1. Install thermal-hanger shield inserts complying with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" at all hangers and rollers.

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

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D. Install removable insulation covers at locations indicated and where required for maintenance. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

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3.6 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation without jacket to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal seams and end joints with weatherproof sealant recommended by insulation manufacturer or if no sealant is recommended with silicone caulk. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

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3.8 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on pre-insulated underground piping.

3.9 INDOOR PIPING INSULATION SCHEDULE

A. Chilled Water, above 40 Deg F: Insulation shall have a maximum k-factor of 0.27 at a mean rating temperature of 75 Deg F and be one of the following:

1. Flexible Elastomeric: 1 inch thick. Do not use on piping larger than 8 inches.
2. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick on piping less than 8 inches, 1-1/2 inches thick for piping 8 inches and larger.

B. Heating-Hot-Water Supply and Return, 200 Deg F and Below: Mineral-Fiber, Preformed Pipe, Type I with a maximum k-factor of 0.29 at a mean rating temperature of 125: 1-1/2 inches thick for pipe smaller than 1-1/2 inches, 2 inches thick for pipe 1-1/2 inches and larger.

C. Refrigerant Suction Piping: Insulation shall be one of the following:

1. Flexible elastomeric: 1 inch thick.
2. Mineral-fiber, preformed pipe insulation: 1 inch thick.

D. Refrigerant Suction Flexible Tubing: Flexible elastomeric, 1 inch thick.

E. Steam and Condensate Return Piping, 250 Deg F and below (Less than 30 psia):

1. Mineral-Fiber, Preformed Pipe Insulation Type I with a maximum k-factor of 0.30 at a mean rating temperature of 150 Deg F: 2-1/2 inches thick for pipe smaller than 4 inches, 3 inches for pipe 4 inches and larger.

F. Steam Piping, 250 Deg F to 350 Deg F (30 psia to 130 psia):

1. Mineral-Fiber, Preformed Pipe Insulation Type I with a maximum k-factor of 0.32 at a mean rating temperature of 200 Deg F: 3 inches thick for pipe less than 1 inch, 4 inch thick for pipe larger 1 inch and 1-1/4 inches, 4-1/2 inches thick for pipe 1-1/2 inches and larger.

G. Air Conditioning Condensate Drain Piping: Flexible elastomeric, 3/4 inch thick.

3.10 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction Piping: Flexible elastomeric, 1 inch thick.

B. Refrigerant Suction Flexible Tubing: Flexible elastomeric, 1 inch thick.

C. Air Conditioning Condensate Drain Piping: Flexible elastomeric, 3/4 inch thick.

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D. Steam and Condensate Return Piping, 250 Deg F and below (Less than 30 psia): Mineral-Fiber, Preformed Pipe Insulation Type I with a maximum k-factor of 0.30 at a mean rating temperature of 150 Deg F: 3 inches thick for pipe smaller than 4 inches, 4 inches for pipe 4 inches and larger

E. Steam Piping, 250 Deg F to 350 Deg F (30 psia to 130 psia): Mineral-Fiber, Preformed Pipe Insulation Type I with a maximum k-factor of 0.32 at a mean rating temperature of 200 Deg F: 4 inches thick for pipe less than 1 inch, 5 inch thick for pipe larger 1 inch and 1-1/4 inches, 6 inches thick for pipe 1-1/2 inches and larger.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option or as directed on the drawings.

C. Piping, Concealed: None.

D. Piping, Exposed:

1. PVC Color-Coded by System: 30 mils thick.

3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed: None.

D. Piping, Exposed:

1. Aluminum, Corrugated or Stucco Embossed: 0.020 inch thick.

3.13 PVC JACKET COLOR CODING SCHEDULE

A. Where directed, provide PVC jacketing in the following colors or as selected by the Owner:

1. Chilled Water Supply: Dark Blue
2. Chilled Water Return: Light Blue
3. Heating Hot Water: Supply: Orange
4. Heating Hot Water Return: Yellow
5. Steam and Steam Condensate: Red

END OF SECTION 23 07 19

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SECTION 23 09 00

BUILDING AUTOMATION SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes control equipment for HVAC systems and components.

B. The BAS Contractor is responsible for the complete installation of this system as necessary to provide the sequence of operations, and monitor and control the equipment and points as shown on the drawings. The complete installation includes all required 120 volt wiring, all low voltage wiring, and communication wiring, refer to Section "Electrical and Control Wiring for Mechanical Systems" for requirements.

1.2 SUBMITTALS

A. Product Data: For the complete Building Automation System indicated and intended for this project. Include the following as a minimum:

1. Sequence of operations intended for each system component on this project.
2. Copy of each graphic screen intended for this project.
3. Operator work station and all associated components.
4. All control hardware including controllers, panels, sensors, thermostats, valves, dampers, etc. intended for this project. Include the following:

    a. Manufacturer and model number.
    b. Equipment dimensions.
    c. Required clearances.
    d. Electrical data.

        1) Amperage.
        2) Voltage/Phase/Hz.
        3) Electrical service point(s) of connection.

    e. Materials of construction.
    f. Accessories and options.

5. Project specific: Point chart for each system component intended for this project.
6. Project specific: Power, signal, and control wiring diagrams.
7. Damper schedule.
8. Valve schedule.
9. Submit within 21 days of notice to proceed.

B. Software and firmware operational documentation.

C. Field quality-control test reports.

D. Warranty information.

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E. Operation and maintenance data: Include the following:

1. Table of contents.
2. As-builts of the system showing all points and terminations in both AutoCAD and hardcopy format.
3. Manufacturer's product data for each item installed.
4. System operator's manuals.
5. Electronic back-up copy of site specific programming, databases, and sequences.
6. Network diagrams.
7. Wiring termination schedules.

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. The BAS Contractor shall be a recognized distributor, manufacturer's representative, or wholesaler of a national manufacturer of Building Automation Systems.

C. The BAS Contractor shall have a facility within a 100-mile radius of the job site supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis. This support facility shall have spare parts and all necessary test and diagnostic equipment required to install, commission and service the specified BAS.

1.4 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of the BAS that fail in materials or workmanship within specified warranty period.

1. Extended warranties include, but are not limited to, the following:

a. Reprogramming of sequences and updating graphics.
b. Parts and labor.

2. Warranty Period: Two years from date of Substantial Completion.

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.

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2.2 CONTROL SYSTEM

A. Manufacturers:

1. Alerton Inc.

B. Communications between the operator workstation and network control units shall use BACNET protocol.

C. Communications between the network controllers and DDC controllers shall use BACNET protocol.

D. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.3 SOFTWARE

A. The software operating the BAS shall provide the following features:

B. Downloading and Uploading:

1. Provide the capability to generate BAS software-based sequences, database items and associated operational definition information and user-required revisions to any OWS and the means to download same to the associated Application Node.
2. Application software tool used for the generation of custom logic sequences shall be resident in both the application node and the OWS.

C. Graphics:

1. Provide graphics to allow for monitoring and control of each piece of equipment on the project.
2. Graphics shall include clickable site plans, floor plans, etc. showing the actual location of each piece of equipment.
3. Floor plans shall use color-coding to indicate areas or items in alarm or not meeting the desired temperature setpoint.
4. Dynamic graphics shall be provided for each piece of equipment showing real-time operating data and allowing modification of adjustable parameters.

D. Schedules:

1. The system shall provide multiple schedule input forms for automatic time-of-day scheduling and override scheduling of BAS operations. At a minimum, the following spreadsheet types shall be accommodated:

   a. Weekly schedules.
   b. Temporary override schedules.
   c. Special "Only Active If Today Is a Holiday" schedules.
   d. Monthly schedules.

2. Schedules shall be provided for each system or sub-system in the BAS. Each schedule shall include all commandable points residing within the system. Each point may have a unique schedule of operation relative to the system use schedule, allowing for sequential starting and

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control of equipment within the system. Scheduling and rescheduling of points shall be accomplished easily via the system schedule spreadsheets.

3. Monthly calendars for a 12-month period shall be provided that allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the weekly schedules.

E. Alarms:

1. Alarms shall be routed directly from primary application nodes to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the OWS software shall, at the minimum, provide the following functions:

   a. Log date and time of alarm occurrence.
   b. Generate a "Pop-Up" window, with audible alarm, informing a user that an alarm has been received.
   c. Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
   d. Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
   e. Provide the ability to direct alarms to an e-mail address or alpha-numeric pager. This must be provided in addition to the pop up window described above. Systems which use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
   f. Any attribute of any object in the system may be designated to report an alarm.

2. BAS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions.
3. The BAS shall annunciate application alarms at minimum.

F. Reports:

1. Reports shall be generated and directed to one or more of the following: User interface displays, printers, or archive at the user's option. As a minimum, the system shall provide the following reports:

   a. All points in the DDC System.
   b. All points in each DDC System application.
   c. All points in a specific application node.
   d. All points in a user-defined group of points.
   e. All points currently in alarm in a DDC System application.
   f. All points locked out in a DDC System application.
   g. All DDC System schedules.
   h. All user defined and adjustable variables, schedules, interlocks and the like.
   i. DDC System diagnostic and system status reports.

G. Historical Trending and Data Collection:

1. Trend and store point history data for all BAS points and values as selected by the user.
2. The trend data shall be stored in a manner that allows custom queries and reports using industry-standard software tools.

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3. At a minimum, provide the capability to perform statistical functions on the historical database:

   a. Average.
   b. Arithmetic mean.
   c. Maximum/minimum values.
   d. Range - difference between minimum and maximum values.
   e. Standard deviation.
   f. Sum of all values.
   g. Variance.

H. Application Routines:

1. Event Messaging: Provide for the automatic execution of user-defined messages on the occurrence of each predefined BAS real-time event including equipment/point status change, approaching limit or alarm, time of day and the like. Direct messages to any number of operator PCs, e-mail destinations, and pagers.
2. Indoor Air Quality: Provide monitoring of outside air, return air and supply air CO_2 concentration, calculate and maintain fresh air requirements. Adjust outdoor air intake to ensure return air CO_2 high level limit is not exceeded.
3. Optimum Start/Stop: Provide software to start equipment on a sliding schedule based upon indoor and outdoor conditions, to determine the minimum time of HVAC system operation needed to satisfy the space environmental requirements. The program shall also determine the earliest possible time to stop the mechanical systems. The optimum start/stop program shall operate in conjunction with, and be coordinated with, the scheduled start/stop and night setback programs.
4. Auto Alarm Lockout: Provide for scheduled and automatic lockout of alarm annunciation from equipment during non-normal operating conditions including shutdown, emergency power operation, fire alarm and the like.
5. Energy Monitoring: Provide software to monitor and totalize consumption as measured by pulse meters.
6. Event Initiated Programs and Custom Logic: Provide software to define custom logic sequences that will reside in the nodes. The definition software will also reside in the node and be accessible via the standard user interface via a browser.
7. System Restart: Upon restoration of the AC power to an HVAC Node, automatically restart all equipment and restore all loads to the state as required by the BAS. Provide appropriate time delays to prevent demand surges or overload trips.
8. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
9. Runtime Totalization: Automatically sample, calculate and store runtime hours for binary input and output points as listed in the point schedule of this specification.
10. Analog/Pulse Totalization: Sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

2.4 DDC EQUIPMENT

A. Operator Workstation (OWS): PC-based microcomputer with minimum configuration as follows:

1. Motherboard: With integrated USB ports, Ethernet network port, audio, bios, and hardware monitoring.
2. Processor: Minimum Intel Pentium.
3. Random-Access Memory: Minimum 4 GB.
4. Graphics: Discrete video adapter, minimum 1600 x 1200 pixels, minimum 1-GB video memory, with TV out.
5. Monitor: Minimum 22 inches, LCD color.

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6. Keyboard: QWERTY, 105 keys in ergonomic shape.
7. Hard-Disk Drive: Minimum 1 TB.
8. DVD-RW Read/Write Drive.
9. Mouse: Three button, wireless optical.
10. Uninterruptible Power Supply: Minimum of 2 kVa.
11. Operating System: Latest version of Microsoft Windows.
12. Printer: Color, ink-jet type with one set of spare ink cartridges.

B. Web Access Server:

1. Provide a web access server to allow users to observe, access and modify set points, scheduling data, operating conditions, alarms, and reports; and save any changes made to the system.
2. Access shall be allowed via any internet connected computer with a standard web browser when the proper password is given.
3. The system information shall be provided using the same style of graphics used at the main operator interface.

C. Network Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

    a. Global communications.
    b. Discrete/digital, analog, and pulse I/O.
    c. Monitoring, controlling, or addressing data points.
    d. Software applications, scheduling, and alarm processing.
    e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

D. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

    a. Global communications.
    b. Discrete/digital, analog, and pulse I/O.
    c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation.

E. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.

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4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

F. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

G. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

H. Uninterruptible Power Supply (UPS):

1. Where indicated for supporting operator PCs, servers, and other equipment as indicated, provide a UPS.
2. UPS shall be sized for 50% spare capacity. The UPS shall be complete with batteries, external bypass and line conditioning.

I. Power Fail / Auto Restart:

1. Provide for the automatic orderly and predefined shutdown of parts or all of the BAS following total loss of power to parts or all of the BAS.
2. Provide for the automatic orderly and predefined startup of parts or all of the BAS following total loss of power to those parts or all of the BAS. Archive and annunciate time and details of restoration.
3. Provide for the orderly and predefined scheduling of controlled return to normal, automatically time scheduled, operation of controlled equipment as a result of the auto restart processes.
4. Maintain the BAS real-time clock operation during periods of power outage for a minimum of 72 hours.

2.5 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.

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2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
3. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

2.6 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

2.7 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. Accuracy: Plus or minus 0.5 deg F at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 18 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
4. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.
5. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
6. Room Sensor: Wallbox or surface mounting with the following features where indicated:
    a. Override button.
    b. LCD display for room temperature and setpoint.
    c. Setpoint adjustment device to provide ± 3 degree (adjustable) range.
    d. Color: White unless noted otherwise.
7. Room Security Sensors: Wallbox mounting, stainless-steel cover plate with insulated back and security screws.
8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

C. RTDs and Transmitters:

1. Accuracy: Plus or minus 0.2 percent at calibration point.

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2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 18 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
4. Averaging Elements in Ducts: 24 inches long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.
5. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
6. Room Sensor: Wallbox or surface mounting with the following features where indicated:

    a. Override button.
    b. LCD display for room temperature and setpoint.
    c. Setpoint adjustment device to provide ± 3 degree (adjustable) range.
    d. Color: White unless noted otherwise.

7. Room Security Sensors: Wallbox mounting, stainless-steel cover plate with insulated back and security screws.
8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

D. Humidity Sensors: Bulk polymer sensor element.

1. Accuracy: 5 percent full range with linear output.
2. Room Sensor Range: 20 to 80 percent relative humidity.
3. Room Sensor: Wallbox or surface mounting with the following features where indicated:

    a. LCD display for room humidity and setpoint.
    b. Color: White unless noted otherwise.

4. Room Security Sensors: Wallbox mounting, stainless-steel cover plate with insulated back and security screws.
5. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
6. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of 32 to 120 deg F.
7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

E. Pressure Transmitters/Transducers:

1. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

    a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
    b. Output: 4 to 20 mA.
    c. Building Static-Pressure Range: 0- to 0.25-inch wg.
    d. Duct Static-Pressure Range: 0- to 5-inch wg.

2. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
4. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
5. Pressure Transmitters: Direct acting for gas or liquid service; range suitable for system; linear output 4 to 20 mA.

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F. Combination Air Flow, Pressure and Temperature Sensor:

1. Basis of Design: STx102-B manufactured by Ebtron, Inc. or comparable product with prior approval.
2. Combination sensor to provide airflow, pressure and air temperature with remote mounted transmitter.
3. Sensor shall contain three hermetically sealed bead-in-glass thermistors. Sensor shall provide bidirectional airflow, bidirectional pressure, and temperature to the transmitter.
4. The transmitter shall equally weight and average the airflow, pressure and temperature of the sensor prior to output along with system status, configuration settings and diagnostics.
5. Operating Range: 0 to ± 3,000 FPM.
6. Accuracy: 2 percent of full scale for airflow, 0.14 degrees F between negative 20 degrees F and 160 degrees F for temperature.
7. Sensor and cable shall be plenum rated.

G. Room Sensor: Wallbox or surface mounting with the following features:

1. Color: White unless noted otherwise.

H. Room sensor accessories include the following:

1. Insulating Bases: For sensors located on exterior walls.
2. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base, or metal wire, tamperproof, or locking, solid metal, ventilated as indicated on drawings.
3. Adjusting Key: As required for calibration and cover screws.

2.8 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

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2.9 GAS DETECTION EQUIPMENT

A. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output;, for wall mounting.

B. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

2.10 THERMOSTATS

A. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.

1. Bulbs in water lines with separate wells of same material as bulb.
2. Bulbs in air ducts with flanges and shields.
3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

B. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

C. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

D. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet.
2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

E. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.

1. Bulb Length: Minimum 20 feet.
2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

F. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig, and cast housing with position indicator and adjusting knob.

2.11 HUMIDISTATS

A. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

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2.12 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Manufacturer: Belimo Automation AG.
2. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
3. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
4. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
6. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
7. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturer: Belimo Automation AG.
2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Dampers: Size for running torque calculated as follows:

    a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
    b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
    c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
    d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
    e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
    f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
7. Power Requirements (Two-Position Spring Return): 24 or 120-V ac.
8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
10. Temperature Rating: 40 to 104 deg F.
11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
12. Run Time: 12 seconds open, 5 seconds closed.

2.13 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

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B. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.

    a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
    b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

4. Sizing: 5-psig maximum pressure drop at design flow rate or the following:

    a. Two Position: Line size.
    b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
    c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.

5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

C. Butterfly Valves: 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.

1. Disc Type: Nickel-plated ductile iron.
2. Sizing: 1-psig maximum pressure drop at design flow rate.

D. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

E. Self-Contained Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.
2. Thermostatic Operator: Liquid-filled integral sensor with integral adjustable dial.

2.14 DAMPERS

A. Dampers: AMCA-rated, opposed-blade design; 0.108-inch-minimum thick, galvanized-steel or 0.125-inch-minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not

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be less than 0.064-inch-thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.

1. Secure blades to 1/2-inch-diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

2.15 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 23 Section "Electrical and Control Wiring for Mechanical Systems."

PART 3 - EXECUTION

3.1 ROOM SENSOR APPLICATION SCHEDULE

A. Furnish the room sensor listed below unless indicated otherwise. Install where indicated on the drawings.

1. Room sensor with display, override button, setpoint adjustment: All areas.

3.2 INSTALLATION

A. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices at an elevation per ADA Requirements.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

B. Install automatic dampers according to Division 23 Section "Air Duct Accessories."

C. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

D. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

E. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

F. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

G. Install electronic and fiber-optic cables according to Division 23 Section "Electrical and Control Wiring for Mechanical Systems."

H. Install combination airflow, pressure and temperature sensors for measuring underfloor plenum temperature and pressure where indicated on the drawings. Install each sensor in a floor diffuser that has been sealed to prevent the migration of air from the underfloor plenum.

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3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, cabinets building wire, cable, signal and communication cable according to Division 23 Section "Electrical and Control Wiring for Mechanical Systems."

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.

B. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

C. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust central plant optimization controllers and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Test calibration of controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test each point through its full operating range to verify that safety and operating control set points are as required.
5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
6. Check temperature instruments and material and length of sensing elements.
7. Check control valves. Verify that they are in correct direction.

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8. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
9. Check DDC system as follows:

    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 COMMISSIONING

A. Commission all functions of the BAS.

B. Acceptance Check Sheet:

1. Prepare a check sheet that includes all points for all functions of the BAS.
2. Submit the check sheet to the Engineer for approval one month prior to testing.
3. Complete the check sheet for all items and functions of the BAS and initial each entry with time/date as record of having fully calibrated and tested the BAS. Submit to Engineer.
4. The Engineer will use the check sheet as the basis for acceptance testing with the BAS Contractor.

C. Provide all necessary specialist labor, materials and tools to demonstrate to the Engineer that the BAS has been commissioned and is operating in compliance with the contract. Prepare a list of noted deficiencies signed by both the Engineer and the BAS Contractor.

D. Promptly rectify all listed deficiencies and submit to the Engineer that this has been done.

3.6 TRAINING

A. The BAS Contractor shall provide the following training services:

1. One eight-hour day of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the DDC System software layout and naming conventions, and a walk through of the facility to identify panel and device locations.
2. Factory training for one Owner representatives in a factory training lab. This training shall be performed by a factory-certified professional trainer and, at a minimum, shall consist of:

    a. Two 8-hour days training covering basic system operation.
    b. One 8-hour day training covering system reporting and alarm management.
    c. One 8-hour day training of scheduling and point trending.

END OF SECTION 23 09 00

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SECTION 23 21 13

HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Makeup-water piping.
4. Blowdown-drain piping.
5. Air-vent piping.
6. Safety-valve-inlet and -outlet piping.

1.2 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:

1. Hot-Water Heating Piping: 125 psig at 200 deg F.
2. Chilled-Water Piping: 125 psig at 100 deg F.
3. Makeup-Water Piping: 80 psig at 100 deg F.
4. Blowdown-Drain Piping: 150 deg F.
5. Air-Vent Piping: 200 deg F.
6. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.3 SUBMITTALS

A. Product Data: Include manufacturer's product literature indicating materials of construction, ratings, options and accessories for each type of the following:

1. Pipe and fittings.
2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves, automatic flow-control valves, reduced-pressure-principle backflow preventers.
3. Air control devices.
4. Hydronic specialties.

B. Field quality-control test reports.

C. Operation and maintenance data.

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1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: Use the following types and grades. Wall thickness is indicated in Part 3 "Piping Applications" Article. Standard weight may be substituted for Schedule 40.

1. NPS 2-1/2 through 12: ASTM A53, Type E (electric-resistance welded), Grade B, black steel, plain ends.
2. NPS 4 and Larger: ASTM A53, Type E (electric-resistance welded), Grade B, black steel, plain ends.
3. Provide hot-dipped zinc coating where required.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article. Provide hot-dipped zinc coated as required to match adjacent piping.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article. Provide hot-dipped zinc coated as required to match adjacent piping.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article. Provide hot-dipped zinc coated as required to match adjacent piping.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article. Provide hot-dipped zinc coated to as required to match adjacent piping.

F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, hot-dipped zinc coating as required to match adjacent piping, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

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2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. Basis-of Design Product: Subject to compliance with requirements, provide product manufactured by Garlock.
2. ASME B16.21, metallic, spiral wound, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper with 15 percent silver content; or BAg-1, silver alloy for joining copper with bronze or steel.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Nipples: Galvanized- or electroplated-steel, or ductile iron nipple with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

2.5 VALVES

A. Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."

C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong Pumps, Inc.
    b. Bell & Gossett Domestic Pump; a division of ITT Industries.
    c. Griswold Controls.
    d. Taco.

2. Body: Bronze, ball, plug or globe type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.

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4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever or handwheel, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.

D. Cast-Iron, Ductile-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong Pumps, Inc.
    b. Bell & Gossett Domestic Pump; a division of ITT Industries.
    c. Griswold Controls.
    d. Taco.

2. Body: Cast-iron, ductile-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever or handwheel, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig.
11. Maximum Operating Temperature: 250 deg F.

E. Differential Pressure Control Valve: Pilot operated valve to maintain an adjustable differential pressure in a hydronic piping zone.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Tour & Andersson AB.

2. Differential Pressure Control Valve:

    a. Body: AMETAL or cast iron.
    b. Bonnet, Cone, Spindles: AMETAL.
    c. Stem Seals: EPDM O-rings.
    d. O-rings: EPDM rubber.
    e. Membrane: Reinforced EPDM or HNBR rubber.
    f. Spring: Stainless steel.
    g. End Connections: Threaded or flanged.
    h. Pressure Gage Connections: Integral seals for portable differential pressure meter.
    i. Handle Style: Plastic handwheel, with memory stop to retain set position.
    j. CWP Rating: Minimum 125 psig.
    k. Maximum Operating Temperature: 250 deg F.

3. Balancing Valve:

    a. Body: Cast- or ductile-iron globe pattern with calibrated orifice or venturi.

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b. Bonnet: AMETAL or ductile-iron.
c. Cone: AMETAL, bronze, or brass.
d. Spindle: AMETAL.
e. Seat Seals: EPDM O-rings.
f. End Connections: Threaded or flanged.
g. Pressure Gage Connections: Integral seals for portable differential pressure meter.
h. Handle Style: Plastic handwheel, with memory stop to retain set position.
i. CWP Rating: Minimum 125 psig.
j. Maximum Operating Temperature: 250 deg F.

4. Interconnection Tubing: Copper tube.

F. Diaphragm-Operated, Pressure-Reducing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump; a division of ITT Industries.
d. Conbraco Industries, Inc.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: stainless steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

G. Diaphragm-Operated Safety Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Bell & Gossett Domestic Pump; a division of ITT Industries.
d. Conbraco Industries, Inc.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: stainless steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.

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10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

H. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Conbraco Industries, Inc.
   b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
   c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 15 psig maximum, through middle third of flow range.
5. Pressure Loss at Design Flow Rate: 12 psig.
6. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
8. Configuration: Designed for horizontal, straight-through flow.
9. Accessories:

   a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
   b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
   c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

10. Strainer: Wye pattern type mounted upstream of inlet isolation valve. Bronze for NPS 2 and smaller and cast iron for NPS 2-1/2 and larger.

2.6 AIR CONTROL DEVICES

A. Manual Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump; a division of ITT Industries.
   d. Taco.

2. Body: Brass or Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/8.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 225 deg F.

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B. Automatic Air Vent:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump; a division of ITT Industries.
   d. Empire.
   e. Hoffman.
   f. Spirax Sarco.
   g. Taco.

2. Body: Brass or Bronze.
3. Internal Parts: Nonferrous.
4. Operation: Automatic float-principle.
5. Inlet Connection: NPS 1/2
6. Discharge Connection: NPS 1/4
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240 degrees F.

C. Bladder Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Aurora Pump; Division of Pentair Pump Group.
   d. Bell & Gossett Domestic Pump; a division of ITT Industries.
   e. Taco.

2. Tank: Bladder type, welded carbon-steel rated for 125-psig working pressure and 240 deg F maximum operating temperature. Factory tested and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Tank taps for system connection, drain and air pressure fitting.
4. Bladder: Replaceable, heavy-duty butyl rubber.
5. Provide lifting rings and floor mounting skirt.

D. Air Separators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Aurora Pump; Division of Pentair Pump Group.
   d. Bell & Gossett Domestic Pump; a division of ITT Industries.
   e. Spirax Sarco, Inc.
   f. Spirotherm, Inc.
   g. Taco.
   h. Wheatley; a division of Global Flow Products LLC.

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2. Centrifugal Air Separators:

   a. Body: Cast-iron or steel with tangential connections. Fabricated and labeled according to ASME Boiler and Pressure Vessel Code Section VIII, Division I.
   b. Body diameter shall be not less than three times the nominal inlet/outlet pipe diameter with a body volume for sufficient velocity reduction.
   c. Maximum Working Pressure: 125 psig.
   d. Maximum Operating Temperature: 250 degrees F.
   e. Air Collector Tube: Perforated stainless steel.

3. Coalescing Air Separators:

   a. Body: Cast iron body and cap for straight or angle flow.
   b. Internals: Stainless steel diffuser and coalescing media.
   c. Air Vent: Replaceable with brass body and non-ferrous internals mounted on top of separator body.
   d. Maximum Working Pressure: Up to 150 psig.
   e. Maximum Operating Temperature: Up to 250 deg F.

2.7 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong Pumps, Inc.
   b. Bell & Gossett ITT; Div. of ITT Fluid Technology Corp.
   c. Griswold Controls.
   d. Mueller Steam Specialty.
   e. Spirax Sarco Inc.

2. Body: Bronze with threaded gasketed cover and bottom drain connection, or ASTM A 126, Class B, cast iron or ductile iron with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
4. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
5. CWP Rating: 125 psig.

B. Stainless-Steel Bellow, Flexible Connectors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Flex-Hose Co., Inc.
   b. Flexonics.
   c. Metraflex.
   d. Twin City Hose.

2. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
3. End Connections: Threaded or flanged to match equipment connected.
4. Performance: Capable of 3/4-inch misalignment.
5. CWP Rating: 150 psig.
6. Maximum Operating Temperature: 250 deg F.

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C. Flexible Pump Connectors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Mason Industries.
   b. Metraflex Co.
   c. Proco Products, Inc.
   d. Vibration Mountings & Controls, Inc.

2. Body: Flexible, single- or double-sphere of EPDM liner and cover, Kevlar tire cord fractioning with steel ring embedded in raised face of rubber-flanged end. Provide ductile iron, external ring between double-spheres.
3. End Connections: Split ductile-iron or steel flanges with hooked interlocks.
4. Control Rods: Required where recommended by manufacturer or indicated on Drawings.
5. CWP Rating: 150 psig.
6. Maximum Operating Temperature: 250 degrees F.

D. Water Meter:

1. AWWA C700, oscillating-piston or nutating disc, magnetic-drive, totalization meter.
2. Body: Bronze.
3. Maximum Pressure Loss at Design Flow: 3 psig.
4. Registration: Gallons or cubic feet.
5. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.
6. Meter shall match size of adjacent piping.

E. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
2. Schedule 40 steel pipe, wrought-steel fittings and welded joints.

C. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

D. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
2. Schedule 40 steel pipe, wrought-steel fittings and welded joints.

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E. Makeup-water piping installed aboveground: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

F. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

G. Air-Vent Piping:

1. Inlet: Same as service where installed.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

H. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install throttling-duty valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves and shutoff-duty valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

G. Install reduced-pressure-principle backflow preventers at the connection between the domestic cold water system and the hydronic systems.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. 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.

D. Do not install hydronic piping within electrical rooms, elevator equipment rooms, MDF or IDF rooms, or stairwells. Exception: Pipe supplying equipment serving the room. Maintain all required clearances to other equipment.

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E. Do not install piping above electrical equipment such as transformers, panels, motor control centers, etc. in other rooms.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Install piping to permit valve servicing.

H. Install piping at indicated slopes.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Install piping to allow application of insulation.

L. Select system components with pressure rating equal to or greater than system operating pressure.

M. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

N. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

O. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

P. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

Q. Make branch connections to mains using flow tees where branch size is not less than 1/3 the diameter of the main. Weld-O-Lets and Thread-O-Lets, may be used in other applications. Hot-taps shall only be used to connect branch lines to live mains.

R. Unless otherwise indicated, install branch connections to mains with the branch connected to the top or side of the main pipe.

S. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

T. Install unions in piping, NPS 2 and smaller at final connections of equipment, and elsewhere as indicated.

U. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

V. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2. Install strainers with strainer basket facing downward to facilitate cleaning and blowdown.

W. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

X. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

Y. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

Z. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

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AA. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Vibration isolation devices are specified in Division 23 Section "Vibration Controls for HVAC Piping and Equipment."

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Wrap copper piping with not less than two layers of 10 mil. thick black plastic tape extending a minimum of 1 inch on each side of clamp for electrolytic protection where hangers or supports are in direct contact with copper piping.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
2. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
3. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.
4. NPS 6: Maximum span, 12 feet; minimum rod size, 1/2 inch.
5. NPS 8: Maximum span, 12 feet; minimum rod size, 5/8 inch.
6. NPS 10: Maximum span, 12 feet; minimum rod size, 3/4 inch.
7. NPS 12: Maximum span, 12 feet; minimum rod size, 7/8 inch.
8. NPS 14: Maximum span, 12 feet; minimum rod size, 1 inch.
9. NPS 16: Maximum span, 12 feet; minimum rod size, 1 inch.
10. NPS 18: Maximum span, 12 feet; minimum rod size, 1-1/4 inch.
11. NPS 20: Maximum span, 12 feet; minimum rod size, 1-1/4 inch.
12. NPS 24: Maximum span, 12 feet; minimum rod size, 1-1/4 inch.

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/4: Maximum span, 6 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
8. NPS 4: Maximum span, 10 feet; minimum rod size, 1/2 inch.
9. NPS 6: Maximum span, 10 feet; minimum rod size, 1/2 inch.
10. NPS 8: Maximum span, 10 feet; minimum rod size, 5/8 inch.
11. NPS 10: Maximum span, 10 feet; minimum rod size, 3/4 inch.
12. NPS 12: Maximum span, 10 feet; minimum rod size, 7/8 inch.

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F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints. Inserted tubing must be cut and dimpled.

I. Hot Taps:

1. Hot taps shall only be made on systems that cannot by isolated or shutdown and are not permitted in new construction.
2. The hot tap machine shall be provided with a depth gauge to prevent cutting of opposite pipe wall.
3. The hot tap machine shall be rated for the expected pressures and temperatures of the system being tapped.
4. Weld-o-lets, split tees, saddles, branch-o-lets, or nozzles shall be used on all hot taps. Full encirclement pads or split tees shall be used if the hot tap diameter is greater than 50% of the run pipe diameter.
5. Pipe coupons must be removed and not allowed to enter system. Return coupons to Owner.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

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B. Install automatic air vents in mechanical equipment rooms at high points of system piping, at heat transfer coils, at the air outlet on the air separator, and elsewhere as required for system air venting.

1. Provide shutoff valve on inlet side of each automatic air vent.
2. Provide drain piping from each automatic air vent outlet to nearest floor sink, mop sink or floor drain.

C. Install piping from air separator to expansion tank with a 2 percent upward slope toward air vent.

D. Install in-line air separators in pump suction NPS 1-1/2 and smaller and centrifugal air separators in NPS 2 through NPS 24. Install drain valve on air separators NPS 2 and larger.

E. Install bypass chemical feeders furnished by HVAC Water Treatment Contractor in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above the floor. Install feeder in minimum NPS 3/4 bypass circuit around circulating pumps. Install full-size, full-port, ball valves at inlet and outlet of feeder. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

F. Install test-coupon rack assembly by HVAC Water Treatment Contractor in each hydronic system where indicated. Install rack in minimum NPS 3/4 bypass line around circulating pumps. Install full-size, full-port, ball valves at inlet and outlet connections to rack.

G. Install expansion tanks where indicated on Drawings.

1. Charge tank to initial fill pressure.
2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install flexible connectors at the inlet and outlet of all moving equipment, except pumps or as indicated otherwise. Match size of adjacent pipe.

C. Install flexible pump connectors at the inlet and outlet of all pumps, except in-line pumps. Match size of adjacent pipe.

D. Install control valves in accessible locations close to connected equipment.

E. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

3.8 CLEANING AND CHEMICAL TREATMENT

A. During the cleaning process, maintain a minimum liquid velocity of 3 feet per second through piping systems. All manual, motorized or thermostatically operated valves are to be open during this process. All equipment such as boilers, chillers, etc., shall be off. All dead end runs shall be looped together with piping not less than 1/3 the size of the run. Remove or isolate the end-run piping loop at the completion of the chemical treatment process. When connecting new piping to an existing system the new piping shall be looped together with piping not less than 1/2 the size of the new mains to allow for cleaning

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before linking the two systems. Remove or isolate the piping loop at the completion of the chemical treatment process.

B. Fill system with fresh water, clean and passivate interior of piping systems using chemicals supplied by HVAC Water Treatment Contractor. Circulate chemicals for a minimum of 24 hours or longer as directed to remove oils, dirt, and other compounds detrimental to the proper operation of the system.

C. Flush piping system with clean water to remove cleaning chemicals and debris. Remove and clean strainer screens, flush mud and debris from drop legs and other low points.

D. Immediately after cleaning and flushing, refill system with fresh water and chemicals supplied by HVAC Water Treatment Contractor to inhibit corrosion. Circulate minimum of 2 hours.

E. Do not repeatedly fill and drain system without proper chemical treatment.

3.9 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 30 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).

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5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 23 21 13

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SECTION 23 21 15

HVAC DRAIN PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes pipe and fitting materials, and joining methods for HVAC drain piping including coil condensate drains.

1.2 PERFORMANCE REQUIREMENTS

A. Drain piping components and installation shall be capable of withstanding 5 psig at 150 deg F.

1.3 SUBMITTALS

A. Product Data: Include manufacturer's product literature indicating materials of construction, ratings, options and accessories for each type of the following:

1. Pipe and fittings.

B. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. DWV Copper Tubing: ASTM B 306, Type DWV.

C. Wrought-Copper Fittings: ASME B16.22.

D. Wrought-Copper Unions: ASME B16.22.

2.2 JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

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B. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

2.3 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Drain Piping: Type DWV or Type L (B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated piping locations and arrangements if such were used to size pipe. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. 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. Avoid routing piping on floor across walkways. Provide steel ramps over piping where floor mounted piping crosses walkways.

D. Do not install drain piping within electrical rooms, elevator equipment rooms, MDF or IDF rooms, or stairwells. Exception: Pipe serving equipment serving the room. Maintain all required clearances to other equipment.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping at a uniform grade of 1.0 percent downward towards drain outlet unless otherwise indicated.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install cleanouts fabricated with a tee fitting with a threaded plug at each change of direction to facilitate cleaning of pipe. Cleanout shall allow for cleaning in direction of flow.

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J. Install piping to allow application of insulation.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Reduce pipe sizes using concentric reducer fitting or eccentric reducer fitting installed with level side up.

M. Make branch connections to mains using flow tees.

N. Unless otherwise indicated, install branch connections to mains with the branch connected to the top or side of the main pipe.

O. Install unions in piping, NPS 2 and smaller at final connections of equipment, and elsewhere as indicated.

P. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

Q. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

R. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

3.3 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Vibration isolation devices are specified in Division 23 Section "Vibration Controls for HVAC Piping and Equipment."

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Wrap copper piping with not less than two layers of 10 mil. thick black plastic tape extending a minimum of 1 inch on each side of clamp for electrolytic protection where hangers or supports are in direct contact with copper piping.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/4: Maximum span, 6 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
8. NPS 4: Maximum span, 10 feet; minimum rod size, 1/2 inch.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

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3.4 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.5 TERMINAL EQUIPMENT CONNECTIONS

A. Install vented traps at cooling coil condensate pan connections. Size trap and connected piping the same as or larger than equipment connections.

B. Size trap to provide seal against fan static pressure.

3.6 FIELD QUALITY CONTROL

A. Prepare drain piping according to ASME B31.9 and as follows:

1. Leave joints uninsulated and exposed for examination during test.
2. Flush drain piping systems with clean water.
3. Isolate equipment from piping.

B. Perform the following tests on drain piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. Subject piping system to hydrostatic test pressure that is equal to 10 feet of water column or maximum that can be obtained based on installed conditions.
3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
4. Prepare written report of testing.

END OF SECTION 23 21 15

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SECTION 23 21 23

HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Close-coupled, in-line centrifugal pumps.
2. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.2 SUBMITTALS

A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:

1. Manufacturer and model number.
2. Rated capacity based on scheduled conditions.
3. Certified performance curves with operating point indicated.
4. Equipment dimensions.
5. Required clearances.
6. Electrical data.
    a. Motor horsepower
    b. Motor Voltage/Phase/Hz
7. Materials of construction.
8. Accessories and options.

B. Warranty information.

C. Operation and maintenance data.

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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

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PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. Bell & Gossett; Div. of ITT Industries.

2.2 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

B. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange or union end connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Steel, with copper-alloy shaft sleeve or Stainless steel.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N or EPT bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings.

C. Motor: Single speed, with permanently lubricated ball bearings for motors 5hp and smaller and grease-lubricated ball bearings, for motors larger than 5hp unless otherwise indicated; and rigidly mounted to pump casing. Select motor to be non-overloading throughout the entire pump curve at the scheduled operating conditions. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.3 SPLIT COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

B. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, and threaded companion-flange or union end connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Stainless steel.
4. Mechanical Seal:

    a. Closed Loop Systems: Internally flushed carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N or EPT bellows and gasket. Include water slinger on shaft between motor and seal.

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b. Open Loop Systems: Externally flushed carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N or EPT bellows and gasket. Include water slinger on shaft between motor and seal.

5. Throttle Bushing: Bronze or carbon graphite.

C. Shaft Coupling: Axially split spacer coupling.

D. Motor: Single speed, with permanently lubricated or grease-lubricated ball bearings, unless otherwise indicated; rigidly mounted to pump casing with lifting eye and supporting lugs in motor enclosure. Select motor to be non-overloading throughout the entire pump curve at the scheduled operating conditions. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.4 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 250 deg F.

B. Pump Construction:

1. Casing: Radially split, cast iron, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and threaded companion-flange or flanged connections. Provide integral mount on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Stainless steel.
4. Mechanical Seal:

   a. Closed Loop Systems: Internally flushed carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N or EPT bellows and gasket.
   b. Open Loop Systems: Externally flushed carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N or EPT bellows and gasket.

5. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

C. Shaft Coupling: Molded EPDM two-piece element with hubs. Element shall be replaceable without disassembly and removal of pump shaft or motor. Provide Woods Dura-Flex coupling or approved equal.

D. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

E. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

F. Motor: Single speed, with grease-lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Select motor to be non-overloading throughout the entire pump curve at the scheduled operating conditions. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

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2.5 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, 175-psig pressure rating, cast or ductile-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.

B. Triple-Duty Valve: Angle or straight pattern, 175-psig pressure rating, cast or ductile-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.

2.6 ACCESSORIES

A. Shaft Grounding Ring: Solid or split aluminum ring with carbon-fiber, electrically-conductive brushes designed to transmit stray electrical current from the motor shaft to the motor casing. Attach ring to motor with conductive epoxy or bolted brackets.

PART 3 - EXECUTION

3.1 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Support pumps as recommended by the manufacturer.

D. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

E. In-Line Pumps: Install continuous-thread hanger rods and hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section "Vibration Controls for HVAC Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

F. Base-Mounted Pumps:

1. Install on cast-in-place concrete equipment bases. Comply with requirements in Division 03.

   a. Coordinate sizes and locations of concrete bases with actual equipment provided.
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
   e. Construct concrete bases 4 inches high and extend base not less than 2 inches in all directions beyond the maximum dimensions of base-mounted pumps unless otherwise indicated or required.
   f. Minimum Compressive Strength: 4000 psi at 28 days.
   g. Mount pumps on isolation bases where required by Division 23 Section "Vibration Controls for HVAC Piping and Equipment." Install isolation bases on concrete bases.

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2. Disconnect couplings on separately coupled pumps before setting. Do not reconnect couplings until alignment procedure is complete.
3. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near anchor bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and concrete base for grouting.
4. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.2 ALIGNMENT

A. Engage a factory-authorized service representative to perform laser alignment services.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft of separately coupled pumps. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten anchor bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install check valve and shutoff valve on discharge side of pumps powered by variable frequency drives or as indicated on the drawings.

F. Install triple-duty valve on discharge side of pumps not powered by variable frequency drives or as indicated on the drawings.

G. Install Y-type strainer or suction diffuser with strainer screen, and shutoff valve on suction side of pumps as indicated on the drawings. Provide suction diffuser with strainer screen where pump does not have a minimum of five pipe diameters of straight piping leading into the pump inlet.

H. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

I. Install a single pressure gage with tubing and isolation valves to strainer inlet, pump suction and pump discharge at integral pressure-gage tapping.

J. Ground equipment according to Division 26.

K. Connect wiring according to Division 26.

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3.4 ADJUSTMENTS

A. During testing and balancing, at no additional cost to the Owner, coordinate with pump supplier to trim impeller as directed by the Test and Balance Contractor if pump flow exceeds 130% of scheduled flow.

END OF SECTION 23 21 23

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SECTION 23 22 13

STEAM & STEAM CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following for LP and HP steam and stream condensate piping:

1. Pipe and fittings.
2. Strainers.
3. Flash tanks.
4. Safety valves.
5. Pressure-reducing valves.
6. Steam traps.
7. Thermostatic air vents and vacuum breakers.

1.2 DEFINITIONS

A. HP Systems: High-pressure piping operating at more than 15 psig as required by ASME B31.1.

B. LP Systems: Low-pressure piping operating at 15 psig or less as required by ASME B31.9.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:

1. HP Steam Piping: 150 psig.
2. LP Steam Piping: 15 psig.
3. Condensate Piping: 150 psig at 250 deg F.
4. Makeup-Water Piping: 80 psig at 150 deg F.
5. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
6. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
7. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

1.4 SUBMITTALS

A. Product Data: Provide manufacturer's product data for each type of the following:

1. Pipe, fittings, and joining materials and methods.
2. Valves.
3. Strainers.
4. Pressure-reducing and safety valve.
5. Steam trap.
6. Air vent and vacuum breaker.
7. Flash Tank.

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8. Meters.
9. Data to be specific to the product proposed for the project with all options and accessories indicated. Include the following as a minimum:

    a. Manufacturer and model number.
    b. Rated capacity based on scheduled conditions and project elevation.
    c. Equipment dimensions.
    d. Required clearances.
    e. Electrical data.

        1) Motor horsepower
        2) Voltage/Phase/Hz
        3) Full load ampacity, minimum circuit ampacity and maximum overcurrent protection device requirements.
        4) Electrical service point(s) of connection.

    f. Materials of construction.
    g. Accessories and options.

B. Warranty information.

C. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals

1.5 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. Wrought-Copper Fittings and Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 106, ASTM A 53, black steel, plain ends, Type, Grade, and Schedule as indicated in Part 3 piping applications articles.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in Part 3 piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in Part 3 piping applications articles.

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D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 piping applications articles.

E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.

F. Stainless-Steel Bellows, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. Basis-of-Design Product: Subject to compliance with requirements, provide products by Flexitallic.
2. ASME B16.21, nonmetallic, spiral wound flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper, 15 percent silver content; or BAg-1, silver alloy for joining copper with bronze or steel.

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

E. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:

1. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

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2.5 VALVES

A. Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Stop-Check Valves:

1. Body and Bonnet: Malleable iron.
2. End Connections: Flanged.
3. Disc: Cylindrical with removable liner and machined seat.
4. Stem: Brass alloy.
5. Operator: Outside screw and yoke with cast-iron handwheel.
6. Packing: Polytetrafluoroethylene-impregnated packing with two-piece packing gland assembly.
7. Pressure Class: 250.

2.6 SAFETY VALVES

A. Bronze Safety Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Armstrong International, Inc.
    b. Kunkle Valve; a Tyco International Ltd. Company.
    c. Spirax Sarco, Inc.
    d. Watts Water Technologies, Inc.
2. Disc Material: Forged copper alloy.
3. End Connections: Threaded inlet and outlet.
4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

B. Cast-Iron Safety Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Armstrong International, Inc.
    b. Kunkle Valve; a Tyco International Ltd. Company.
    c. Spirax Sarco, Inc.
    d. Watts Water Technologies, Inc.
2. Disc Material: Forged copper alloy with bronze nozzle.
3. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
4. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.

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7. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.
8. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.7 STRAINERS

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 100 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
4. Tapped blowoff plug.
5. CWP Rating: 250-psig working steam pressure.

2.8 PRESSURE-REDUCING VALVES

A. Basic-of Design: Subject to compliance with requirements, provide Fisher type 92B.

B. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.

C. Description: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff.

D. Body: Cast iron.

E. End Connections: Threaded connections for valves NPS 2 and smaller and flanged connections for valves NPS 2-1/2 and larger.

F. Trim: Hardened stainless steel.

G. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.

H. Gaskets: Non-asbestos materials.

2.9 STEAM TRAPS, AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. TLV.

2. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
3. Trap Type: Balanced-pressure.
4. Bellows: Stainless steel or monel.
5. Head and Seat: Replaceable, hardened stainless steel.
6. Pressure Class: 125.

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B. Float and Thermostatic Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. TLV.

2. Body and Bolted Cap: ASTM A 126, cast iron.
3. End Connections: Threaded.
4. Float Mechanism: Replaceable, stainless steel.
5. Head and Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless steel cage, valve, and seat.
10. Maximum Operating Pressure: 125 psig.

C. Inverted Bucket Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Armstrong International, Inc.

2. Body and Cap: Cast iron.
3. End Connections: Threaded.
4. Head and Seat: Stainless steel.
5. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
6. Bucket: Brass or stainless steel.
7. Strainer: Integral stainless-steel inlet strainer within the trap body.
8. Air Vent: Stainless-steel thermostatic vent.
9. Pressure Rating: 250 psig.

D. Thermostatic Air Vents:

1. Body: Cast iron, bronze, or stainless steel.
2. End Connections: Threaded.
3. Float, Valve, and Seat: Stainless steel.
4. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
5. Pressure Rating: 125 psig.
6. Maximum Temperature Rating: 350 deg F.

E. Vacuum Breakers:

1. Body: Cast iron, bronze, or stainless steel.
2. End Connections: Threaded.
3. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
4. O-ring Seal: EPR.
5. Pressure Rating: 125 psig.
6. Maximum Temperature Rating: 350 deg F.

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PART 3 - EXECUTION

3.1 HP STEAM PIPING APPLICATIONS

A. HP Steam Piping, NPS 2 and Smaller: Schedule 40, Type S, Grade B, steel pipe; Class 250 cast-iron fittings; and threaded or welded joints.

B. HP Steam Piping, NPS 2-1/2 through NPS 12: Schedule 80, Type S, Grade B, steel pipe; Class 150 wrought-steel fittings, and welded joints.

C. Condensate piping above grade, NPS 2 and smaller, shall be the following: Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

D. Condensate piping above grade, NPS 2-1/2 and larger, shall be the following: Schedule 80, Type S, Grade B, steel pipe; Class 150 wrought-steel fittings, and welded joints.

E. Condensate piping below grade, NPS 2 and smaller, shall be the following: Schedule 80, Type S, Grade B, steel pipe; Class 250 cast-iron fittings; and threaded joints.

F. Condensate piping below grade, NPS 2-1/2 and larger, shall be the following: Schedule 80, Type S, Grade B, steel pipe; Class 150 wrought-steel fittings, and welded joints.

3.2 LP STEAM PIPING APPLICATIONS

A. LP Steam Piping: Schedule 40, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. Condensate Piping above Grade: Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

C. Condensate Piping below Grade: Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

3.3 ANCILLARY PIPING APPLICATIONS

A. Makeup-water piping installed above grade shall be the following:

1. Drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

B. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

C. Air-Vent Piping:

1. Inlet: Same as service where installed.
2. Outlet: Type K annealed-temper copper tubing with soldered or flared joints.

D. Vacuum-Breaker Piping: Outlet, same as service where installed.

E. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

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3.4 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.5 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. 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.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to top of main pipe.

P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

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Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as required for proper system operation and as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

U. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

V. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.

1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 200 feet.
2. Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced, but to no less than NPS 4.

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

3.6 STEAM-TRAP INSTALLATION

A. Install steam traps in accessible locations as close as possible to connected equipment.

B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.7 PRESSURE-REDUCING VALVE INSTALLATION

A. Install pressure-reducing valves in accessible location for maintenance and inspection.

B. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.

C. Install shut-off valves on both sides of pressure-reducing valves.

D. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections respectively.

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E. Install pressure gages on low-pressure side of pressure-reducing valves after the bypass connection according to Division 23 Section "Meters and Gages for HVAC Piping."

F. Install strainers upstream for pressure-reducing valve.

G. Install safety valve downstream from pressure-reducing valve station.

3.8 STEAM OR CONDENSATE METER INSTALLATION

A. Install meters with lengths of straight pipe upstream and downstream according to steam meter manufacturer's instructions.

B. Provide data acquisition wiring.

3.9 SAFETY VALVE INSTALLATION

A. Install safety valves according to ASME B31.9, "Building Services Piping."

B. Pipe safety-valve discharge without valves to atmosphere outside the building.

C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.

D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.10 HANGERS AND SUPPORTS

A. Install hangers and supports according to Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with requirements below for maximum spacing.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 9 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 9 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 12 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 12 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 12 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 4 feet; minimum rod size, 1/4 inch.
2. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.

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3. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
4. NPS 1-1/4: Maximum span, 6 feet; minimum rod size, 3/8 inch.
5. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
7. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.11 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube ends. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube," using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12 using qualified processes and welding operators.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.12 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

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3.13 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.9, "Building Services Piping," and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush system with clean water. Clean strainers.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Perform the following tests on steam and condensate piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

C. Prepare written report of testing.

END OF SECTION 23 22 13

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SECTION 23 22 23

STEAM CONDENSATE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes electric-driven and steam-driven steam condensate pumps.

1.2 SUBMITTALS

A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:

1. Manufacturer and model number.
2. Rated capacity based on scheduled conditions and project elevation.
3. Equipment dimensions.
4. Required clearances.
5. Electrical data.
    a. Motor horsepower
    b. Voltage/Phase/Hz
    c. Full load ampacity, minimum circuit ampacity and maximum overcurrent protection device requirements.
    d. Electrical service point(s) of connection.
    e. AIC rating of the equipment.
6. Materials of construction.
7. Accessories and options.
8. Controls.

B. Warranty information.

C. Operation and maintenance data.

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. ASME Compliance: Fabricate and label steam condensate pumps to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

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PART 2 - PRODUCTS

2.1 ELECTRIC-DRIVEN STEAM CONDENSATE PUMPS

A. Manufacturers: Subject to compliance with requirements provide products from the following:

1. Bell & Gossett; Div. of ITT Industries.

B. Configuration: Duplex floor-mounting pumps with receiver and float switches; rated to pump minimum 210 deg F steam condensate.

1. Receiver: Floor-mounting, close-grained cast iron or welded steel; externally adjustable float switches; with water-level gage, steam condensate thermometer, discharge-pressure gage for each pump, bronze gate valves between receiver and pumps, flanges for pump mounting, and lifting eyebolts.
2. Inlet Strainer: Cast iron with self-cleaning bronze screen, dirt pocket, and cleanout plug on receiver inlet.
3. Pumps: Centrifugal, close coupled, vertical design, permanently aligned, and bronze fitted; with replaceable bronze case rings, stainless-steel shafts, and mechanical seals; mounted on receiver flanges; rated to operate with a minimum of 2 feet of NPSH.
4. Control Panel: NEMA 250, Type 1 enclosure with hinged door and grounding lug, mounted on stand; factory wired for single external electrical connection; and with the following components within cabinet:

    a. Motor controller for each pump.
    b. Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
    c. Manual lead-lag control to override electrical pump alternator to manually select the lead pump.
    d. Momentary contact "TEST" push button on cover for each pump.
    e. Numbered terminal strip.
    f. Disconnect switch.
    g. Fused transformer for control circuit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install electrically-driven pumps according to HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

B. Install electrically-driven pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Support pumps and piping separately so piping is not supported by pumps.

D. Install assemblies on concrete base. Anchor assemblies to bases using inserts or anchor bolts.

E. Install thermometers and pressure gages.

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3.2 CONNECTIONS

A. Install piping adjacent to machine to allow service and maintenance.

B. Install check valve and globe valve at pump discharge connections for each electric-driven pump.

C. Pipe drain to nearest floor drain for overflow and drain piping connections.

D. Install full-size vent piping to outdoors, terminating in 180-degree elbow at point above highest steam system connection or as indicated.

END OF SECTION 23 22 23

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SECTION 23 25 00

HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following HVAC water-treatment systems:

1. Closed-loop chemical feed systems.
2. HVAC water-treatment chemicals.

1.2 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, and requirements and guidelines of authorities having jurisdiction.

C. Closed-loop hydronic systems shall have the following water qualities:

1. pH: Maintain a value within 8.3 to 9.5.
2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
3. Boron: Maintain a value within 100 to 200 ppm.
4. Chemical Oxygen Demand for Non-Glycol Systems: Maintain a maximum value of 100 ppm.
5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
6. TDS: Maintain a maximum value of 1500 ppm.
7. Ammonia: Maintain a maximum value of 20 ppm.
8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
9. Microbiological Limits:

a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

1.3 SUBMITTALS

A. Product Data: For each type of product or chemical indicated. Include pretreatment and chemical treatment equipment showing tanks, maintenance space required, electrical requirements, and piping connections to HVAC systems.

1. Wiring Diagrams: Power and control wiring.

B. Material Safety Data Sheets for all chemicals.

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C. Field quality-control test reports.

D. Other Informational Submittals:

1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
2. Water Analysis: Illustrate water quality available at Project site.
3. Loop Cleaning confirmation Report: Verify proper cleaning of the hydronic loops and confirm this observation in a letter to the Engineer.

1.4 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

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 WARRANTY

A. Special Guarantee: Provide a guarantee that the treated systems will remain scale and algae free for a period of two years when the provided chemicals are used as directed. If scaling or fouling occurs when the provided chemicals are used as directed the Water Treatment Firm shall clean the system(s) at no cost to the Owner.

B. Provide all parts, chemicals, and labor required to maintain the chemical treatment systems in good working order during the warranty period.

PART 2 - PRODUCTS

2.1 PROVIDERS

A. Approved Providers: Engage the services of the NAU approved provider.

2.2 CLOSED-LOOP CHEMICAL TREATMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.

1. Capacity: 5 gal.
2. Minimum Working Pressure: 125 psig.

B. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH and inhibitor concentrations.

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C. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

1. Two-station rack for closed-loop systems.
2. Provide 8, pre-weighed C1010 mild steel coupons and 8, pre-weighed CDA 110 copper coupons.

D. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.

1. Cleaner: Alkaline based cleaner designed for the removal of oil, corrosion and other contaminants from closed loop piping systems and equipment, and to form passivating film to protect against corrosion. The clean shall contain the following as a minimum:

   a. Polyphosphonate: Mild Steel Corrosion Inhibitor
   b. Tolyltriazole (TT): Yellow Metal Corrosion Inhibitor
   c. Polymer: Dispersant & Oil Emulsifier

2. Corrosion Inhibitor: Designed to prevent corrosion in closed loop piping and containing the following:

   a. Nitrite: Mild Steel Corrosion Inhibitor
   b. Molybdate: Mild Steel Corrosion Inhibitor
   c. Tolyltriazole (TT): Yellow Metal Corrosion Inhibitor
   d. Polymer Control: General Dispersant & Deposition
   e. Inert Chemical Tracer: Testing, Monitoring & Online Control

3. Closed Loop Biocide: Provide a non-oxidizing biocide for quarterly treatment of each closed loop system. This biocide shall be Glutaraldehyde.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Furnish to and coordinate with Mechanical Contractor all items specified herein that are installed in piping systems.

B. Install water testing equipment on wall near water chemical application equipment.

C. Install test equipment and provide test-kit to Owner. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.

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3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings.

D. Unless otherwise indicated, connect piping with unions and shut-off valves to allow equipment to be disconnected without draining piping.

E. Install shutoff valves on HVAC water-treatment equipment inlet and outlet.

3.4 CLEANING

A. Provide cleaner to Mechanical Contractor as required to maintain the manufacturer's recommended concentration for cleaning of the hydronic systems.

B. Supervise cleaning of the hydronic systems to ensure the following:

1. The cleaning solution is circulated a minimum of 24 hours or longer as required to thoroughly clean the interior of the piping systems.
2. The system is drain and flushed until all cleaning chemicals and suspended materials have been removed from the system.

3.5 CHEMICAL ADDITION

A. Closed Loop Systems:

1. Immediately after system testing, cleaning and flushing, add the required amount of corrosion inhibitor to reach the manufacturer's recommended concentration or the following.

a.	Chilled Loop Molybdate:	62 – 125 ppm as MoO_4
b.	Chilled Loop Nitrite:	250 – 500 ppm as NO_2
c.	Hot Loop Molybdate:	125 – 187 ppm as MoO_4
d.	Hot Loop Nitrite:	500 – 750 ppm as NO_2

2. Install the corrosion coupons in the coupon rack after the initial chemical addition.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

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B. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials and retest piping until no leaks exist.

C. At one-week intervals during the warranty period, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" Article.

D. Corrosion Coupons:

1. Remove and replace the corrosion coupons at 90 day intervals during the warranty period.
2. Deliver the removed coupons to a certified laboratory for testing.
3. Return the coupons and certified analysis to the Owner's representative.
4. If the coupons from the closed loop system(s) show any noticeable metal loss the system water shall be tested and the appropriate action taken to prevent additional metal loss.

E. Comply with ASTM D 3370 and with the following standards:

1. Silica: ASTM D 859.
2. Acidity and Alkalinity: ASTM D 1067.
3. Iron: ASTM D 1068.
4. Water Hardness: ASTM D 1126.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Division 01 Section "Demonstration and Training."

B. Review manufacturer's safety data sheets for handling of chemicals.

C. Train Owner's maintenance personnel in performing on-site testing of water samples.

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3.8 SUPPLIES

A. Provide all chemicals, testing supplies, log sheets, laboratory analysis, and other consumables required to maintain the proper chemical balance in the system(s) during the warranty period.

END OF SECTION 23 25 00

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SECTION 23 25 01

GLYCOL FEED SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes a complete, assembled glycol feed system complete with tanks, pump, controls, frame, piping, etc.

1.2 SUBMITTALS

A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:

1. Manufacturer and model number.
2. Rated capacity based on scheduled conditions.
3. Equipment dimensions.
4. Required clearances.
5. Electrical data.
    a. Motor horsepower
    b. Voltage/Phase/Hz
    c. Full load ampacity, minimum circuit ampacity and maximum overcurrent protection device requirements.
    d. Electrical service point(s) of connection.
    e. AIC rating of the equipment.
6. Materials of construction.
7. Accessories and options.
8. Controls.

B. Warranty information.

C. Operation and maintenance data.

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.

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PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. Advantage Controls.
2. J. L. Wingert Company.
3. John Wood Company.
4. Neptune Chemical Pump Company.

2.2 GLYCOL FEED SYSTEM

A. Tank: Translucent, polyethylene tank with fluid scale on side, minimum 50 gallon capacity, with cover and fill port.

B. Stand: Painted, welded steel designed to support tank, pump controls and piping. Provided with bolt pads for securing system to mounting pad.

C. Pump: Bronze rotary gear pump with a capacity of 1.5 gallons per minute at a pressure of 100 PSI. Pump shall be mounted below the tank.

D. Pump Discharge Manifold: All steel or brass construction complete with pump isolation valve, pressure gauge, check valve, and brass relief valve. Relief valve outlet to be piped to top of tank.

E. Pump Intake Piping: Steel or PVC pipe and fittings complete with strainer and ball valve.

F. Control Panel: NEMA 4X sized with main power switch, pump hand/off/auto switch and indicator light, low-level indicator light, contactor for building automation system monitoring of low-level alarm. Panel to be mounted to stand.

G. Wiring: All system wiring to be contained in conduit. No exposed wiring is permitted.

H. Controls: Low level switch to monitor tank fluid level and disable pump on low fluid level. Pressure switch to start/stop pump based on pressure in system piping loop.

PART 3 - EXECUTION

3.1 FEED SYSTEM INSTALLATION

A. Install system with access for periodic maintenance and filling.

B. Install on cast-in-place concrete equipment bases. Comply with requirements in Division 03.

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

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5. Construct concrete bases 4 inches high and extend base not less than 2 inches in all directions beyond the maximum dimensions of base-mounted pumps unless otherwise indicated or required.
6. Minimum Compressive Strength: 4000 psi at 28 days.

C. Set pump cut-off pressure 10 psi higher than pressure reducing valve setpoint indicated on drawings.

D. Set pump cut-in pressure minimum 20 psi higher than cut-off pressure.

E. Label tank with contained solution.

F. Fill tank with proper solution.

3.2 CONNECTIONS

A. Connect glycol feed system discharge piping to closed loop pressure reducing valve using minimum 3/4 inch piping or size as indicated on drawings.

B. Ground equipment according to Division 26.

C. Connect wiring according to Division 26.

3.3 FIELD QUALITY CONTROL

A. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set for required system pressure.
4. Fill tank with proper solution.

END OF SECTION 23 25 01

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SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular rigid ducts and fittings.
2. Round rigid ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

1.2 PERFORMANCE REQUIREMENTS

A. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Provide the following for each duct application and pressure classification: metal gauge, construction methods, reinforcement details and spacing, hangers and support details, seam and joint types. Include manufacturer, description of material, locations for use, R-value, and thickness for duct liner.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that duct systems comply with the latest addition of ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with the latest addition of ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
3. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with the latest addition of ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-Up."
4. Product Data for Credit IEQ 4.1: For adhesives and sealants, including printed statement of VOC content.

C. Welding certificates.

1.4 QUALITY ASSURANCE

A. 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 D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

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B. ASHRAE Compliance: Applicable requirements in the latest addition of ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in the latest addition of ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 RECTANGULAR RIGID 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. Duct sizes shown on drawings are clear, inside dimensions. Adjust sizes of sheet metal ductwork to account for duct lining.

C. Transverse Joints: Fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," or manufacturer's instructions 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." Select joint types from the following:

1. Flat Drive Slip.
2. Standing Drive Slip.
3. Companion, Angle-Van Stone Type.
4. Flanged, formed or one of the following manufactured products:

    a. Ductmate or WDCI by Ductmate Industries, Inc.
    b. Elgen- or J-Flange by Elgen Manufacturing.
    c. FLG J or H by Ward Industries; a division of Hart & Cooley, Inc.
    d. J Flange by CL Ward & Family, Inc.
    e. J Flange by Nexus PDQ; Division of Shilco Holdings Inc.

D. Longitudinal Seams: 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." Select seam type based on the following:

1. Duct with Static Pressure 2-Inch wg and Less: Pittsburg lock hammered flat or button punch snap lock. Do not use button punch snap lock on aluminum duct.
2. Duct with Static Pressure Greater Than 2-Inch wg: Pittsburg lock hammered flat.

E. Elbows: Fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2 "Rectangular Elbows." Comply with requirements for indicated static-pressure class, sealing requirements, support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Select elbows from the following types:

1. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3. Mitered Type RE 2 with single thickness turning 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."

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F. Branches: Fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-5 "Divided Flow Branches" and Figure 2-6 "Branch Connections." Comply with requirements for indicated static-pressure class, sealing requirements, support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Select branch connections from the following types:

1. Rectangular Main to Rectangular Branch: 45-degree entry.
2. Rectangular Main to Round Branch: Conical or 45-degree lead in.

G. Transitions, Offsets, 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 ROUND RIGID DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Duct sizes shown on drawings are clear, inside dimensions. Adjust sizes of sheet metal ductwork to account for duct lining.

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," 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."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged or one of the following manufactured products:

    a. SpiralFlange by CL Ward & Family, Inc.

D. Longitudinal Seams: Select a snaplock seam type for straight seam ductwork and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," 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."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

E. Elbows: Fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3 "Round Duct Elbows." Comply with requirements for indicated static-pressure class, sealing requirements, support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Minimum Radius-to-Diameter Ratio shall be 1.5.
2. Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
3. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
4. Round Elbows, 14 Inches and Larger in Diameter: Welded.

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F. Tees and Laterals: Fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Comply with requirements for indicated static-pressure class, sealing requirements, support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Select tees and laterals based on the following:

1. Velocity Up to 1500 fpm: Conical tap.
2. Velocity 1500 fpm or Higher: 45-degree lateral.

2.3 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.
3. Minimum thickness: 24 gauge.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

D. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

F. Tie Rods: Galvanized steel, stainless steel, or aluminum to match duct material, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed Corporation; Insulation Group.
b. Johns Manville.
c. Knauf Insulation.
d. Owens Corning.

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2. Maximum Thermal Conductivity:

   a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
   b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

   a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Mechanical Fasteners:

1. Metal, Capacitor-Discharge-Weld Pin, Insulation Hangers: Copper-coated, low carbon steel, or stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated. May be provided with base.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
3. Metal, Cupped-Head, Capacitor-Discharge-Weld Pins:

   a. Head: Galvanized, carbon-steel or stainless steel sheet, minimum of 0.016-inch-thick with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   b. Spindle: Copper- or zinc-coated, low carbon steel, or stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

C. Shop Application of Fibrous-Glass Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

1. Duct sizes shown on drawings are clear, inside dimensions. Adjust sizes of sheet metal ductwork to account for duct lining.
2. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
3. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
4. Butt transverse joints without gaps, and coat joint with adhesive.
5. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
6. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
7. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
8. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
9. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

   a. Fan discharges.
   b. Intervals of lined duct preceding unlined duct.

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c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 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. Polymer Joint and Seam Sealant:

1. Application Method: Pump applied during duct forming or assembly.
2. Solids Content: Minimum 90 percent.
3. Water resistant.
4. Mold and mildew resistant.
5. Non-skinning, non-drying.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor or outdoor.
8. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

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: 10-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.

D. 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).

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

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.

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2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Strap and Rod Sizes: 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."

C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

D. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

G. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

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.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

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H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. 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.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

L. 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. Fabricate exposed ductwork with internal seam sealant.

C. Construct joints with internal sealing elements.

D. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

E. 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.

F. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

G. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. All Ductwork: Seal Class A.
2. All joints, wall penetrations, and seams to be externally sealed even if internal sealant is applied during duct forming and fabrication, except for exposed ductwork.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.

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2. Install powder-actuated concrete fasteners after concrete is placed and completely cured and as directed by structural engineer.

C. 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.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. 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 intervals of 16 feet.

F. 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 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and requirements herein for branch, outlet and inlet, and terminal unit connections.

3.6 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 "Air 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.

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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 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.

3.7 START UP

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

3.8 DUCT SCHEDULE

A. Fabricate rigid ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Underground Ducts: Concrete-encased, PVC-coated, galvanized sheet steel with thicker coating on duct exterior.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Air-Conditioners, Heat Pumps, and Terminal Units.

    a. Pressure Class: Positive 2-inch wg.
    b. Minimum SMACNA Seal Class: See Article 3.4 "Duct Sealing".
    c. SMACNA Leakage Class for Rectangular: 24.
    d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Constant-Volume Air-Handling Units:

    a. Pressure Class: Positive 2-inch wg.
    b. Minimum SMACNA Seal Class: See Article 3.4 "Duct Sealing" SMACNA Leakage Class for Rectangular: 12.
    c. SMACNA Leakage Class for Round and Flat Oval: 6.

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3. Ducts Connected to Variable-Air-Volume Air-Handling Units:

   a. Pressure Class: Positive 3-inch wg.
   b. Minimum SMACNA Seal Class: See Article 3.4 "Duct Sealing".
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round and Flat Oval: 3

4. Ducts Connected to Equipment Not Listed Above:

   a. Pressure Class: Positive 2-inch wg.
   b. Minimum SMACNA Seal Class: See Article 3.4 "Duct Sealing".
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 6.

C. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Air-Conditioners, Heat Pumps, and Terminal Units:

   a. Pressure Class: Positive or negative 1-inch wg.
   b. Minimum SMACNA Seal Class: See Article 3.4 "Duct Sealing".
   c. SMACNA Leakage Class for Rectangular: 24.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Air-Handling Units:

   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: See Article 3.4 "Duct Sealing".
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Equipment Not Listed Above:

   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: See Article 3.4 "Duct Sealing".
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 6.

D. 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: See Article 3.4 "Duct Sealing".
   c. SMACNA Leakage Class for Rectangular: 24.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Air-Handling Units:

   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: See Article 3.4 "Duct Sealing" 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.

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3. Ducts Connected to Equipment Not Listed Above:

   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round and Flat Oval: 3.

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

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

   a. Pressure Class: Positive or negative 1-inch wg.
   b. Minimum SMACNA Seal Class: See Article 3.4 "Duct Sealing".
   c. SMACNA Leakage Class for Rectangular: 24.
   d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Air-Handling Units:

   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: See Article 3.4 "Duct Sealing".
   c. SMACNA Leakage Class for Rectangular: 12.
   d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Equipment Not Listed Above:

   a. Pressure Class: Positive or negative 2-inch wg.
   b. Minimum SMACNA Seal Class: See Article 3.4 "Duct Sealing".
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round and Flat Oval: 6.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
2. PVC-Coated Ducts:

   a. Exposed to Airstream: Match duct material.
   b. Not Exposed to Airstream: Match duct material.

3. Stainless-Steel Ducts:

   a. Exposed to Airstream: Match duct material.
   b. Not Exposed to Airstream: Match duct material.

4. Aluminum Ducts: Aluminum.

G. Duct Liner: Furnish ducts with duct liner for the following applications unless noted otherwise on the drawings:

1. Rectangular Supply and Return Air Ducts Within the Building Envelope: Fibrous glass, Type I, 1-1/2 inches thick with a minimum R-value of 6.
2. Rectangular Supply and Return Air Ducts Outside the Building Envelope: Fibrous glass, Type I, 2 inches thick with a minimum R-value of 8.
3. Rectangular Exhaust Air Ducts Within the Building Envelope: Fibrous glass, Type I, 1/2 inch thick.

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4. Supply and Return Fan Plenums Within the Building Envelope: Fibrous glass, Type II, 1-1/2 inches thick with a minimum R-value of 6.
5. Supply and Return Fan Plenums Outside the Building Envelope: Fibrous glass, Type II, 2 inches thick with a minimum R-value of 8.
6. Transfer Ducts: Fibrous glass, Type I, 1/2 inch thick.

7. Exception: Do not line ductwork connected to evaporative coolers, ductwork connected to kitchen hoods, outside air intakes, ductwork serving shower areas, or combustion air ducts.

END OF SECTION 23 31 13

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SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Fire dampers.
5. Combination fire/smoke dampers.
6. Flange connectors.
7. Turning vanes.
8. Duct-mounted access doors.
9. Flexible connectors.
10. Flexible ducts.

1.2 SUBMITTALS

A. Product Data: Provide manufacturer's product data for each duct accessory intended for use on this project. Data to be specific to the items proposed for the project with all options and accessories indicated. Include the following as a minimum:

1. Manufacturer and model number.
2. Dimensions.
3. Electrical data for damper motor operators including voltage and motor ampacity.
4. Materials of construction.
5. Accessories and options.
6. Installation details for fire, and combination fire/smoke dampers for each application intended for this project.

B. LEED Submittal:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with the latest addition of ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Test reports for combination fire/smoke dampers.

D. Warranty information.

E. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

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B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 MATERIALS

A. 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. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. 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.

2.2 DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.
2. Elgen Manufacturing.
3. Greenheck Fan Corporation.
4. McGill Airflow LLC.
5. Metal Form.
6. National Controlled Air.
7. Nailor Industries Inc.
8. Pottorff.
9. Ruskin Company.
10. Safe-Air-Dowco.
11. Vent Products Company, Inc.
12. Young Regulator Company.

B. Backdraft and Pressure Relief Dampers:

1. Description: Counterbalanced.
2. Maximum Air Velocity: 2000 fpm.
3. Static Pressure Range: 0.01 to 0.10-inch wg.

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4. Frame: Hat-shaped, minimum 0.052-inch-thick, galvanized sheet steel, 0.063-inch-thick extruded aluminum or 0.052-inch-thick stainless steel, with welded corners and mounting flange.
5. Blades: Multiple single-piece blades, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum or 0.050-inch-thick aluminum sheet with sealed edges. Blade material shall match frame material.
6. Blade Action: Parallel.
7. Blade Seals: Extruded vinyl or neoprene mechanically locked.
8. Blade Axles:

    a. Material: Galvanized steel, stainless steel or aluminum to match frame and blades.
    b. Diameter: Minimum 0.20 inch.

9. Tie Bars and Brackets: Aluminum or galvanized steel to match axles.
10. Bearings: Steel ball or synthetic pivot bushings.
11. Counterweights: Adjustable for varying differential static pressure as well as horizontal and vertical airflow.

C. Manual Volume Dampers:

1. Rectangular:

    a. Factory fabricated for shut-off or balancing duty in branch ducts:

        1) Standard leakage rating, with linkage outside airstream.
        2) Suitable for horizontal or vertical applications.
        3) Frames:

            a) Hat-shaped, galvanized-steel or aluminum channels.
            b) Mitered and welded corners.
            c) Flanges for attaching to walls and flangeless frames for installing in ducts.

        4) Blades:

            a) Multiple with maximum blade width of 8 inches.
            b) Opposed-blade design.
            c) Stiffen damper blades for stability.
            d) Galvanized-steel, 0.064 inch thick or aluminum 0.10 inch thick to match frame.

        5) Blade Axles: Galvanized steel or aluminum to match frame and blades.
        6) Bearings:

            a) Oil-impregnated bronze or molded synthetic.
            b) Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

        7) Tie Bars and Brackets: Galvanized steel or aluminum to match frame and blades.
        8) Jackshaft:

            a) Size: 1-inch diameter.

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b) Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
c) Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

9) Damper Hardware:

a) Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
b) Include center hole to suit damper operating-rod size.
c) Include elevated platform for insulated duct mounting.

b. Shop and field fabricated for balancing duty in duct run-outs serving a single diffuser, grille or register:

1) Blade: Single blade volume damper constructed per SMACNA standards.
2) Handle: Stamped or cast metal configured to indicate damper position in duct. Provide extension to raise handle above duct insulation and locking device such as wing nut to secure extension device to side of damper bearing and duct, or standoff with locking quadrant to secure damper in position.

2. Round:

a. Factory fabricated for shut-off or balancing duty in branch ducts:

1) Standard leakage rating.
2) Suitable for horizontal or vertical applications.
3) Frames: Galvanized-steel channel.
4) Blades: Galvanized steel, minimum 16 gauge.
5) Blade Axles: Plated steel extending minimum 6 inches beyond frame.
6) Bearings: Nylon sleeve with stainless steel thrust washers.
7) Stops: Plated screw for both open and closed positions.
8) Damper Hardware:

a) Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
b) Include center hole to suit damper operating-rod size.
c) Include elevated platform for insulated duct mounting.
d) Include locking quadrant to secure damper in position.

b. Shop and field fabricated for balancing duty in duct run-outs serving a single diffuser, grille or register:

1) Blade: Single blade volume damper constructed per SMACNA standards.
2) Handle: Stamped or cast metal configured to indicate damper position in duct. Provide extension to raise handle above duct insulation and locking device such as wing nut to secure extension device to side of damper bearing and duct, or standoff with locking quadrant to secure damper in position.

3. Remote Damper Operators:

a. Damper operator for remote operation of manual balancing dampers located above hard ceilings or other inaccessible locations.

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b. Electrically Activated: Greenheck RBD-10.

1) Electrically actuated motor for field mounting on manual balancing damper shaft.
2) Plenum-rated, interconnect cable in length suitable to reach remote- wall, ceiling, or diffuser plate.
3) Handheld, battery powered controller for actuation of motor.

c. Manually Activated: Young 270-315.

1) Galvanized steel rack and pinion controller for attachment to the balancing damper shaft.
2) Bowden cable with galvanized steel outer casing and stainless steel inner wire in length as required but no more than 50 feet.
3) Ceiling mounted, die cast mounting cup, with adjustable threaded cover.

d. Provide all accessories required for the intended application.

D. Control Dampers:

1. Rectangular:

a. Manufacturers: Provide Tamco airfoil control dampers by T.A. Morrision and Co.
b. Frames:

1) Hat or U-channel.
2) Galvanized-steel, minimum 0.064 inch thick.
3) Mitered and welded corners.

c. Blades:

1) Airfoil shape.
2) Multiple blade with maximum blade width of 8 inches.
3) Opposed-blade design.
4) Galvanized steel.
5) 0.080 inch thick.
6) Blade Edge Seals: Closed-cell neoprene.
7) Blade Jamb Seals: Flexible metal compression seal.

d. Blade Axles: 1/2-inch-diameter; plated or galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1) Operating Temperature Range: From minus 40 to plus 200 deg F.

e. Bearings:

1) Oil-impregnated bronze, stainless steel, or molded synthetic.
2) Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3) Thrust bearings at each end of every blade.

f. Leakage: Maximum of 3 cfm/sf at 1 inch water gauge.

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2. Round:

a. Frames: Galvanized-steel, minimum 0.040 inch thick.
b. Blade: Two layers of galvanized steel each a minimum 0.080 inch thick.
c. Blade Seal: Neoprene sandwiched between blade layers extending beyond blades all around.
d. Blade Axle: 1/2-inch-diameter extended full length of blade; plated or galvanized steel extending beyond frame as required for operator mounting.

1) Maximum Operating Temperature: 200 deg F.

e. Bearings: Oil-impregnated bronze, stainless steel, or molded synthetic.
f. Leakage: Maximum of 0.15 cfm per inch of blade circumference at 4 inch water gauge.

2.3 FIRE DAMPERS, COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation.
2. Pottorff; a division of PCI Industries, Inc.
3. Ruskin Company.

B. Fire Dampers:

1. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
2. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.
3. Fire Rating: 1-1/2 hours or longer as required or noted on drawings.
4. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
5. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

a. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
b. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

6. Mounting Orientation: Vertical or horizontal as indicated.
7. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
8. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
9. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

C. Combination Fire and Smoke Dampers:

1. General Requirements: Label according to UL 555 and UL 555S by an NRTL.
2. Closing rating in ducts up to 4 inch wp static pressure and maximum air flow through the open damper of 2000 FPM.

3. Smoke Detector: Integral, factory wired for single-point connection where indicated.
4. Fire rating: 1-1/2 hours or longer as required or noted on drawings.
5. Frame: Hat-shaped, minimum 0.094-inch-thick, galvanized sheet steel, with welded or interlocking, gusseted corners and mounting flange.

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6. Leakage: Class 1.
7. Blades: Horizontal, airfoil shaped, minimum 0.063-inch-thick, galvanized sheet steel.
8. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application.
9. Heat Response Device: Electric fuse link 165 deg F rated.
10. Damper Motors: Two-position action, externally mounted unless indicated otherwise.
11. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

    a. Motor Sizes: Provide motor large enough so driven load will not require motor to operate in service factor range above 1.0.
    b. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
    c. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
    d. Spring-Return Motors: Equip with an integral spiral-spring mechanism. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
    e. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
    f. Electrical Connection: 115 V, single phase, 60 Hz.

12. Accessories:

    a. Auxiliary switches for signaling or position indication where indicated.
    b. Momentary test switch, and test and reset switches damper or remote mounted as indicated.

2.4 TURNING VANES

A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades; set into vane runners suitable for duct mounting.

B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

C. Vane Construction: Single thickness with 3/4 inch trailing edge spaced at 1.5 inch centers.

2.5 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. American Warming and Ventilating.
2. CL Ward & Family, Inc.
3. Ductmate Industries, Inc.
4. Flexmaster U.S.A., Inc.
5. Greenheck.
6. McGill AirFlow Corporation.
7. Nailor Industries Inc.
8. Ventfabrics, Inc.

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9. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Rectangular Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 2-10, "Duct Access Doors and Panels."

1. Door:

   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Where used in product conveying ducts, match duct material.
   c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
   d. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets. Where used in product conveying ducts, match duct material.
3. Number of Hinges and Locks:

   a. Access Doors Less than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
   d. Access Doors Larger than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

C. Round Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 2-11, "Access Panels - Round Duct."

1. Door:

   a. Double wall, rectangular or oval.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Where used in product conveying ducts, match duct material.
   c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
   d. Fabricate doors airtight and suitable for duct pressure class.

2. Number of Hinges and Locks:

   a. Access Doors Less than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.

D. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 10-inch wg
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch-thick, fibrous-glass or polystyrene-foam board.

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2.6 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. CL Ward & Family, Inc.
2. Ductmate Industries, Inc.
3. Duro Dyne Inc.
4. Elgen.
5. Ventfabrics, Inc.
6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd.
2. Minimum Tensile Strength: 500 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

2.7 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Atco Flex.
2. Elgen.
3. Flexmaster U.S.A., Inc.
4. Genflex.
5. Manville.
6. Owens-Corning.
7. Therma Flex.
8. Wiremold.

B. Insulated, Flexible Duct: UL 181, Class 1, polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.

1. Pressure Rating:

   a. Low Pressure: 4-inch wg positive and 0.5-inch wg negative.

2. Maximum Air Velocity: 4000 fpm.

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3. Temperature Range: Minus 20 to plus 175 deg F.
4. Insulation R-Value: Comply with the latest addition of ASHRAE/IESNA 90.1.

C. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Select duct accessories suitable for the pressure class of the ductwork to which it is attached.

B. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts

C. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

D. Install turning vanes in all rectangular duct elbows having a 45-degree or greater bend as indicated.

E. Install dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

F. Install volume dampers at points on supply, return, and exhaust systems where branches serving diffusers and grilles extend from larger ducts. Install dampers where accessible and as close to mains as possible. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

G. Install volume dampers in outside air systems at the connection to the equipment served.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

H. Remote Damper Operators:

1. Install remote damper operators for all dampers located above hard ceilings or for dampers that will otherwise be inaccessible at the completion of construction.
2. Install remote damper operator in accordance with the manufacturer's written instructions.
3. Locate operator interface as indicated on the drawings or as instructed by the Architect/Engineer.
4. Finish cover to match adjacent ceiling.

I. Set dampers to fully open position before testing, adjusting, and balancing.

J. Install fire and smoke dampers according to UL listing at all duct penetrations of rated assemblies as required to maintain the rating as designated on the drawings.

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K. Mount duct smoke detectors in strict conformance with manufacturer's recommendations. Duct smoke detectors to be furnished and wired in Division 21, 26 or 28.

L. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment. Locate on side of duct with greatest clearance. Install at the following locations:

1. On both sides of duct coils. (Minimum head and hand access.)
2. Upstream and downstream from duct filters. (Minimum head and hand access.)
3. At outdoor-air intakes and mixed-air plenums. (Minimum head and hand access.)
4. At drain pans and seals. (Minimum head and hand access.)
5. Downstream from control dampers, backdraft dampers, and other duct-mounted equipment. (Minimum head and hand access.)
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors; and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers. (Minimum two hand access.)
7. At each change in direction and at maximum 50-foot spacing. (Minimum two hand access.)
8. Upstream and downstream from turning vanes. (Minimum two hand access.)
9. Control devices requiring inspection. (Minimum head and hand access.)
10. Elsewhere as indicated.

M. Install access doors with swing against duct static pressure.

N. Minimum Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

O. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

P. Install flexible connectors to connect ducts to equipment. Provide sheet metal sunshields on flexible connectors exposed to weather.

Q. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

R. Flexible duct may only be used in the following locations with the following limitations:

1. Connect terminal units to supply ducts with maximum 12-inch lengths of high pressure flexible duct. Do not use flexible ducts to change directions.
2. Connect diffusers, grilles, or registers located in lay-in ceilings to ducts with maximum 48-inch lengths of low pressure flexible duct secured in place with stainless steel clamps. Do not use flexible ducts to change directions.
3. Install flexible ducts stretched and supported without kinks or sags.

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3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.

END OF SECTION 23 33 00

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SECTION 23 34 23

HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ceiling-mounted and in-line ventilators.
2. In-line centrifugal fans.

1.2 SUBMITTALS

A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:

1. Manufacturer and model number.
2. Rated capacity based on scheduled conditions and project elevation.
3. Equipment dimensions and weights.
4. Required clearances.
5. Electrical data.
    a. Motor horsepower.
    b. Voltage/Phase/Hz.
    c. Electrical service point(s) of connection.
6. Materials of construction.
7. Accessories and options.
8. Controls.

B. Warranty information.

C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

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

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

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PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Greenheck Fan Corporation.
2. TLG.
3. Trane.

2.2 CEILING-MOUNTED AND IN-LINE VENTILATORS

A. Housing: Steel, lined with acoustical insulation.

B. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

C. Grille: Aluminum or Painted aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

D. Electrical Requirements: Junction box for electrical connection on housing and disconnect receptacle for motor plug-in.

E. Backdraft Damper: Aluminum with continuous hinge.

F. Accessories: Provide accessories indicated on drawings.

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
4. Motion Sensor: Motion detector with adjustable shutoff timer.
5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless-steel springs, and fusible link.
6. Filter: Washable aluminum to fit between fan and grille.
7. Isolation: Rubber-in-shear vibration isolators.
8. Manufacturer's standard roof jack and curb, or wall cap with transition fittings.

2.3 IN-LINE CENTRIFUGAL FANS

A. Housing: Bolted and/or welded galvanized steel with integral duct collars and access doors on three sides with neoprene gasketing.

B. Direct-Drive Units: Motor mounted in airstream, with wheel, inlet cone.

C. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing, drives shall be sized for 150 percent of installed motor horsepower. Bearings shall be regreasable ball type in pillow block housing with a minimum L10 life in excess of 40,000 hours.

D. Fan Wheels: Aluminum, airfoil or backward inclined blades welded to aluminum hub.

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E. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent for all direct drive units.
2. Companion Flanges: For inlet and outlet duct connections.
3. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
5. Backdraft damper: motorized.
6. Disconnect switch: NEMA 1, factory wired and located on outside of housing.
7. Finish: Baked epoxy powder coat.

F. Capacities and Characteristics:

1. Vibration Isolators:

a. Type: Elastomeric hangers.
b. Static Deflection: 1 inch.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "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. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

2.5 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch Vibration-control devices are specified in Division 23 Section "Vibration Controls for HVAC Piping and Equipment."

B. Install units with clearances for service and maintenance.

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C. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Division 23 Section "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.

END OF SECTION 23 34 23

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SECTION 23 36 00

AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-duct air terminal units.

1.2 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports shall withstand the effects of gravity and loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

1.3 SUBMITTALS

A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:

1. Manufacturer and model number.
2. Rated capacity.
3. Equipment dimensions.
4. Required clearances.
5. Materials of construction.
6. Accessories and options.
7. Controls.

B. LEED Submittal:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with the latest addition of ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Warranty information.

D. Operation and maintenance data.

1.4 QUALITY ASSURANCE

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

B. ASHRAE Compliance: Applicable requirements in the latest addition of ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

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PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Carrier Corporation.
2. Environmental Technologies, Inc.
3. Krueger.
4. Metal Industries, Inc.
5. Nailor Industries, Inc.
6. Price Industries
7. Titus.
8. Trane; a business of American Standard Companies.

2.2 SINGLE-DUCT AIR TERMINAL UNITS

A. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

B. Compliance: ANSI/AHRI Standard 880-11.

C. Casing: Minimum 0.029-inch thick steel, single wall.

1. Casing Lining: Adhesive attached, 1/2-inch-thick, coated, fibrous-glass duct liner complying with ASTM C 1071, UL181, NFPA 90-A and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.

2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in the latest addition of ASHRAE 62.1.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 4-inch wg inlet static pressure.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in the latest addition of ASHRAE 62.1.

E. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

F. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

1. Provide multi-point, averaging, airflow measuring sensor in air inlet. Connect sensor tubing to unit controller.

G. Direct Digital Controls: Unit controller to be provided by Control Contractor and installed by terminal unit manufacturer.

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2.3 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Steel Cables: Galvanized steel complying with ASTM A 603 or Stainless steel complying with ASTM A 492.

C. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

D. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

E. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to ARI 880.

1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, 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 and as directed by the structural engineer.

C. Hangers: Threaded rod and angle or channel supports.

D. 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.

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3.3 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

C. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts."

D. Make connections to air terminal units with flexible connectors complying with requirements in Division 23 Section "Air Duct Accessories."

3.4 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. On units with heaters include heating capacity (BTUH), GPM, or KW. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified. (Damper modulates from minimum to maximum position, heat modulates, fan cycles, etc.)
7. Verify that recommended and required service clearances have been provided.

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3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 23 36 00

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SECTION 23 37 13

DIFFUSERS, REGISTERS & GRILLES

PART 1 - GENERAL

1.1 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate drawing designation, manufacturer, model number, materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, noise ratings and accessories furnished.

PART 2 - PRODUCTS

2.1 BASIS-OF-DESIGN PRODUCT

A. Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Krueger.
2. Price Industries.
3. Titus.

2.2 MATERIALS

A. Provide diffusers, registers, and grilles constructed of the materials indicated on drawings.

B. Diffusers, registers, and grilles mounted in damp or wet locations such as shower rooms, kitchen areas, or installed in evaporative cooler systems shall be all aluminum construction.

C. Diffusers, registers, and grilles are to be factory finished unless noted otherwise. Provide color as scheduled or as directed by the Architect.

2.3 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 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

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B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, and fire dampers.

D. Paint all interior ductwork visible through the diffuser, register or grille flat black.

3.2 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

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SECTION 23 41 00

PARTICULATE AIR FILTRATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pleated panel filters.
2. Self-supported pocket filters.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated include the following:

1. Manufacturer and model number.
2. Rated capacity and pressure drop curves.
3. Materials of construction.

B. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5, "Systems and Equipment."
2. Product Data for Credit IEQ 4.1: For adhesives and sealants, including printed statement of VOC content.

C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. ASHRAE Compliance:

1. Comply with applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality"; Section 5 - "Systems and Equipment"; and Section 7 - "Construction and Startup."
2. Comply with ASHRAE 52.1 for arrestance and ASHRAE 52.2 for MERV for methods of testing and rating air-filter units.

B. Comply with NFPA 90A and NFPA 90B.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AAF International.

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2. Airguard.
3. Camfil Farr.
4. Filtration Group.
5. Flanders-Precisionaire.
6. Purafil, Inc.
7. Purolator

2.2 PLEATED PANEL FILTERS

A. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters with holding frames.

B. Filter Unit Class: UL 900, Class 2.

C. Media: Interlaced glass, synthetic, or cotton and synthetic fibers coated with nonflammable adhesive.

1. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Media shall be coated with an antimicrobial agent.
3. Separators shall be bonded to the media to maintain pleat configuration.
4. Welded wire grid shall be on downstream side to maintain pleat.
5. Media shall be bonded to frame to prevent air bypass.
6. Support members on upstream and downstream sides to maintain pleat spacing.

D. Filter-Media Frame: Cardboard frame with perforated metal retainer sealed or bonded to the media.

E. Capacities and Characteristics:

1. Thickness or Depth: 1 inch, 2 inches or 4 inches as indicated on the drawings.
2. Maximum or Rated Face Velocity: 300 fpm for 1 inch media and 500 fpm for 2 inch and 4 inch media.
3. Efficiency: 90 percent when tested according to ASHRAE 52.1.
4. Initial Resistance: 0.20-inch wg for 1 inch media and 0.26-inch wg for 2 inch and 4 inch media.
5. Recommended Final Resistance: 1.0 inches wg.
6. MERV Rating: 7 when tested according to ASHRAE 52.2.

2.3 SELF-SUPPORTED POCKET FILTERS

A. Description: Factory-fabricated, panel-type, disposable air filters with contoured media for extended surface.

B. Filter Unit Class: UL 900, Class 1.

C. Media: Fibrous material constructed so individual pleats are maintained in tapered form under rated-airflow conditions by flexible internal supports.

1. Media shall be coated with an antimicrobial agent.

D. Configuration: Multipocket.

E. Filter-Media Frame: Galvanized steel.

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F. Capacities and Characteristics:

1. Thickness or Depth: 24 inches.
2. Maximum or Rated Face Velocity: 500 fpm.
3. Efficiency: 85 percent when tested according to ASHRAE 52.1.
4. Initial Resistance: .40 inches wg.
5. Recommended Final Resistance: 1.5 inches wg.
6. MERV Rating: 13 when tested according to ASHRAE 52.2.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install filters in position to prevent passage of unfiltered air.

B. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

C. Coordinate filter installations with duct and air-handling-unit installations.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test for leakage of unfiltered air while system is operating.

C. Prepare test and inspection reports.

3.3 CLEANING

A. After completing system installation and testing, adjusting, and balancing of air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION 23 41 00

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SECTION 23 57 00

HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes shell-and-tube and plate-and-frame heat exchangers.

1.2 SUBMITTALS

A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:

1. Manufacturer and model number.
2. Rated capacity based on scheduled conditions.
3. Equipment dimensions and weights.
4. Required clearances.
5. Materials of construction.
6. Accessories and options.

B. Warranty information.

C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

A. ASME Compliance: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

PART 2 - PRODUCTS

2.1 SHELL-AND-TUBE HEAT EXCHANGERS

A. Manufacturers:

1. ITT Industries; Bell & Gossett.

B. Configuration: U-tube with removable bundle.

C. Shell Materials: Steel.

D. Head:

1. Materials: Cast iron.
2. Flanged and bolted to shell.

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E. Tube:

1. Seamless copper tubes.
2. Tube diameter is determined by manufacturer based on service.

F. Tubesheet Material: Steel.

G. Baffles: Steel.

H. Piping Connections:

1. Inlet and outlet fluid connections, threaded drain, and vent connections.

I. Design Pressure Ratings:

1. Tubeside-150 psi, Shellside-150 psi.

J. Fluid: As scheduled on the drawings.

K. Support Saddles:

1. Fabricated of material similar to shell.
2. Foot mount with provision for anchoring to support.

2.2 PLATE-AND-FRAME HEAT EXCHANGERS

A. Manufacturers:

1. Alfa Laval Thermal, Inc.
2. Mueller.
3. Polaris Plate Heat Exchangers.
4. Sondex.
5. Tranter.

B. Configuration: Freestanding assembly consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets.

C. Frame:

1. Capacity to accommodate 30 percent additional plates.
2. Painted carbon steel with provisions for anchoring to support.

D. Top and Bottom Carrying and Guide Bars: Painted carbon steel, aluminum, or stainless steel.

E. End-Plate Material: Painted carbon steel.

F. Tie Rods and Nuts: Steel or stainless steel.

G. Plate Material: 0.015 inch thick before stamping; Type 304 stainless steel.

H. Gasket Material: EPDM.

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I. Piping Connections:

1. Threaded port for NPS 2 and smaller. For larger sizes, furnish end-plate port with threaded studs suitable for flanged connection.

J. Enclose plates in a solid aluminum removable shroud.

K. Design Pressure Rating:

1. Hotside-150 psi.
2. Coldside-150 psi.

L. Fluid: As scheduled on the drawings.

2.3 BRAZED PLATE HEAT EXCHANGERS

A. Manufacturers:

1. Bell & Gossett.

B. Configuration: Brazed assembly consisting of two end plates, one with threaded nozzles and pattern-embossed plates.

C. End-Plate Material: Type 316 stainless steel.

D. Threaded Nozzles: Type 316 stainless steel.

E. Plate Material: Type 316 stainless steel.

F. Brazing Material: Copper or nickel.

G. Design Pressure Rating: Hotside-150 psi, Coldside-150 psi.

H. Fluid: As scheduled on the drawings.

PART 3 - EXECUTION

3.1 HEAT-EXCHANGER INSTALLATION

A. Install shell-and-tube heat exchangers on saddle supports.

B. Install shell-and-tube and plate-and-frame heat exchangers on, and anchor to, concrete base.

3.2 CONNECTIONS

A. Connect piping to heat exchangers with shutoff valves, thermometer, common pipe to pressure gage, and drain connection with valve. Make connections to heat exchanger with a flange.

B. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain.

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C. Install vacuum breaker at heat-exchanger steam inlet connection.

D. Install hose end valve to drain shell.

END OF SECTION 23 57 00

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SECTION 23 73 13

INDOOR AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Variable volume air-handling units.

1.2 SUBMITTALS

A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:

1. Manufacturer and model number.
2. Rated capacity based on scheduled conditions and project elevation.
3. Fans:
    a. Certified fan-performance curves with system operating conditions indicated.
    b. Certified fan-sound power ratings.
    c. Fan construction and accessories.
    d. Motor ratings, electrical characteristics, and motor accessories.
4. Certified coil-performance ratings with system operating conditions indicated.
5. Filters with performance characteristics.
6. Equipment dimensions and weights.
7. Required clearances.
8. Electrical data.
    a. Motor horsepower.
    b. Voltage/Phase/Hz.
    c. Full load ampacity, minimum circuit ampacity and maximum overcurrent protection device requirements.
    d. Electrical service point(s) of connection.
    e. AIC rating of the equipment.
9. Materials of construction, metal thickness, finishes, insulation, etc.
10. Accessories and options.
11. Controls.
12. Dampers, including housings, linkages, and operators.
13. Sound power ratings for the unit.

B. LEED Submittal:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with the latest addition of ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Source quality-control reports.

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D. Start-up procedures.

E. Warranty information.

F. Operation and maintenance data.

1.3 QUALITY ASSURANCE

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

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.

D. ASHRAE Compliance: Applicable requirements in the latest addition of ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in the latest addition of ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Energy Labs.
2. Huntair.
3. Temtrol.

2.2 UNIT CASINGS

A. General Fabrication Requirements for Casings:

1. Outside Casing: Galvanized steel, minimum 16 GA thick.
2. Inside Casing: Galvanized steel, solid, minimum 18 GA thick.
3. Floor Plate: Galvanized steel, minimum 14 GA thick with integral safety tread.
4. Insulation Thickness: 2 inches.
5. Casing Leakage Rating: Less than 1% of rated unit airflow at 6 inches of wg.
6. Factory Finish for Steel and Galvanized-Steel Casings: Apply manufacturer's standard primer immediately after cleaning and pretreating.
7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in the latest addition of ASHRAE 62.1.
8. Casing panels shall be double-wall, thermally broken, with minimum R-12 foam-type insulation between inner and outer panels.

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9. Casing panels shall be sealed to unit frame with a neoprene full-perimeter gasket.

B. Inspection and Access Panels and Access Doors:

1. Panel and Door Fabrication: Construction and thickness shall be similar to casing panels.
2. Inspection and Access Panels:

   a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
   b. Gasket: Neoprene, applied around entire perimeter of panel frames.
   c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

3. Access Doors:

   a. Hinges: A minimum of two hinges or stainless-steel piano hinge and two latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential. Hinges and latches shall be adjustable.
   b. Gasket: Neoprene, applied around entire perimeters of panel frames.

4. Locations and Applications:

   a. Fan Section: Doors.
   b. Access Section: Doors.
   c. Coil Section: Inspection and access panel.
   d. Damper Section: Doors.
   e. Filter Section: Doors large enough to allow removal and installation of filters.
   f. Mixing Section: Doors.

C. Condensate Drain Pans:

1. Double-wall, insulated, fabricated with slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and to direct water toward drain connection.

   a. Length: Extend drain pan downstream from leaving face to comply with the latest addition of ASHRAE 62.1.

2. Materials: Stainless steel sheet.
3. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple.
4. Insulation: Closed cell foam of sufficient thickness to prevent condensation from forming on exterior surfaces of pan and casing.
5. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

D. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

2.3 SUPPLY FAN, DRIVE, AND MOTOR SECTION

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

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1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.

    a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
    b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

B. Fan Array Units:

1. The fan array, shall consist of multiple, direct driven, arrangement 4 plenum fans constructed per AMCA requirements for the duty specified, (Class II). All fans shall be selected to deliver the specified airflow quantity at the specified operating total static pressure and specified fan/motor speed. The fan array shall be selected to operate at a system total static pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed. Each fan/motor "cube" shall include an 11 gauge, A60 Galvanized steel intake wall, 14 gauge spun steel inlet funnel, and an 11 gauge G90 galvanized steel motor support plate and structure. The fan intake wall, inlet funnel, and motor support structure shall be powder coated for superior corrosion resistance. All motors shall be standard pedestal mounted type, (ODP), T-frame motors selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere. All motors shall include isolated bearings or shaft grounding. Each fan/motor cartridge shall be dynamically balanced to meet AMCA standard 204-96, category BV-5, to meet or exceed Grade 2.5 residual unbalance.
2. The fan array shall be provided with acoustical silencers that reduce the bare fan discharge sound power levels by a minimum of 15 db re 10^-12 watts throughout the eight octave bands with center frequencies of 125, 250, 500, 1000, 2000, 4000, and 8000 HZ when compared to the same unit without the silencers. The silencers shall not increase the fan total static pressure, nor shall it increase the airway tunnel length of the air handling unit when compared to the same fan array unit without the silencer array.
3. The fan array shall consist of multiple fan and motor "cubes", spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein. Each fan cube shall be individually wired to a control panel, sized for the total connected HP for all fan motors contained in the fan array. Provide a motor circuit protector and auxiliary contact for each motor. Wire sizing shall be determined, and installed, in accordance with applicable NEC standards.
4. Each fan "cube" shall be provided with a gravity type, low-leakage damper to prevent air circulation backwards through a failed fan.
5. The fan array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit not to exceed the specified cooling coil and/or filter bank face velocity when measured at a point 12" from the intake side of the fan array intake plenum wall, and at a distance of 48" from the discharge side of the fan array intake plenum wall. Each fan/motor assembly shall be removable through a 30" wide, free area, access door.
6. Each fan array shall be supplied with (1) complete flow measuring system which indicates airflow in cubic feet per minute. The flow measuring system shall consist of a flow measuring station with four static pressure taps and four total pressure tubes located at the throat of the fan inlet cone. The flow measuring station shall not obstruct the inlet of the fan and shall have no effect on fan performance (flow or static) or sound power levels. A surface mounted indicator, located on the unit exterior, shall provide a digital CFM readout, and a 4-20 ma output control signal for use in the BAS as specified elsewhere.
7. The manufacturer shall provide a complete spare fan array fan/motor assembly, unit mounted and wired. During normal operation, all fans will run at reduced speed to meet design duty. Fans / motors shall be sized such that design airflow is accomplished with one fan off.
8. Each fan shall be sized to perform as indicated on the equipment schedule. The wheel diameter shall not be less than that shown on the equipment schedule.
9. Fan performance curves shall be in accordance with current AMCA Standard 210.
10. Sound power level data shall be in accordance with current AMCA Standard 300.

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C. Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
2. 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.
3. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23.
4. Mount unit-mounted IEC starter-disconnect on exterior of unit. Units shall be factory wired, include a circuit breaker, control transformer, hand-off-auto switch with NEMA Type 1 enclosure.

2.4 COIL SECTION

A. General Requirements for Coil Section:

1. Comply with ARI 410.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. Coils shall not act as structural component of unit.

B. Water Coils:

1. Tube Material: Copper or as indicated on the drawings.
2. Tube Thickness: 0.020 inches minimum or as indicated on the drawings.
3. Fin Type: Plate or spiral.
4. Fin Material: Aluminum or as indicated on the drawings.
5. Fin Spacing: 12 fins per inch maximum or as indicated on the drawings.
6. Fin and Tube Joint: Mechanical bond.
7. Headers:

    a. Cast iron or copper with cleaning plugs and drain and air vent tappings.
    b. Seamless copper tube with brazed joints, prime coated.
    c. Fabricated steel, with brazed joints, prime coated.
    d. Provide insulated cover to conceal headers exposed outside casings.

8. Frames: Channel frame, 18 GA thick galvanized steel minimum.
9. Coil Working-Pressure Ratings: 175 psig, 325 deg F.

2.5 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat orientation with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum where indicated.
4. Comply with requirements of Division 23 Sections.
5. Provide filters as indicated on drawings.

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B. Filter Gage:

1. 3-1/2-inch-diameter, diaphragm-actuated dial in metal case.
2. Vent valves.
3. Black figures on white background.
4. Front recalibration adjustment.
5. 2 percent of full-scale accuracy.
6. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch tubing, and 2- or 3-way vent valves.

2.6 DAMPERS

A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.

B. Damper Operators: Comply with requirements in Division 23 Section "Instrumentation and Control for HVAC."

C. Outdoor- and Return-Air Dampers: Doubleskin airfoil parallel-blade or opposed blade, galvanized-steel or aluminum dampers mechanically fastened to cadmium-plated steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

2.7 ELECTRICAL

A. Fused Disconnects: Provide individual fused disconnects for each piece of electrically driven equipment such as fans, electric heaters, etc. Locate disconnect outside of unit adjacent to the door where component is located.

B. Service Light: 100-W vaporproof fixture or magnetically attached LED light with switched junction box located outside adjacent door.

1. Locations: Minimum of one light per section.
2. Lights may be controlled via a common switch if switch is provided with a pilot light.

C. Convenience Outlet: Provide a GFCI, 20-amp, duplex outlet mounted on the unit exterior adjacent to the fan section door.

2.8 SOURCE QUALITY CONTROL

A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

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PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment Mounting: Install air-handling units on concrete bases without vibration isolation devices. Secure units to anchor bolts installed in concrete bases. Comply with requirements for concrete bases specified in Division 03.

1. Install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

E. Comply with requirements for piping specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

F. Install piping adjacent to air-handling unit to allow service and maintenance.

G. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

H. Condensate Drain Piping: Comply with applicable requirements in Division 23 Section "HVAC Drain Piping." Connect condensate drain pans, extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

I. Coil-Water Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

J. Connect duct to air-handling units with flexible connections. Comply with requirements in Division 23 Section "Air Duct Accessories."

END OF SECTION 23 73 13

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SECTION 23 82 19

FAN COIL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes fan-coil units and accessories.

1.2 SUBMITTALS

A. Product Data: Provide manufacturer's product data for each unit indicated on the drawings. Data to be specific to the equipment proposed for the project with all options and accessories indicated. Include the following as a minimum:

1. Manufacturer and model number.
2. Rated capacity based on scheduled conditions and project elevation.
3. Equipment dimensions and weights.
4. Required clearances.
5. Electrical data.
    a. Motor horsepower.
    b. Voltage/Phase/Hz
    c. Full load ampacity, minimum circuit ampacity and maximum overcurrent protection device requirements.
    d. Electrical service point(s) of connection.
    e. Wiring diagrams.
6. Materials of construction.
7. Accessories and options.
8. Controls.

B. Warranty information.

C. Operation and maintenance data.

D. LEED Submittals:

1. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
2. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1-2004, Section 5 - "Systems and Equipment."

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.

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B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on drawings or comparable product by one of the following:

1. Carrier Corporation.
2. McQuay.
3. Trane; American Standard Inc.

2.2 FAN-COIL UNITS

A. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.

B. Coil Section Insulation: Minimum 1/2-inch-thick, coated glass fiber, foil-covered, closed-cell foam or matte-finish, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

C. Main and Auxiliary Drain Pans: Plastic or stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1-2004. Provide condensate overflow switch wired to shut off unit in case of condensate drain malfunction.

D. Chassis: Galvanized steel where exposed to moisture. Floor-mounting units shall have leveling screws.

E. Cabinet: Steel with baked-enamel finish.

1. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with discharge grilles.

F. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Pleated Cotton-Polyester Media: 1" thick, 90 percent arrestance and 7 MERV.

G. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins maximum of 12 fins per inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

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H. Fan and Motor Board: Removable.

1. Fan: Forward curved, double width, centrifugal; directly connected to motor.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
3. Wiring Termination: Connect motor to chassis wiring with plug connection.

I. Control devices are specified in Division 23 Sections "Instrumentation and Control for HVAC."

J. Basic Unit Controls:

1. Control voltage transformer.
2. Unit mounted disconnect switch.

K. Electrical Connection: Factory wire motors and controls for a single electrical connection.

2.3 DUCTED FAN-COIL UNITS

A. Description: Factory-packaged and -tested units rated according to ARI 430, ASHRAE 33, and UL 1995.

B. Casing Insulation: 1-inch-thick coated glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

C. Drain Pans: Plastic or stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1-2004. Provide condensate overflow switch wired to shut off unit in case of condensate drain malfunction.

D. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panels.

E. Cabinets and Structural Components: Galvanized steel or steel with baked-enamel finish.

1. Mixing Plenum: Sheet metal plenum finished and insulated to match the chassis with outdoor- and return-air, formed-steel dampers.
2. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.

F. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 as noted on the drawings.

G. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins maximum of 12 fins per inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

H. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

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I. Belt-Driven Fans: Double width, forward curved, centrifugal dynamically balanced; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet.

1. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

J. Control devices are specified in Division 23 Section "Building Automation System for HVAC."

K. Basic Unit Controls:

1. Control voltage transformer.
2. Motor contactor and disconnect switch.

L. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fan-coil units to comply with NFPA 90A.

B. Suspend fan-coil units from structure with elastomeric hangers. Vibration isolators are specified in Division 23 Section "Vibration Controls for HVAC Piping and Equipment."

C. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

D. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect condensate drain to indirect waste.

a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

E. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

3.2 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 23 82 19

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SECTION 23 82 39

HOT WATER UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cabinet unit heaters with centrifugal fans and hot-water coils.

1.2 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

B. LEED Submittal:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with the latest addition of ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Plans, elevations, sections, and details.
2. Location and size of each field connection.
3. Equipment schedules to include rated capacities, furnished specialties, and accessories.

D. Operation and maintenance data.

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. ASHRAE Compliance: Applicable requirements in the latest addition of ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in the latest addition of ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

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B. Hot Water:

1. Carrier.
2. International Environmental Corp.
3. Trane.
4. USA Coil & Air.

C. Description: A factory-assembled and -tested unit complying with ARI 440.

1. Electric units shall comply with UL 2021.

D. Coil Section Insulation: Glass-fiber insulation; surfaces exposed to airstream shall be aluminum-foil facing or erosion-resistant coating to prevent erosion of glass fibers.

1. Thickness: 1/2 inch.
2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in the latest addition of ASHRAE 62.1.

E. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint.

1. Exposed Panels: Minimum 0.0528-inch-thick, galvanized, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
2. Recessing Flanges: Steel, finished to match cabinet.
3. Extended Piping Compartment (Hot Water Units): 8-inch-wide piping end pocket.

F. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.

G. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

H. Fan and Motor Board: Removable.

1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

I. Hot-Water Piping Package: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet and outlet.

1. Hose Kits: Minimum 400-psig working pressure, and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.

a. Length: 24 inches.
b. Minimum Diameter: Equal to cabinet unit heater connection size.

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2. Two-Piece, Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
3. Calibrated-Orifice Balancing Valves: Bronze body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venture, connection for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.
4. Y-Pattern, Hot-Water Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig minimum working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 threaded pipe and full-port ball valve in strainer drain connection.
5. Wrought-Copper Unions: ASME B16.22.

J. Basic Unit Controls:

1. Control voltage transformer.

K. Electrical Connection: Factory wire motors and controls for a single field connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install unit heaters to comply with NFPA 90A.

B. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater.

C. Install new filters in each unit within two weeks of Substantial Completion.

D. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

E. Install piping adjacent to machine to allow service and maintenance.

F. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

G. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."

H. Comply with safety requirements in UL 1995 (Hot Water Units Only).

I. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

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1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 23 82 39

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SECTION 23 83 16

HYDRONIC SNOW MELT SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes hydronic snow melt system, including pipes, fittings, controls, and piping specialties.

1.2 SUBMITTALS

A. Product Data: Provide manufacturer's product data for type of product indicated. Data to be specific to the systems proposed for the project including piping, fittings, manifolds, specialties, and controls with all options and accessories indicated. Include the following as a minimum:

1. Manufacturer and model number.
2. Pressure and temperature ratings.
3. Oxygen-barrier performance.
4. Fire-performance characteristics.
5. Water-flow and pressure-drop characteristics.

B. Shop Drawings: Show piping layout and details drawn to scale, including valves, manifolds, controls, and support assemblies, and their attachments to building structure.

C. Warranty information.

D. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PEX PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. FloorHeat Company (The).
2. Heat Innovations Inc.
3. HeatLink Group Inc.
4. Infloor Radiant Floor Heating.
5. IPEX Inc.
6. Mr Pex Systems Inc.
7. REHAU Incorporated.
8. Slant/Fin Corporation.
9. Uponor.
10. Viega.
11. Warmboard Inc.
12. Watts Radiant, Inc.; a Watts Water Technologies company.
13. Zurn Industries, LLC; Zurn Pex, Inc.

B. Pipe Material: PEX plastic according to ASTM F 876.

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C. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.

D. Fittings: ASTM F 1807, metal insert and copper crimp rings.

E. Pressure/Temperature Rating: Minimum 100 psig and 180 deg F.

2.2 DISTRIBUTION MANIFOLDS

A. Manifold: Minimum NPS 1 brass, copper, or stainless steel.

B. Main Shutoff Valves:

1. Factory installed on supply and return connections.
2. Two or three-piece body.
3. Body: Brass or bronze.
4. Ball: Chrome-plated bronze.
5. Seals: PTFE.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

C. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Key furnished with valve, or screwdriver bit.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

D. Balancing Valves:

1. Body: Bronze, ball or plug, or globe cartridge type.
2. Ball or Plug: Brass or stainless steel.
3. Globe Cartridge and Washer: Brass with EPDM composition washer.
4. Seat: PTFE.
5. Visual Flow Indicator: Flowmeter with visible indication in a clear plastic cap at top of valve.
6. Handle Style: Lever or knob, with memory stop to retain set position if used for shutoff.
7. CWP Rating: Minimum 125 psig.
8. Maximum Operating Temperature: 250 deg F.

E. Zone Control Valves:

1. Body: Bronze, ball or plug, or globe cartridge type.
2. Ball or Plug: Brass or stainless steel.
3. Globe Cartridge and Washer: Brass with EPDM composition washer.
4. Seat: PTFE.
5. Actuator: Replaceable electric motor.
6. CWP Rating: Minimum 125 psig.
7. Maximum Operating Temperature: 250 deg F.

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F. Thermometers:

1. Mount on supply and return connections.
2. Case: Dry type, metal or plastic, 2-inch diameter.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, connecting element and pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Black metal.
7. Window: Plastic.
8. Connector: Rigid, back type.
9. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem.
10. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

G. Mounting Brackets: Copper or copper-clad steel, where in contact with manifold.

2.3 PIPING SPECIALTIES

A. Cable Ties:

1. Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
2. Minimum Width: 1/8 inch.
3. Tensile Strength: 20 lb. minimum.
4. Temperature Range: Minus 40 to plus 185 deg F.

B. Mounting Clamps:

1. Two bolts, steel, with corrosion-resistant coating and smooth finish without sharp edges.
2. Minimum Thickness: 3/32 inch.
3. Width: Minimum, wider than tubing.

2.4 CONTROLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Danfoss Inc.
2. HeatLink Group Inc.
3. Honeywell International Inc.
4. Infloor Radiant Floor Heating.
5. IPEX Inc.
6. REHAU Incorporated.
7. Slant/Fin Corporation.
8. tekmar Control Systems, Ltd.
9. Uponor.
10. Viega.
11. Watts Radiant, Inc.; a Watts Water Technologies company.
12. Zurn Industries, LLC; Zurn Pex, Inc.

B. Precipitation and Temperature Sensor:

1. Automatic control with manual on, automatic, and standby/reset switch.

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2. Precipitation and temperature sensors shall sense the surface conditions of pavement and shall be programmed to operate pump and zone control valves as follows:

   a. Temperature Span: 34 to 44 deg F.
   b. Adjustable Delay Off Span: 30 to 90 minutes.
   c. Start Pump or Open Zone Control Valves: Following two-minute delay if ambient temperature is below set point and precipitation is detected.
   d. Stop Pump or Close Zone Control Valves: On detection of a dry surface plus time delay.

3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
4. Minimum 30-A contactor to start pump and open valves.
5. Precipitation sensor shall be mounted in pavement.
6. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control-system workstation.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Install the following types of piping for the applications described:

   1. Piping in Exterior Pavement: PEX.

3.2 INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings or coordination drawings.

B. Install piping in accordance with manufacturer's written installation instructions.

C. Install radiant-heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.

D. Connect radiant piping to manifold in a reverse-return arrangement.

E. Do not bend pipes in radii smaller than manufacturer's minimum bend radius dimensions.

F. Install manifolds in accessible locations, or install access panels to provide maintenance access as required in Division 08.

G. See Section 232113 "Hydronic Piping" for pipes and connections to hydronic systems and for glycol-solution fill requirements.

H. Fire- and Smoke-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials according to Division 07.

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I. Piping in Exterior Pavement:

1. Secure piping in concrete by attaching pipes to reinforcement using cable ties.
2. Space cable ties a maximum of 18 inches o.c. and at center of turns or bends.
3. Maintain 3-inch minimum cover.
4. Install a sleeve of 3/8-inch thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
5. Maintain minimum 40-psig pressure in piping during concrete placement and continue for 24 hours after placement.

J. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Architect.

K. After system balancing has been completed, mark balancing valves to permanently indicate final position.

L. Perform the following adjustments before operating the system:

1. Open valves to fully open position.
2. Check operation of automatic valves.
3. Set temperature controls so all zones call for full flow.
4. Purge air from piping.

M. After concrete or plaster heating panel has cured as recommended by concrete or plaster supplier, operate radiant-heating system as follows:

1. Start system heating at a maximum of 10 deg F above the ambient radiant-panel temperature and increase 10 deg F each following day until design temperature is achieved.
2. For freeze protection, operate at a minimum of 60 deg F supply-water temperature.

3.3 FIELD QUALITY CONTROL

A. Prepare radiant-heating piping for testing as follows:

1. Open all isolation valves and close bypass valves.
2. Open and verify operation of zone control valves.
3. Flush with clean water and clean strainers.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Leak Test: After installation, charge system and test for leaks. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Radiant-heating piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

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E. Protect hydronic piping system from damage during construction.

END OF SECTION 23 83 16

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SECTION 26 05 00

GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE

A. Provisions of this section apply to all work specified in all sections under Division 26.

B. In addition, work in Division 26 is governed by the provisions of the Bidding Requirements, Contract Forms, General Conditions, and all sections under Division 01.

1.2 DEFINITIONS

A. Exposed, not concealed.

B. Finished Spaces: Spaces other than mechanical, electrical, and communication equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and utility tunnels.

C. Exposed, Interior Installations: Exposed to view indoors. Examples include un-finished spaces, mechanical, electrical, and communication equipment rooms.

D. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations and equipment yards.

E. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

F. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

G. Unfinished Space: A room or space that is ordinarily accessible only to building maintenance personnel, a room noted on the "Finish Schedule" with exposed and unpainted construction for walls, floor or ceilings, or specifically mentioned as "unfinished."

1.3 EXAMINATION OF PREMISES

A. Visit the site, verify all measurements and job conditions, and pay all costs necessary to perform the work.

1.4 ELECTRICAL CONTRACTOR

A. The Electrical Contractor shall be licensed and hold a current contracting license that has been valid for a minimum of two years in the State of Arizona as an electrical contractor.

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1.5 REGULATIONS, PERMITS, FEES, CHARGES, INSPECTIONS

A. Regulations: Comply with all applicable codes, rules and regulations.

B. Fees and Permits: Pay all connection, installation, use, development, etc., fees and/or charges. Obtain and pay for all required permits and licenses. Refer to Division 01.

C. Inspections: All work must be inspected and approved by local authorities. Prior to final approval, furnish the Engineer with certificates of inspections and approvals by the local authorities in accordance with Division 01.

1.6 DRAWINGS AND SPECIFICATIONS

A. If a conflict exists on the drawings or between the drawings and specifications, promptly notify the Engineer.

1.7 SUBMITTALS

A. Submittals are for information and coordination only. The Engineer will diligently review the submittals and attempt to verify compliance with the project requirements. Such review, however, does not constitute approval or disapproval of obligation to comply with all project requirements. The submittals are not to be construed to be contract documents. Any failure by the Engineer to note a point of non-compliance shall not be construed to be acceptance or approval of the discrepancy.

B. Product Information Sheets: Provide manufacturer's literature which includes the information required by the Product Data paragraph of the applicable Specification Section. Where Product Information Sheets show multiple models or options, clearly mark the model and options to be provided.

C. Assembly: Assemble all required submittal information for each specification section and submit in PDF format.

1. Assemble PDF submittals in one PDF file for each Division. Separate and order sections within each file by corresponding specification number. Provide bookmarks at the first page of each section and label each bookmark with the specification number and name to allow for easy navigation of the submittal.
2. Partial submittals will be returned without review.

D. Identification and Information:

1. Name the PDF file with the Project name, Division number and sequential submittal number. (I.E. The first submittal shall be No. 1, the second submittal shall be No. 2.)
2. Provide a cover sheet at the front of each submittal with the following information:

    a. Project name.
    b. Date.
    c. Name of Engineer.
    d. Name of Contractor.
    e. Name of subcontractor.

3. Provide a cover sheet at the front of each submittal section with the following information:

    a. Name of supplier.
    b. Name of manufacturer.

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c. Number and title of appropriate Specification Section.
d. Drawing number and detail references, as appropriate.
e. Other necessary identification.

E. Options:

1. Identify options requiring selection by the Engineer.
2. Identify options included with submittal item.

F. Deviations: Identify deviations from the Contract Documents on submittals

1.8 MATERIAL SAFETY DATA SHEETS

A. Provide current, Material Safety Data Sheets (MSDS), for all hazardous chemicals that are proposed for use at the project site.

1. Provide one complete set to the Owner for review and approval a minimum of one week prior to the delivery of any hazardous chemicals to the site.
2. Maintain a second complete set at the project location, readily accessible by both the Owner's personnel and the contractor's personnel.

1.9 REQUEST FOR INFORMATION

A. Request for Information:

1. A document submitted by the Contractor requesting clarification of a portion of the Contract Documents, hereinafter referred to as RFI.
2. A properly prepared request for information shall include a detailed written statement of the clarification, apparent conflict, or information requested that indicates the specific drawings or specification in need of clarification and the nature of the clarification requested.

a. Drawings shall be identified by drawing number and location on the drawing sheet.
b. Specifications shall be identified by section number, page, and paragraph.

3. Include a proposed solution, where appropriate, based upon the field conditions and best knowledge of the Contractor.

B. Improper or Frivolous RFIs: RFIs which are not properly prepared or that request information which is clearly shown in the contract documents will be returned unanswered. Processing time for multiple submissions of improper or frivolous RFIs will be billed at the Engineer's standard hourly rate to the Owner who may deduct an equal amount from the monies due the Contractor.

1.10 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings, Submittals and Shop Drawings.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Include underground and overhead conduit. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

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a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
b. Include dimensions both horizontally and vertically to permanent points of reference accurate within 6 inches. Include descriptors such as "below slab", "above ceiling", etc.
c. Record data daily or as soon as possible after obtaining it.
d. Record and check the markup before enclosing concealed installations.

2. Mark the Contract Drawings, Submittals and Shop Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of marked-up record prints.
3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Identification: As follows:

a. Project name.
b. Date.
c. Designation "PROJECT RECORD DRAWINGS."
d. Name of Engineer.
e. Name of Contractor.

3. Remove or obscure Engineer's seal from Record Drawings.

C. Building Information Model: Prepare and maintain an up to date building information model throughout the project.

1. Prepare a Building Information Model at the beginning of construction using the latest version of Autodesk REVIT software.
2. Use manufacturer prepared families wherever they are available for the actual equipment used on the project. Include manufacturer's name, model number, serial number, and include links to Operation and Maintenance Information.
3. Update the information contained in the model as the project progresses.
4. Deliver the updated model and all support files to the Owner at the completion of the project.

1.11 OPERATION AND MAINTENANCE MANUAL

A. Prior to completion of the project, compile a complete equipment, operation and maintenance manual for all equipment supplied under Division 26.

B. Schedule:

1. Submit a preliminary copy of the manual not less than 30 days prior to substantial completion for review and comment.
2. Submit the final version the manual not more than four weeks after substantial completion of the project.

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C. Format: Submit manuals in both of the following formats:

1. PDF electronic file. Assemble each manual into a composite electronically-indexed file. Submit on digital media acceptable to Engineer.

    a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically-linked operation and maintenance directory.
    b. Enable inserted reviewer comments on draft submittals.
    c. Provide one final copy to Engineer and two copies to Owner.

2. Three paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. Engineer will return three copies.

D. Provide operating and maintenance manuals for all systems, subsystems, and equipment that requires operation and regular maintenance, or has replaceable parts.

E. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, product data, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below. In addition to requirements in this Section, include operation and maintenance data required in individual Specification Sections.

F. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

G. Product Data: Include the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Approved submittals.
3. Include the following if not shown on approved submittals:

    a. Product name and model number. Use designations for products indicated on Contract Documents.
    b. Manufacturer's name.
    c. Equipment identification with serial number of each component.
    d. Equipment function.
    e. Operating characteristics.
    f. Limiting conditions.
    g. Performance curves.
    h. Engineering data and tests.

H. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures. Including precautions against improper use.

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10. Operating logs.

I. Wiring Diagrams: Diagram of factory installed wiring including any options as well as any field modifications.

J. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

K. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

L. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

M. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

N. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

O. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

P. Licenses: Include copies of any licenses with requirements including inspection and renewal dates.

Q. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1.12 WORK AND MATERIALS

A. Unless otherwise specified, all materials must be new and of the quality specified. The workmanship shall be of a quality that is acceptable to the Architect, Engineer, and Owner, and is equal to the standards of the trades. Contractor must staff the project with sufficient skilled workmen, including a fully qualified construction superintendent, to complete the work in the time allotted. The superintendent must be qualified to supervise all of the work in his work category.

B. Uniformity: Unless otherwise specified, provide all equipment and products of same type or classification by the same manufacturer.

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1.13 APPROVALS OF MATERIALS AND EQUIPMENT

A. Refer to Division 01 for description of material and equipment for prior approvals and substitutions.

1.14 COOPERATIVE WORK

A. Correct without charge any work requiring alteration due to lack of proper supervision or failure to make proper provision in time. Correct without charge any damage to adjacent work caused by the alteration. See Division 01 for additional requirements.

B. Cooperative Work Includes:

1. General supervision and responsibility for proper location, rough-in, and size of work related to Division 26 but provided under other divisions of these specifications.
2. Installation of sleeves, inserts and anchors bolts for work under sections in Division 26.

1.15 EXISTING MATERIALS AND EQUIPMENT

A. Disposition: With the exception of items that are to be reused or retained by the Owner, all other materials indicated to be removed shall be removed and disposed of by the Contractor. Items that are indicated to be retained or returned to the Owner and shall be delivered to a storage area designated by the Owner.

B. Unused Materials: All unused raceways, conductors, boxes, equipment, and miscellaneous materials shall be removed by the Contractor except where located within walls, below or above existing construction which is not being altered and would require removal and replacement of this existing construction. All visible raceways, conductors, boxes, equipment, and miscellaneous materials shall be removed and sealed or capped within wall, below floor unless noted otherwise.

C. Exterior Services: The Contractor shall be responsible for maintaining electrical and control service to the existing building during the construction period. Existing services are to be retained until such a time that the new services, if any, are completely installed and ready for use. Scheduling of service interruptions is to be coordinated with the Engineer and Owner.

D. Disconnect, demolish, and remove electrical systems, equipment, and components that are indicated to be removed.

1. Conduit to be Removed: Remove portion of conduit indicated to be removed and cap or plug remaining conduit with same or compatible conduit material. Patch insulation, as required, to match adjacent areas.
2. Conduit to be Abandoned In Place: Cap or plug conduit with same or compatible conduit material.
3. Equipment to be Removed: Disconnect services and remove equipment.
4. Equipment to be Removed and Reinstalled: Disconnect and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to be Removed and Salvaged: Disconnect and remove equipment and deliver to Owner.

E. Continuity of Services in Existing Building: Contractor shall permanently reroute existing electrical and control services or provide temporary connection as required to maintain service to existing fixtures in building which are to remain in service.

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F. Rerouting and Relocation of Existing Electrical Equipment and Services in Existing Building:

1. General: Contractor shall reroute, relocate all existing materials which are in conflict with the building alterations and which are required to be maintained in use.
2. Existing Raceways and Conductors: Where applicable, existing material may be reused in their original location unless otherwise indicated.

G. Testing: All existing services affected by the new construction and which are to remain in operation shall be returned to their original condition. The existing services shall be tested as new, as described in other sections of these specifications. If for any reason these requirements cannot be met, the Contractor shall immediately notify the Engineer.

1.16 CONSTRUCTION FACILITIES

A. General: Under this division of the specifications, execute all work in a manner to provide safe and lawful ingress and egress to the Owner's establishment and such facilities shall be kept clear of materials or equipment. Refer to Division 01 for additional requirements.

B. Furnish and maintain from the beginning to the completion of all work all lawful and necessary guards, railings, fences, canopies, lights, and warning signs. Take all necessary precautions required by city and state laws to avoid injury or damage to any and all persons and property.

1.17 GUARANTEE

A. Guarantee all material, equipment, installation and workmanship for all sections under Division 26 in writing to be free from defects of material and workmanship for one year from date of final acceptance as outlined in Division 01. Equipment warranties shall be a minimum of two year from date of substantial completion or as specified elsewhere. Replace without charge any material or equipment proving defective during this period. The guarantee shall include performance of the equipment under all conditions of load, installing any additional items of control and/or protective devices as required and the replacing of any refrigerant lost.

B. ELECTRICAL WIRING

C. Provide all line voltage power wiring, line voltage interlock wiring, and line voltage control wiring for the equipment that is to be provided under Divisions 21, 22 & 23 unless wiring is specifically shown on electrical drawings.

D. The following schedule is intended to summarize the division of work material responsibilities between the Mechanical Contractor, Controls Contractor and the Electrical Contractor.

Item	Furn. By	Set By	Power Wiring	Control Wiring
Equipment Motors	MC	MC	EC	--
Motor Control Center	EC	EC	EC	CC
Motor Starters, Controllers, Contactors and Overload Heaters	MC*	EC**	EC	CC
Fused and Non-Fused Disconnect Switches	EC	EC	EC	--
Manual Operating Switches, Multispeed Switches, Pushbutton Stations and Pilot Lights	CC	CC	CC	CC
Control Relays and Transformers	CC	CC	CC	CC

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Item	Furn. By	Set By	Power Wiring	Control Wiring
Line Voltage Thermostats and Time Switches***	MC	MC	EC	EC
Low Voltage Thermostats	MC	MC	-	MC
Temperature Control Panels	MC	MC	EC	CC
Smoke Detectors (Duct Mounted)	EC	MC	EC	MC or CC
Motor and Solenoid Valves, Damper Motors, PE and EP Switches	CC	MC	CC	CC
Water Treatment Equipment	MC	MC	EC	CC

MC = Mechanical Contractor
CC = Controls Contractor
EC = Electrical Contractor

*Except where such devices are located in MCC's.

**Unless required by these specifications to be provided as part of a factory furnished assembly (i.e. fan coils, air handlers, chillers, etc.).

***Motor-drive units which are controlled from line voltage automatic controls such as line voltage thermostats, float switches or time switches which conduct full load current of the motor shall be wired for both power and control circuit under the electrical contract.

1.18 CONNECTIONS TO UTILITY SYSTEMS

A. Provide connections to serving utility companies including but not limited to power, telephone, and CATV, as indicated on the plans. Contact utility companies and obtain the final design plans. Coordinate equipment, installation, and inspections with the serving utility. The Contractor shall include contact, coordination, inspections, utility company fees and work described on the serving utility design plans as part of the work of this contract.

1.19 CONSTRUCTION FACILITIES

A. General: Under this section of the specifications, execute all work in a manner to provide safe and lawful ingress and egress to the Owner's establishment. Construction facilities shall be kept clear of materials or equipment as directed by the Engineer.

B. From the beginning to completion, furnish and maintain all lawful and necessary guards, railings, fences, canopies, lights, warning signs, etc. Take all necessary precautions required by city and state laws and OSHA to avoid injury or damage to any persons and property.

C. Temporary toilet facilities are specified and furnished under another section.

1.20 COMMISSIONNING

A. This project will be commissioned. See commissioning requirements in Division 01.

PART 2 - PRODUCTS

2.1 CONCRETE

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A. Where used for structures to be provided under the contract such as bases, etc., concrete work and associated reinforcing shall be as specified under that Division.

B. See other sections for additional requirements for underground vaults, cable ducts, etc.

2.2 FRAMING CHANNEL

A. The framing channel shall be a cold-rolled, high-quality, carbon steel channel with factory-applied, hot-dipped-after-fabrication finish. Utilize factory-built interconnecting components, mounting straps, connectors, etc., designed for use with the framing channel supplied. Channel nuts shall be spring type and shall utilize standard US threads. Provide heavy zinc paint for field touch-up. B-Line "B" series, Unistrut "P" series, or as accepted by the Engineer.

2.3 ANCHORS

A. Anchors shall be expandable lead type, as manufactured by Ackerman-Johnson, Pierce, Diamond, Hilti, or as accepted by the Engineer.

B. Adjustable concrete hanger inserts shall be as manufactured by Grinnell or as accepted by the Engineer.

PART 3 - EXECUTION

3.1 SUBMITTALS

A. Prepare submittals as directed for review by the Contractor, Owner, Architect, and Engineer.

B. Submit one copy of PDF submittals via email, project website or other electronic media.

3.2 RECORD DRAWINGS

A. Recording: Post changes and modifications to project record documents as they occur; do not wait until the end of Project.

B. Maintenance of Record Documents and Samples: Store record documents in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Engineer's reference during normal working hours.

3.3 OPERATION AND MAINTENANCE MANUALS

A. Prepare Operation and Maintenance Manuals as directed for review by the Contractor, Owner, Architect, and Engineer.

B. Make corrections and resubmit as required.

3.4 VERIFICATION OF DIMENSIONS

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A. Scaled and figured dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions at site, and be responsible for properly fitting equipment and materials together and to the structure in spaces provided.

B. Drawings are diagrammatic and many offsets, bends, special fittings and exact locations are not indicated. Carefully study drawings and premises in order to determine best methods, exact locations, routes, building obstructions, and install apparatus and equipment in available locations. Install apparatus and equipment in manner and in locations to avoid obstructions, preserve headroom, and keep openings and passageways clear.

3.5 CUTTING AND PATCHING

A. Cut work and patch per Division 01 as necessary to properly install the new work. As the work progresses, coordinate necessary openings, holes, chases, etc., in their correct location. If the required openings, holes and chases are not in their correct locations, make the necessary corrections at no cost to the Owner. Avoid excessive cutting and do not cut structural members without the consent of the Engineer. Include as a part of the work all structural framing required by penetrations through the roof and necessary steel to support ducts and pipes between structural steel unless shown on the structural drawings.

3.6 CLOSING-IN OF UNFINISHED WORK

A. Cover no work until inspected, tested and approved. Where work is covered before inspection and test, uncover it, and when inspected, tested and approved, restore all work to original proper condition.

3.7 EXCAVATION AND BACKFILL

A. Perform all necessary excavation, shoring and backfilling required for the proper laying of all raceways, ducts, and conduits inside the building and premises, and outside as may be necessary. Remove all excess excavated materials from the site or dispose of on site as directed by General Contractor.

B. Excavate all trenches open cut, keep trench banks as nearly vertical as practicable, and sheet and brace trenches where required for stability and safety. Excavate trenches true to line and make bottoms not less than 18" wide but no wider than necessary to provide ample work room. Grade trench bottoms accurately to provide uniform bearing and support for each section of pipe on undisturbed soil along its entire length. Dig "bell" holes after the trench bottom has been graded. Machine grade only to the top line of the raceways, doing the balance by hand. Do not cut any trench near or under footings without first consulting the Engineer. Comply with OSHA requirements.

C. Provide not less than 4 inches of granular material as pipe bedding prior to laying pipe in trench to continuously support pipe and maintain required slope. Granular material shall be pea gravel or sand.

D. Provide backfilling and compaction in accordance with provisions of these specifications and under the direction of the Engineer to the required density.

E. Provide not less than 4 inches of granular material, same as conduit bedding, all around pipe. Make the first 2 feet of fill in 6 inch layers, each thoroughly compacted as directed, and free from rocks, large clods of earth, leaves, branches, and debris. Compact the rest of the backfill as directed, using in the backfill no rocks larger than 4 inches in diameter, and using no rock in the top 12 inches.

3.8 ACCESSIBILITY

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A. Install all control devices or other specialties requiring reading, adjustment, inspection, repairs, removal or replacement conveniently and accessibly throughout the finished building. Where any of these devices are shown on the contract drawings to be installed above any inaccessible ceiling or behind any inaccessible wall, the Electrical Contractor shall furnish access doors or panels as required.

B. All access doors or panels in walls and ceilings required for access to control devices, traps, valves and similar devices are to be furnished and installed as part of the work under this section. Provide type as specified under Division 08.

C. Refer to architectural drawings for type of wall and ceiling in each area and for rated construction.

D. Coordinate work of various sections to locate valves, traps, and dampers with others to avoid unnecessary duplication of access doors.

E. The Contractor, along with the Owner's representative, shall complete the Electrical Accessibility/Clearance Checklist at the end of this section for all electrical equipment. The chart shall be submitted to the Engineer for approval prior to substantial completion. All conflicts shall be resolved to the Architect's, and Engineer's and Owner's satisfaction prior to submission.

F. Provide doors that pierce a fire separation with the same fire rating as the separation.

3.9 ROOF FLASHINGS

A. Flash and counterflash all conduit penetrating roofing membrane with flashing per roofing manufacturer's recommendations. Refer to architectural drawings for detailing of duct and pipe penetrations through roof.

3.10 PRODUCT AND EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. All equipment, detectors, etc., shall be installed in strict conformance with the manufacturer's recommendations and all codes.

B. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install electrical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.

E. Do not install any equipment in an application not recommended by the manufacturer.

F. All electrical work shall be inspected and approved by the NAU Electrical Shop or its designee before being covered. All tests are to be observed by the NAU Electrical Shop or its designee.

G. Any electrical work that will interfere with or interrupt the operation of existing building electrical and/or telecommunications services must be scheduled with the NAU Project Manager at least one (1) week in advance. Such work may be required to be performed during non-working hours. Preparation work shall be complete prior to service outage. Emergency generators will be required at the discretion of NAU.

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3.11 EQUIPMENT ROUGH-IN

A. Rough in all equipment and fixtures as designated on the drawings and in the specifications. The drawings indicate only the approximate location of rough-ins. The exact rough-in locations must be determined from large-scale certified drawings. The Contractor shall obtain all certified rough-in information before progressing with any work for rough-in final connections.

B. Be responsible for providing all outlets and services of proper size at the required locations.

C. Minor changes in the contract drawings shall be anticipated and provided for under this Division.

1. Rough-in only (unless otherwise designated on the drawings) shall include providing all services as indicated and required, including all conduit and conductors. Cap all conduit stub-outs. Cap all conduits stub-outs in a manner suitable for future extension.

3.12 EQUIPMENT FINAL CONNECTIONS

A. Provide all final connections for the following:

1. All equipment furnished under this Division.
2. Electrical equipment furnished under other sections of the specifications (except as otherwise designated).
3. Owner-furnished equipment as shown on the drawings.

3.13 OWNER-FURNISHED AND OTHER EQUIPMENT

A. Rough-in only for all Owner-furnished equipment reference Division 01 and all equipment furnished under other sections of the specifications, except as otherwise specified and/or noted on the drawings.

3.14 WIRING OF EQUIPMENT FURNISHED UNDER OTHER SECTIONS

A. All electrical wiring including power wiring and control wiring (except as specified in Divisions 21, 22 & 23), including all raceways, wiring, outlet and junction boxes, and labor for installation of the wiring and equipment, shall be included in this section of the specifications.

B. Wiring diagrams, complete with all connection details, shall be furnished under each respective section.

C. Provide all connections as described per Divisions 21, 22 & 23.

3.15 EQUIPMENT SUPPORTS

A. Erection of Metal Supports and Anchorages:

1. Refer to Division 05 for structural steel.
2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment. Neatly fabricate and erect steel work with burrs and welding spatter ground off. Paint after fabrication with a rust-inhibitive primer.
3. Field Welding: Comply with AWS D1.1.

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B. Erection of Wood Supports and Anchorages:

1. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support and anchor electrical materials and equipment.
2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
3. Attach to substrates as required to support applied loads.

C. Concrete Inserts: Furnish and install all concrete inserts required for all materials and equipment specified and/or shown on the drawings for Division 26.

D. Concrete Bases: Work under this section includes coordination of construction of all concrete foundations indicated or required for equipment specified under Division 26. Materials and workmanship shall be described under Division 03. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at project.

1. Construct concrete bases of dimensions indicated, but not less than 1 inch (25 mm) larger in both directions than supported unit footprint. Where servicing apparatus for draw-out circuit breakers requires a level surface in front of the switchboard or switchgear, coordinate pad front extension so as to allow service to occur using standard apparatus. Where utility meters occur, pads shall conform to the serving utility requirements.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extends through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

E. Grouting:

1. Grout under all equipment after leveling, filling completely the space between machinery bed plate and foundation surface as specified in Division 03.
2. Mix and install grout for electrical equipment base bearing surfaces and other equipment base plates, and anchors.
3. Clean surfaces that will come into contact with grout.
4. Provide forms as required for placement of grout.
5. Avoid air entrapment during placement of grout.
6. Place grout, completely filling equipment bases.
7. Place grout on concrete bases and provide smooth bearing surface for equipment.
8. Place grout around anchors.
9. Cure placed grout.
10. Finish exposed surface of grout for a neat appearance.

3.16 CLEANUP

A. In addition to cleanup specified under Division 01, thoroughly clean all parts of the equipment. Where exposed parts are to be painted, thoroughly clean off any splattered construction materials and remove all oil and grease spots. Wipe the surface carefully and scrape out all cracks and corners.

B. During the progress of the work, keep the premises clean and free of debris.

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3.17 PAINTING

A. Except as otherwise specified or indicated in the architectural drawings and/or specifications, paint all exposed unfinished metal with one coat of rust-inhibiting primer. Galvanized ductwork and factory painted equipment shall be considered as having primed surface.

B. Damage and Touch-Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

C. Finished painting is specified under Division 09.

3.18 OBJECTIONABLE NOISE AND VIBRATION

A. Construct and brace the metal partitions, ducts and sheet metal housings to prevent vibration or rattling when systems are in operation. Install connections to equipment so noise and vibration will not reach the conditioned area through ducts, conduit, sheet metal work, or the building structure.

3.19 TESTING

A. Upon completion of the electrical work, the entire installation shall be tested and demonstrated to be operating satisfactorily. Tests and documentation shall be in accordance with NETA Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems.

B. Tests, calibrations, and settings shall include the following:

1. Wiring shall be tested for continuity, short circuits and/or accidental grounds. All systems shall be entirely free from grounds, short circuits, and any or all defects.
2. Motors shall be operating in proper rotation and control devices shall be functioning properly. Check all motor controllers to determine that properly sized overload devices are installed. Check all electrical equipment for proper operation.
3. Insulation resistance test for all switchboard buses, bus ducts, motor and feeder conductors, including neutrals, using a megohmeter. Apply to each conductor and maintain for 15 seconds or until reading stabilizes. Minimum value for each conductor shall be 20 megohms at 30 deg C. This test shall be performed by an independent testing company.
4. Test, calibrate, and set all relays, circuit breaker trip devices, and ground fault protection trip units after receipt of engineered settings. Circuit breaker setups shall be performed or witnessed by a qualified representative of the circuit breaker manufacturer. This representative shall be identified by name and initial related test report(s).
5. Additional equipment-specific testing is described in the equipment's respective section of this Division.

C. Furnish a written report of testing to the Engineer. At a minimum, the report shall include:

1. Testing Contractor's letterhead
2. Testing technician's name and signature.
3. Date and time that test was performed.
4. Ambient temperature and weather conditions.
5. Test equipment manufacturer, model number, and last calibration date.
6. The manufacturer, model number and, as applicable, trip unit model number and available adjustments of tested equipment.
7. Statement of "As Left" conditions.
8. Pass/Fail statement relative to NETA Chapter 10 recommendations.
9. Recommendations if any.

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D. The Contractor shall submit the testing schedule to the Engineer two weeks prior to initiation of testing activity.

E. Upon placing an order for equipment, but in no case less than two weeks prior to energization, provide the following to the Engineer:

1. List of circuit breakers supplied on the project. The list shall include manufacturer and model number, trip unit model number, frame rating, trip plug rating, available adjustments, and proposed circuit breaker trip settings. Categorize the submission by plan electrical equipment name (switchboard, panelboard, MCC, etc.), then by frame ampere rating. The Contractor shall implement settings.
2. List of ground fault protection trip units supplied on the project. The list shall include manufacturer and model number, trip unit model number, and available adjustments. Categorize the submission by plan electrical equipment name (switchboard, panelboard, MCC), then by frame ampere rating.

F. Ground fault protection (GFP) trip units shall be calibrated and tested prior to energizing any equipment served by GFP devices.

G. The Contractor shall furnish the necessary instruments and labor required for testing, calibration, and implementation of engineered settings.

H. Tests and adjustments shall be made prior to acceptance of the electrical installation by the Engineer, and a certificate of inspection and acceptance of the electrical installation shall be provided by local inspection authorities.

I. Any equipment or wiring provided, which through testing proves to be defective or operating improperly, shall be corrected or replaced promptly, at no additional cost to the Owner.

3.20 COORDINATION STUDY

A. The Contractor shall provide an overcurrent and ground-fault device coordination study to determine device types and trip settings, in order to achieve a fully-coordinated electrical power delivery system. Clearly indicate all component equipment/device conflicts that exist based on the study information. Provide recommendations for a fully coordinated system.

B. The study shall include service entrance switchboard main devices and downstream overcurrent and feeder ground fault devices.

C. The study shall be performed by an Engineer registered in the state in which the project is being constructed.

D. Submit a sealed written report inclusive of backup data, graphs, charts, coordination curve overlays, and final settings for each adjustable parameter of each overcurrent and feeder ground fault device.

E. The coordination study shall be completed prior to any affected equipment submittals are prepared for review. Coordinate equipment.

END OF SECTION 26 05 00

ELECTRICAL ACCESSIBILITY / CLEARANCE CHECKLIST (See Paragraph 3.8.E)									
Bldg. Name	Equipment Name	Room No.	Acceptable Access		Conflict	Date	Action	Observer	
			Yes	No				Owner	Contractor

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SECTION 26 05 01

SCOPE OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. The work under this Division includes furnishing all labor, material and equipment necessary for the installation and placing into operation of the electrical systems as indicated on the drawings.

B. The work shall also include the completion of such minor details of electrical work not mentioned or shown which are necessary for the successful operation of all electrical systems described on the drawings or required by these specifications.

1.2 SCOPE

A. The work includes, but is not necessarily limited to, furnishing and installing the following:

1. Complete power and lighting systems, service switchboards, distribution switchboards, distribution panelboards, generators and all accessories, transformers, branch circuit panelboards, switches, feeders, branch circuits, lighting fixtures, lamps, controls and accessories.
2. Motor and power wiring for all motors and/or equipment furnished under the contract. Except as otherwise specified to be furnished by or under other Divisions of these specifications, all wiring devices, starter wiring, conduit, feeders, control wiring, accessories and final connections to all equipment shall be furnished under this section.
3. Install controls for all equipment except as specified under automatic temperature control system.
4. All equipment and materials specified in this Division.
5. Empty conduit systems as indicated on the drawings.
6. All other items and/or work indicated on the drawings.
7. Equipment lists and maintenance manuals.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 26 05 01

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SECTION 26 05 13

MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cables and related cable splices, terminations, and accessories for medium-voltage (2001 to 35,000 V) electrical distribution systems.

B. Provide fault current indicator on each cable at the source of the feeder.

1.2 SUBMITTALS

A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

B. Cables shall be provided with a 40 year warranty.

2.2 SYSTEM DESCRIPTION

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

B. Comply with NFPA 70.

2.3 CABLES

A. Cable Type: Type MV 105.

B. Comply with UL 1072, AEIC CS8, ICEA S-93-639/NEMA WC 74, and ICEA S-97-682.

C. Conductor: Copper (or Aluminum where specifically indicated on the plans).

D. Conductor Stranding: Compact round, concentric lay, Class B.

E. Conductor Insulation: Ethylene-propylene rubber.

1. Voltage Rating: 5 or 15 kV (based on system voltage as indicated on the plans).
2. Insulation Thickness: 133 percent insulation level.

F. Shielding: Copper tape, helically applied over semiconducting insulation shield.

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G. Three-Conductor Cable Assembly (where specifically indicated on the plans): Three insulated, shielded conductors cabled together with ground conductors.

H. Cable Jacket: Sunlight-resistant PVC.

2.4 CONNECTORS

A. Comply with ANSI C119.4 for connectors between aluminum conductors or for connections between aluminum to copper conductors.

B. Copper-Conductor Connectors: Aluminum barrel crimped connectors.

2.5 SOLID TERMINATIONS

A. Multiconductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.

1. Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.

B. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone-rubber, insulator modules; shield ground strap; and compression-type connector.

2.6 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Load-Break Cable Terminators: Elbow-type units with 200-A-load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

D. Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.

1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.

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3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

F. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.7 SPLICE KITS

A. Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, materials, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.

2.8 MEDIUM-VOLTAGE TAPES

A. Ethylene/propylene rubber-based, 30-mil splicing tape, rated for 130 deg C operation. Minimum 3/4 inch wide.

B. Silicone rubber-based, 12-mil self-fusing tape, rated for 130 deg C operation. Minimum 1-1/2 inches wide.

C. Insulating-putty, 125-mil elastic filler tape. Minimum 1-1/2 inches wide.

2.9 ARC-PROOFING MATERIALS

A. Tape for First Course on Metal Objects: 10-mil- thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, and compatible with cable jacket.

C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1 inch wide.

2.10 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-97-682 before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

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B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches on the pull rope.

1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.
2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

E. Install direct-buried cables on leveled and tamped bed of 3-inch- thick, clean sand. Separate cables crossing other cables or piping by a minimum of 2 inches of tamped earth, plus an additional 2 inches of sand. Install permanent markers at ends of cable runs, changes in direction, and buried splices.

F. Install "buried-cable" warning tape 12 inches above cables.

G. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.

H. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.

I. Install conductors without splice, except as specifically indicated on the plans install cable splices with standard kits.

J. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.

K. Install separable insulated-connector components as follows:

1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.
3. Standoff Insulator: At each terminal junction, with one on each terminal.

L. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:

1. Clean cable sheath.
2. Wrap metallic cable components with 10-mil pipe-wrapping tape.

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3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
5. Band arc-proofing tape with two layers of 1-inch- wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.

M. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

N. Identify cables according to Section 26 05 53 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.2 FIELD QUALITY CONTROL

A. Testing shall be performed by an independent third party testing agency.

B. Perform the following tests and inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.
3. Perform Partial Discharge test of each new conductor according to NETA ATS, Ch. 7.3.3 and to test equipment manufacturer's recommendations.

C. Prepare test and inspection reports.

END OF SECTION 26 05 13

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SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS & CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install wire and cable for branch circuits and feeders as specified herein and as shown on the drawings.

PART 2 - PRODUCTS

2.1 WIRE AND CABLE

A. All wire and cable shall be new, 600-volt insulated copper, of types specified below for different applications. All wire and cable shall bear the UL label and shall be brought to the project in unbroken packages. Wire and cable #4 AWG size and smaller shall be type THHN or THWN. Wire and cable larger than #4 AWG size and air conditioning feeders shall be type XHHW-2.

B. Approved Manufacturers are Calec, Hi-Tec, Capitol, Rome, Essex, or General.

C. Wire Pulling Lubricant: Richards "Gel Lube 7/5"; American Polywater A, C, G&J; Quelcor "Quelube"; American Colloid "Slip X-300"; Thomas/Jet Line "Slipry Loob"; Ideal "Wire Lube"; Mac "Wirepull"; Minerallac "Wire-Wax"; or Electro "Y-er Eas."

D. Metal-clad (MC) cable shall be steel corrugated interlocking type and shall include an equipment ground conductor, AFC, AmerCable, or as accepted. Metal-clad (MC) cable shall not be permitted to be used in this project unless indicated on the drawings or as noted in PART 3 of this Section.

E. Mineral insulated cable shall be AmerCable, M.I. Cable Company (MICC), or as accepted.

F. Armor-clad (AC) cable shall not be permitted to be used in this project.

G. Fire Rated Cable Assemblies shall be Draka Cableteq "Lifeline RHW" 600-volt copper, or as accepted.

2.2 TERMINATIONS, SPLICES, AND JOINTS

A. Terminations at Circuit Breakers and Switches:

1. #10 and #8 AWG wire, locking tongue lug, Buchanan "Termend," or as accepted.
2. #6 AWG and larger wire, round flange solderless lug, Burndy "Quick-Lug" type QDA, or as accepted.

B. Fixture Connections: Pressure-type solderless connectors, Buchanan, Scotchlok, Wing Nut, or accepted equal.

C. Motor Connections: Solderless lug with RayChem GelCap, or as accepted.

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D. Wire Splices:

1. Joints in Wire:

a. #10 AWG and smaller wire, pressure-type solderless connectors, Buchanan, Scotchlok, Wing Nut, or as accepted.
b. #8 AWG and larger wire, irreversible compression type, Burndy, Ilsco, or as accepted.

2. Wire Taps: Solderless lug, solderless compression lug, each with Raychem Gtap, Ilsco GTA, or GTT with insulating cover, or as accepted.
3. Exterior Below Grade Joints in Wire (Specific, case by case approval by the Engineer is required): Solderless lug, solderless compression lug, each with Raychem GelCap or as accepted.

2.3 APPLIED INSULATION

A. Insulating materials shall be listed for the application. Voltage rating shall be equal to or greater than the factory-applied wire insulation. Raychem, 3M, Ilsco, or as accepted.

2.4 MARKERS AND TAGS

A. Plastic Wire Markers: T&B or Brady.

B. Thermoplastic electrical insulating tape shall be 7 mil flame retardant and weather resistant to hot and cold weather, applies well at 0 degrees F, has an operating range up to 220 degrees F, and meets the requirements of ASTM D-3005-72 Type 1, UL 510, HHI-595C, and CAS Bulletin No. 561A (105 degrees C).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Conductors for branch circuit lighting, receptacle, power and miscellaneous systems must be a minimum of #12 AWG. Wire indicated to be larger than #12 AWG shall be increased the entire length of the circuit.

B. Provide dedicated neutral conductors for all multiwire branch circuits except where the branch circuit supplies only one piece of utilization equipment.

C. Wire and cable shall be pulled into conduits without strain, using an approved lubricant.

D. In no case shall wire be re-pulled if same has been pulled out of a conduit run for any purpose.

E. No conductors shall be pulled into conduit until conduit system is complete, including junction boxes, pull boxes, etc. Wire sized #14 through #12 AWG shall be solid; wire sized #10 AWG and larger shall be stranded.

F. All connections to circuit breakers, switches, fixtures, motors, and all joints in wires shall be made as noted below:

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1. Terminations at Circuit Breakers and Switches:

   a. #12 AWG wire formed around binding post or screw.
   b. #10 and #8 AWG wire, locking tongue lug.
   c. #6 AWG and larger wire, round flange, solderless lug.

2. Fixture Connections: Circuit wiring connections to fixture wire shall be made with pressure-type solderless connectors.
3. Motor Connections: Solderless lug.
4. Joints in Wire:

   a. #10 AWG and smaller wire, pressure-type solderless connectors.
   b. #8 AWG and larger wire, irreversible compression type.

5. Wire Taps: Solderless lug, solderless compression lug.
6. Exterior Below Grade Joints in Wire (Specific, case by case approval by the Engineer is required): Solderless lug, solderless compression lug.
7. Solderless connectors not used for grounding shall be insulated. Applied wire insulation voltage rating shall be equal to or greater than the factory-applied wire insulation. Insulate by one of the following methods:

   a. One or more layers of rubber tape, equal in thickness to the conductor insulation, followed by two layers of electrical vinyl tape.
   b. Pre-manufactured insulating caps.
   c. Heat shrink insulating sleeve or tape. Shrink in accordance with the manufacturer's recommendations.

G. Wire compression type sleeves or lugs shall be installed with the manufacturer's recommended tool, in accordance with their published instructions.

3.2 COLOR CODING AND MARKING

A. All wiring throughout shall be color-coded as follows:

	480 Volt System	208 Volt System
A Phase	Brown	Black
B Phase	Orange	Red
C Phase	Yellow	Blue
Neutral*	Grey	White
Ground	Green	Green
Iso Ground		Green with orange stripe

*Where multiple neutrals are installed within the same raceway, each individual neutral shall be distinctly identified by one or more color stripes.

B. All control wiring in a circuit shall be color-coded, each phase leg having a separate color, and with all segments of the control circuit, whether in apparatus or conduit, utilizing the same color-coding.

C. Wiring must be color-coded throughout its entire length, except that feeders may have color-coded plastic tape at both ends and all accessible points.

D. At all terminations of control wiring, the wiring shall have a numbered wire marker.

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3.3 MANUFACTURED CABLING

A. Metal clad (MC) cables may be used where approved.

1. MC cable shall be installed with anti-shorting devices at each termination. MC cable shall be terminated with fittings designed for the application.

B. In medical applications, mineral insulated (MI) cables may be used for life safety or critical system circuits within architectural millwork.

1. MI cable shall be terminated with fittings designed for the application.

3.4 FIRE RATED CABLE ASSEMBLIES

A. Fire rated cable assemblies shall be permitted where fire rated cable assemblies are specifically allowed by the NEC. Coordinate use with project Fire/Life Safety Analysis Documents. Provide copy of listing requirements to local AHJ for inspection during construction. Install according to the listing requirements.

3.5 GENERAL WIRING

A. Drawings, in general, indicate location of items of equipment. Exact locations of motors and other devices are to be determined in the field by the Contractor. Provide an electrical feed for all equipment, not smaller than shown or NEC size where size is omitted from drawings, together with a suitable circuit protective device. Verify panel schedules and layout, maintaining number of spare branches indicated.

B. Complete rough-in requirements of all equipment to be wired under the Contract are not indicated. Coordinate with respective trades furnishing equipment or with the Architect, as the case may be, for complete and accurate requirements to result in a neat, workman-like installation.

C. Feeder conductors to distribution equipment shall be adjusted to limit voltage drop. Contractor shall review the anticipated installed length and confirm the selected feeder provides not more than 2% voltage reduction. Base calculations on 80% of the supplied equipment bus rating or the actual load whichever is greater.

D. Conductors for branch circuit lighting, receptacle, power, and miscellaneous systems shall be as stated in this section. Wire indicated specifically to be larger than the specified minimum shall be increased for the entire length of the circuit.

E. Conductor sizes for lighting, receptacles, and small motor branch circuits with less than a 20-ampere connected load are not shown. Conductors for such circuits are sized as follows:

1. For Branch Circuits (120V) 65 Feet in Length from Branch Circuit Panel to Center of Load: Not smaller than No. 12. (16 amps)
2. For Branch Circuits (120V) up to 110 Feet in Length from Branch Circuit Panel to Center of Load: Not smaller than No. 10. (16 amps)
3. For Branch Circuits (120V) up to 165 Feet in Length from Branch Circuit Panel to Center of Load: Not smaller than No. 8. (16 amps)
4. For Branch Circuits (120V) up to 255 Feet in Length from Branch Circuit Panel to Center of Load: Not smaller than No. 6. (16 amps)
5. For Branch Circuits (208V) 110 Feet in Length from Branch Circuit Panel to Center of Load: Not smaller than No. 12. (16 amps)

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6. For Branch Circuits (208V) up to 185 Feet in Length from Branch Circuit Panel to Center of Load: Not smaller than No. 10. (16 amps)
7. For Branch Circuits (208V) up to 280 Feet in Length from Branch Circuit Panel to Center of Load: Not smaller than No. 8. (16 amps)
8. For Branch Circuits (208V) up to 440 Feet in Length from Branch Circuit Panel to Center of Load: Not smaller than No. 6. (16 amps)
9. For Branch Circuits (277V) 150 Feet in Length from Branch Circuit Panel to Center of Load: Not smaller than No. 12. (16 amps)
10. For Branch Circuits (277V) up to 250 Feet in Length from Branch Circuit Panel to Center of Load: Not smaller than No. 10. (16 amps)
11. For Branch Circuits (277V) up to 380 Feet in Length from Branch Circuit Panel to Center of Load: Not smaller than No. 8. (16 amps)
12. For Branch Circuits (277V) up to 590 Feet in Length from Branch Circuit Panel to Center of Load: Not smaller than No. 6. (16 amps)

END OF SECTION 26 05 19

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SECTION 26 05 26

GROUNDING & BONDING OF ELECTRICAL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install grounding and grounding conductors as specified herein and as shown on the drawings.

PART 2 - PRODUCTS

2.1 GROUNDING ELECTRODES

A. Concrete-encased electrodes shall be sized as noted on the plans, but not less than #4 AWG solid copper.

B. Ground ring shall consist of copper stranded conductor, sized as noted on the plans, but not less than #2 AWG. Minimum length shall be 20 feet.

C. Ground rods shall be copper or copper-clad steel, 3/4" diameter by 10-feet long, listed for the purpose.

D. Plate electrodes shall be sized as noted on the plans, but not less than 2 foot round x 1/4" (6.35 mm) thick steel or iron. Where copper or bronze plates are used, thickness shall not be less than 1/16" (1.5875 mm).

PART 3 - EXECUTION

3.1 GROUNDING

A. All panelboard cabinets, equipment, enclosures, and conduit systems shall be grounded securely in accordance with pertinent sections of the NEC, as amended by any local codes. Conductors shall be copper. All electrically operated equipment shall be bonded to the grounded conduit system. All non-current carrying conductive surfaces that are likely to become energized and subject to personal contact shall be grounded by one or more of the methods detailed in the NEC. All ground connections shall have clean contact surfaces. Install all grounding conductors in conduit and make connections readily accessible for inspection. Furnish and install grounding electrodes as described on the drawings.

B. Grounding of metal raceways shall be assured by means of grounding bushings on feeder conduit terminations at the service entrance, distribution switchboards and panelboards, and by means of a continuous, stranded, copper grounding wire extended from the ground bus in the enclosure to the conduit grounding bushings.

C. A separate insulated grounding conductor, sized per the NEC, shall be installed in all electrical metallic tubing (EMT).

D. Where the project includes cable tray, provide #6CU AWG ground conductor, 1/2"C between grounding electrode system and cable tray. Utilize listed grounding connectors.

E. Install concrete encased electrodes per the NEC.

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F. Install ground rings per the NEC.

G. Install ground rods per the NEC.

H. Install plate electrodes per the NEC.

END OF SECTION 26 05 26

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SECTION 26 05 33

RACEWAY & BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install conduit and fittings as shown on the drawings and as specified herein.

1.2 COORDINATION

A. It shall be the responsibility of the Contractor to consult the other trades before installing conduit and boxes. Any conflict between the location of conduit and boxes, piping, ductwork, or structural steel supports shall be adjusted before installation. In general, large pipe mains, waste, drain, and steam lines which pitch, large air ducts, and all structural steel shall be given priority.

B. Conduit size shall be such that the required number and sizes of wires can be easily pulled in and the Contractor shall be responsible for the selection of the conduit sizes. Conduit sizes shown on the drawings are minimum sizes in accordance with appropriate tables in the NEC. If, because of bends or elbows, a larger conduit size is required, the Contractor shall so furnish without further cost to the Owner.

C. The Contractor shall be entirely responsible for the proper protection of this work from the other trades on the project. When conduit becomes bent, holes are punched through same, or outlets are moved after being roughed-in, the Contractor shall replace same, without additional cost to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. Conduit sizes for various numbers and sizes of wire shall be as required by the NEC Chapter 9, but shall not be smaller than 3/4" size except as otherwise noted.

B. Each length of conduit shall be stamped with the name or trademark of the manufacturer and shall bear the UL label.

C. All concrete inserts and pipe clamps shall be galvanized. All steel bolts, nuts, washers, and screw shall be galvanized or cadmium plated. Individual hangers, trapeze hangers, and rods shall be prime-coated.

D. Calibrated pull string/measuring tape shall be Greenlee Part No. 435, or as accepted.

2.2 CONDUIT

A. Rigid galvanized steel (RGS), intermediate metallic conduit (IMC), and electrical metallic tubing (EMT) shall be Allied Tube & Conduit, Republic Conduit, Western Tube & Conduit Corp., or as accepted.

B. PVC coated RGS or IMC shall be Robroy Industries Inc., or as accepted.

C. Polyvinyl chloride (PVC) conduit shall be Schedule 40 minimum, Carlon, Cantex, or as accepted.

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D. Liquid-tight flexible metallic conduit shall be Anaconda Sealtite Type UA, or as accepted.

E. Flexible metal tubing, electrical non-metallic tubing (ENT), and liquid-tight nonmetallic flexible conduit (LFNC) shall not be allowed.

F. Conduit systems shall be color coded. Reference Section 26 05 53 Identification for Electrical Systems for additional requirements.

2.3 FITTINGS

A. Couplings and connectors for RGS or IMC conduit shall be steel, threaded, and rain- and concrete-tight. Couplings and connectors that are exposed, installed in hollow construction, or above ceilings shall be threaded, unicouple or compression type. Steel set-screw type or compression-type, steel, watertight fittings shall be used for EMT. Die-cast or pressure-cast EMT fittings shall not be allowed.

B. Bushings and locknuts shall be malleable iron with sharp, clean-cut threads.

C. Fittings shall be Appleton, Crouse-Hinds, Steel City, T & B, or as accepted.

D. Expansion joint fittings on RGS or IMC conduit shall be Crouse-Hinds type XJ, or as accepted. Expansion joint fittings on PVC conduit shall be Carlon type E945, or as accepted.

E. Entrance seals shall be O.Z. type FSK, or as accepted.

F. Explosion-proof seals shall be listed for 40% fill application, vertical and horizontal, and shall be Appleton type EY, or as accepted.

G. Couplings and connectors for PVC conduit shall be of the same manufacturer as the conduit to be coupled or connected. Fittings shall be provided in accordance with the manufacturer's recommendations.

2.4 SURFACE RACEWAY

A. Where devices are shown within the surface raceway, they shall meet the requirements of a "Multi Outlet Assembly" as described in Division 26.

1. Assemblies shall be metallic, two compartment, listed for grounding as a raceway, and shall accept full size wiring devices. Provide all components necessary for a complete installation.
2. Product provided shall be Walker/Wiremold G4000 Series, or as accepted.
3. Coordinate finish color with the Architect prior to ordering.

2.5 BOXES

A. All boxes must conform to the provisions of Article 314 of the NEC. All boxes shall be of the proper size to accommodate the quantity of conductors enclosed in the box. Boxes shall not be less than 4" square and 1-1/2" deep unless otherwise noted.

B. All data boxes must conform to the provisions of Article 314 of the NEC. All boxes shall be of the proper size to accommodate the quantity of cables enclosed in the box. Boxes shall not be less than a double gang square and 2-1/4" deep, with a single gang trim and 1" conduit homerun, unless otherwise noted. Provide 1-1/4" conduit homerun where a second data drop is included.

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C. Generally, boxes shall be hot-dipped galvanized steel with knockouts. Where recessed, boxes shall have square cut corners. Outlet, switch, and gang size junction boxes on exterior surfaces or in damp locations shall be corrosion-resistant, cast malleable iron. Boxes shall have threaded hubs for rigid conduit and neoprene gaskets for their covers. Boxes shall be Appleton type FS or FD, Crouse-Hinds, or as accepted. Conduit bodies shall be corrosion-resistant, cast malleable iron and shall have threaded hubs for rigid conduit and neoprene gaskets for their covers. Bodies shall be Appleton Unilets, Crouse-Hinds, or as accepted.

D. Deep boxes shall be used in walls covered by wainscot acoustical wall panels or paneling and in walls of glazed tile, brick, or other masonry which will not be covered with plaster. The bottom of the box shall be located on the horizontal joint. Through-the-wall type boxes shall not be used unless specifically called for. All boxes shall be non-gangable. Boxes in concrete shall be of a type to allow the placing of conduit without displacing the reinforcing bars. All lighting fixture outlet boxes shall be equipped with the proper fittings to support and attach a light fixture.

E. All light switch, receptacle, and similar outlets shall be provided with approved boxes, suitable for their function. Back boxes shall be furnished and installed as required for the equipment and/or systems under this contract.

F. Pull and junction boxes shall be substantially-made code-gauge boxes with screw covers. Boxes shall be rigid under torsional and deflecting forces and shall be provided with angle-iron framing where required. Boxes shall be 4" square with a blank cover in unfinished areas and with a plaster ring and blank cover in finished areas, and shall be installed where required to pull cable or wire, but only in finished areas by approval of the Architect. Boxes shall be rigidly attached to the structure, independent of any conduit support. Boxes shall have their covers accessible. Covers shall be fastened to boxes with machine screws to ensure continuous contact all around. Covers for surface-mounted boxes shall line up evenly with the edges of boxes. Covers for flush-mounted oversize boxes shall extend 3/4" past the box all around. Covers for 4" square and 4" ganged boxes shall extend 1/4" past the box all around.

G. Outlets are only approximately located on the plans and great care must be used in the actual location of outlets by consulting the various detailed drawings. Outlets shall be flush with finished wall or ceiling. Trim, cases, or other fixtures shall have their boxes installed symmetrically on such trim or fixture. Refer to drawings for location and orientation of all outlet boxes.

H. Furnish and install all plaster rings as may be required. Plaster rings shall be installed on all boxes where the boxes are recessed. Plaster rings shall be of a depth to reach the finished surface. Extension rings, where required, shall be installed so that the plaster ring is flush with the finished surface.

I. Exterior gang type boxes shall be cast type. Where any box occurs within 12" of the earth, provide cast iron type.

J. Where exposed to weather, install WLRD/WLRS covers by Crouse-Hinds, Arrow-Hart, or as accepted.

K. Boxes with unused punched-out openings shall have the openings filled with factory-made knockout seals.

L. Construct pull boxes and rack space for future conduits equal to 25% of present runs. Provide required barriers. Attach a plastic label to each pull box cover listing the feeder numbers enclosed within and the source of current. Identify each conduit at pull box termination with voltage and feeder number in red. Provide sufficient cable slack at terminations and in junction and pull boxes to allow for cable contraction and for future splicing. Fireproof cable in pull boxes where more than one feeder is enclosed.

M. Boxes shall be as manufactured by Steel City, Appleton, Raco, or as accepted.

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2.6 FLOOR BOXES

A. All boxes must conform to the provisions of Article 314 of the NEC. Box construction shall be UL 514A listed.

B. The floor box unit shall be constructed of cast iron. The box assembly shall provide for 2" pre-pour and 1/2" after-pour adjustment. The box shall be concrete-tight and treated to prevent corrosion. The box shall be of the proper size to accommodate the quantity of conductors enclosed in the box. Each compartment shall accept 1" conduits. Provide barriers between systems operating at different voltages.

C. Floor box internal activation shall include mounting plates and brackets for devices indicated as required for the intended use.

D. Floor box activation shall be made of cast brass and consist of a carpet or hard surface flange and brass cover plate with openings as required for the intended use.

2.7 RECESSED MULTI-SERVICE FLOOR BOXES

A. Meet the same requirements as floor boxes except as follows:

1. Telephone/data compartments shall accept up to 1-1/4" conduits.
2. Activation covers shall be cast metal material, brass as specified, and shall be designed to accept carpet or hard flooring inserts.
3. The box and activation shall be as manufactured by Wiremold/Walker Model RFB4-CI Series with RAKMII Series activation, or as accepted.

PART 3 - EXECUTION

3.1 CONDUIT

A. Applications:

1. PVC conduit may be used for all exterior underground systems, in slab, below slab on grade, and in concrete or masonry walls. All plastic conduit shall be rigid, Schedule 40, heavy wall PVC. All PVC conduit shall be UL listed. Install bell ends at all conduit terminations in manholes and pull boxes. All bends over 30 degrees shall be made with wrapped intermediate metallic conduit. All plastic conduit, except that used for telephone, shall contain a code-sized bond wire.
2. Intermediate metallic conduit (IMC) shall be used for all conduit larger than 2", and for all underground or in-slab conduit, except where PVC is permitted or where rigid galvanized steel is specified. IMC conduit shall be used in explosion-proof areas.
3. Rigid galvanized steel (RGS) conduit shall be used in place of IMC or where it is specified on plans.
4. RGS or IMC conduit shall be used where exposed to weather or subject to mechanical damage, to house medium-voltage conductors in all above-ground locations, and in mechanical rooms below 10 feet above finished floor.
5. PVC-coated rigid galvanized steel (PVC-RGS) conduit shall be used in corrosive areas where exposed to physical damage, or where specified on the plans.
6. Liquid-tight flexible metallic conduit, in lengths not exceeding 4 feet, shall be used to connect motors and transformers. Installation shall be such that considerable slack is realized. The conduit shall contain a separate grounding conductor. Connectors shall be steel or malleable iron.

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7. Galvanized steel, flexible metallic conduit, in lengths not exceeding 6 feet, shall be used to connect fire alarm and wiring devices mounted in movable panels such as acoustical ceiling tiles, etc. Installation shall be such that considerable slack is realized. The conduit shall contain a separate grounding conductor. Connectors shall be steel or malleable iron.
8. All other conduit shall be electrical metallic tubing (EMT). A separate insulated grounding conductor, sized per the NEC, shall be installed in EMT.

B. Conduit shall be continuous from outlet to outlet, cabinet or junction box, and shall be so arranged that wire may be pulled in with the minimum practical number of junction boxes.

C. All conduit shall be concealed wherever possible. All conduit runs may be exposed in mechanical equipment rooms, electrical equipment rooms, and electrical closets, and where indicated on the drawings. No conduit shall be run exposed in finished areas without specific acceptance by the Architect.

D. Exposed conduit shall be run in straight lines at right angles to or parallel with walls, beams, or columns. In no case shall conduit be supported or fastened to other pipes or installed to prevent the ready removal of other pipe.

E. Where possible, all conduit for wiring within stud or moveable partitions shall enter the partition from above.

F. Provide sleeves and chases where conduit passes through floors or walls as part of the work of this section. Core drilling will only be permitted where accepted by the Architect.

G. Conduit stubbed up/down or through floor slabs shall be wrapped RGS or wrapped IMC with a minimum of 6" of conduit exposed out of slab for connection of threaded or compression fitting. Where conduit bends extend out of slab, the conduit shall be placed at the maximum allowable distance from the exit surface and shall have a bend radius as allowed by code to provide as true and square a conduit exit as possible. Conduit deck flanges will be used where conditions allow and where the flange can be tightly secured flush to the face of a concrete form.

H. Openings through fire-rated floors and fire walls through which conduit passes shall be sealed by fire stop material to seal off cold smoke and toxic fumes. Fire-seal material shall have an hourly fire rating equal to or higher than the fire rating of the floor or wall through which the cable or conduit passes. Material used shall conform to the Authority Having Jurisdiction requirements. Openings through smoke walls through which cable or conduit passes shall be sealed with non-shrink, non-combustible material approved by the Authority Having Jurisdiction to seal off cold smoke and toxic fumes.

I. Conduit above lay-in grid-type ceilings shall be installed in such a manner that it does not interfere with the "lift-out" feature of the ceiling system.

J. Conduit runs shall be installed to maintain the following minimum spacing wherever practical:

1. Water and Waste Piping: Not less than 3".
2. Steam and Condensate Lines: Not less than 12".
3. Radiation and Reheat Lines: Not less than 6".

Where contact between these systems is unavoidable, approved insulation shall be used between the systems.

K. All underground conduit outside of any buildings shall be a minimum of 24" below finished grade, except where noted otherwise on the drawings.

L. All underground feeder conduit (this does not include branch circuits) outside of any buildings shall be concrete encased. Concrete shall be 3/8" aggregate with a nominal compressive strength of 2,500 PSI.

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The slump shall be 7" to 8". It shall have enough slump to flow to the bottom of the duct formation and not so wet as to cause the ducts to float. Each conduit shall be completely encased in concrete not less than 3" all around. Concrete shall not be poured until conduit has been inspected by the Architect. Separators or spacing blocks shall be made of plastic or other suitable non-metallic, non-decaying material placed on not greater than 5-foot centers. Ducts shall be anchored to prevent movement during placement of concrete.

M. Provide corrosion protection for metallic conduit under concrete or in earth. Provide half-lap wrap of polyethylene 20-mil tape, factory PVC coating, or as accepted. Where PVC coating is provided, joints must be sealed in accordance with the coating manufacturer's published instructions.

N. PVC-coated rigid galvanized steel (PVC-RGS) joints must be sealed in accordance with the coating manufacturer's published instructions.

O. Empty conduit shall be provided with a nylon pull string installed in each.

P. Medical equipment conduit shall be provided with a calibrated pull string/measuring tape installed in each.

Q. Bending: Changes in direction shall be made by bends in the conduit wherever possible, and these bends shall be made smooth and even without flattening the pipe or flaking the finish. Bends shall be of as long a radius as possible, but in no case less than shown in the NEC.

R. Not more than three 90 degree bends will be allowed in one raceway run. Where more bends are necessary, a pull box shall be installed. All bends in 1" and smaller conduit shall be made with a conduit bender, and all larger conduit sizes shall have machine bends.

S. Plastic conduit joints shall be made up in accordance with the manufacturer's recommendations for the particular conduit and coupling selected. Conduit joint couplings shall be made watertight. Plastic conduit joints shall be made up by brushing a plastic solvent cement on the inside of a plastic coupling fitting and on the outside of the conduit ends. The conduit and fitting shall then be slipped together with a quick one-quarter turn twist to set the joint tightly. Transition from plastic to steel conduit shall be with PVC female threaded adaptors occurring at a box or enclosure.

T. Plastic conduit shall be stored on a flat surface and protected from the direct rays of the sun.

U. The ends of all conduit shall be securely plugged, and all boxes temporarily covered to prevent foreign material from entering the conduit. All conduit shall be thoroughly swabbed out with a dry swab to remove moisture and debris before conductors are drawn into place.

V. Conduit installation shall be such that conduits are not abraded, scraped, flattened, dented or wrinkled and the interior diameter is not effectively reduced. Install conduit in such a way that condensation or water cannot be trapped.

W. Spare conduits from flush-mounted panelboards to accessible location above ceiling. Cap and mark for future use.

X. Provide moisture-tight hubs for conduit entries to top or sides or exterior boxes, gutters, panelboards, switchboards, and other electrical enclosures.

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3.2 FITTINGS

A. Bushings and Locknuts: Where conduit enters boxes, panels, cabinets, etc., it shall be rigidly clamped to the box by locknuts on the outside and inside, and a bushing on the inside of the box. All conduit shall enter the box squarely.

B. Provide insulated bushings per the NEC on all conduit. The use of insulated bushings does not exclude the use of double locknuts to fasten conduit to the box.

C. Provide threaded bushings and connectors for all terminations of telecommunications conduits at cable trays. Clamp conduit to tray with O-Z/Gedney CTC clamp or as approved.

D. Provide expansion fittings for all conduit where it crosses building expansion joints, or not to exceed 100 feet apart. Fittings shall be complete with bonding jumpers and clamps and shall be suitably bonded to conduit.

E. Conduit runs shall not exceed 90 feet between boxes.

F. Provide weatherproof fittings in exterior installations or as noted on the plans.

3.3 SUPPORTS

A. All raceways that are not buried or embedded in concrete shall be supported by straps, clamps, or hangers to provide a rigid installation.

B. Conduit shall be supported at intervals no greater than 8 feet, within 3 feet of any bend, and within 3 feet of every outlet, junction box, panel, etc. This shall apply to vertical runs as well as horizontal runs. Where conduit is run individually, it shall be supported by approved conduit straps or beam clamps. Straps shall be secured by means of toggle bolts on hollow masonry; expansion shields and machine screws or standard preset inserts on concrete or solid masonry; machine screws or bolts on metal surfaces; and wood screws on wood construction. No perforated straps or wire hangers of any kind will be permitted. Where individual conduits are suspended from the ceiling, or above ceiling, they shall be supported by hanger rods and hangers. Conduit installed exposed in damp locations shall be provided with clamp backs under each conduit clamp, to prevent accumulation of moisture around the conduit. Where a number of conduits are to be run exposed and parallel, one with another, they shall be grouped and supported by trapeze hangers. Hanger rods shall be fastened to structural steel members with suitable beam clamps or to concrete inserts set through the opening provided in the concrete inserts. Beams clamps shall be suitable for structural members and conditions. Rods shall be galvanized steel, 3/8" diameter minimum. Each conduit shall be clamped to the trapeze hanger with conduit clamps.

3.4 GENERAL

A. Install all boxes parallel and perpendicular to the finished floor. Adjust all flush mounting positions so as to compensate for wall material thickness. Where devices occur in the same horizontal viewing plane, align devices.

B. Where outlet boxes occur on opposite sides of a common wall, do not place back-to-back or use through-the-wall boxes, so as to limit sound transmission between rooms.

C. Where fire-rated walls occur, all membrane penetrations shall comply with the International Building Code (IBC) for walls/partitions, and for floor-ceilings/roof-ceilings. Outlet boxes in rated walls shall be steel. Outlet boxes on opposite sides of a rated wall shall be separated by a minimum of 24 inches horizontally.

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D. Support all boxes independently of conduit, except cast type which may be supported by rigid steel conduit only. Secure flush-mount boxes to wall and interior partition studs using stamped steel bridges as required to accurately position boxes. Secure ceiling-hung boxes to adjustable steel channel fasteners.

E. All cabinets and boxes shall be secured by means of toggle bolts on hollow masonry; expansion shields and machine screws or standard precast inserts on concrete or solid masonry; machine screws or bolts on metal surfaces; and wood screws on wood construction. All wall- and ceiling-mounted outlet boxes shall be supported by bar supports extending from the studs or channels on either side of the box. Boxes mounted on drywall or plaster shall be secured to wall studs or adequate internal structure.

F. Boxes with unused punched-out openings shall have the openings filled with factory-made knockout seals.

G. Where emergency power and normal power are located in the same outlet box or a potential of 480 volts is present in a switch box, install partition barriers to separate the various systems.

3.5 RECESSED MULTI-SERVICE FLOOR BOXES

A. Install boxes level, parallel, and perpendicular to the finished floor and walls, respectively. Adjust all finish trims tight to the respective floor material.

B. Provide pre-pour support below each box consisting of 1" thick concrete pad, size as needed.

C. Provide a vapor-barrier below each galvanized steel floor box or pocket. The barrier shall extend 12" beyond each side of the box.

3.6 SEPARATE CONDUIT SYSTEMS

A. Each system shall be contained in a separate conduit system. This includes each power system, lighting system, signal system of whatever nature, telephone, emergency system, emergency subsystems, sound system, control system, fire alarm system, etc.

B. Each item of building equipment shall have its own run of power wiring. Control wiring may be included in properly sized conduit for equipment feeders of #6 AWG and smaller, but separate conduits shall be used for larger size feeders.

END OF SECTION 26 05 33

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SECTION 26 05 36

CABLE TRAY FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install cable tray as specified and where shown on the associated drawings.

B. Cable tray shall conform to NEMA standard VE-1 and the requirements of the National Electrical Code.

C. Acceptable manufacturers are B-Line, Cablofil, P-W Industries, and Walker.

PART 2 - PRODUCTS

2.1 CABLE TRAY

A. Cable tray system shall include all straight sections, fittings and accessories required to provide a complete and functional installation.

B. Cable tray systems shall be grounded per the NEC and shall be electrically continuous. Provide properly sized bonding jumpers at mechanically discontinuous joints and fittings. Provide bonding from cable tray to bonding bushings on telecommunications conduits where cable tray is discontinued at soffit locations.

C. Provide cable tray expansion joints as required by NEMA standard VE-1 and as required to coordinate with building expansion joints.

D. Cable tray systems shall be aluminum ladder type cable tray with size as indicated on the drawings. Bend fittings shall have a minimum turn radius of 36". Ladder type tray shall have maximum 6" rung spacing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cable tray using trapeze type hangers at 5' on center and within 1'-6" of terminations or changes of direction. 12' on center to meet NEMA 12A for 50 lb/ft loading plus a 115% safety factor. Hanger rods shall be fastened to structural steel members with suitable beam clamps or to concrete inserts. Beam clamps shall be suitable for the structure type and mounting conditions. Hanger rods shall be galvanized steel 3/8" diameter minimum. All beam clamps, inserts and hardware shall be galvanized. Supports connected to structural steel shall be installed prior to application of fireproofing. Supports connected to existing fireproofed structural steel shall have fireproofing reapplied to damaged area after installation is completed.

B. Coordinate cable tray installation to avoid conflicts with, light fixtures, piping, duct work, or structural steel supports. Any conflict shall be adjusted before installation. In general, large pipe mains, waste, drain, and steam lines which pitch, large air ducts, mechanical equipment servicing requirements, and all structural steel shall be given priority over cable tray. Installed cable tray shall be easily accessible for

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cable above suspended ceilings and below any piping or ductwork. It shall be the responsibility of the Contractor to consult the other trades before installing cable tray.

C. Provide warning labels on cable tray system at 12'-0" intervals stating "Warning: Do NOT use as a walkway, ladder, or support for personnel. Use only as a mechanical support for cables."

D. Where cable tray must pass through fire rated walls, openings shall be sealed by fire stop materials to seal off cold smoke and toxic fumes. Fire seal material shall have an hourly fire rating equal to or higher than the wall through which the cable tray is installed.

E. Provide #6CU AWG ground conductor between discontinuous cable tray sections. Utilize listed grounding connectors.

END OF SECTION 26 05 36

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SECTION 26 05 37

CABLE BASKET FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install a continuous, rigid, welded steel wire mesh type cable "Basket" as specified and where shown on the associated drawings.

B. Cable basket shall conform to NEMA standard VE-1 and the requirements of the National Electrical Code.

C. Cable Basket Systems include straight sections, supports, and any accessories.

D. Manufacturer shall maintain an ISO 9001:2000 certification.

E. Acceptable manufacturers are B-Line, Cablofil, GS Metals Flextray Corp, or as accepted.

1.2 REFERENCES

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

B. ASTM A 510 - General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel

C. ASTM B 633 - Electrodeposited Coatings of Zinc on Iron and Steel

D. ASTM A 641 – Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire

E. ASTM A 580 – Standard Specification for Stainless Steel Wire

F. ASTM A 653 – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

G. NEMA VE1- Metal Cable Tray Systems

H. NEMA VE2- Cable Tray Installation Guidelines

I. TIA 569-A – Commercial Building Standard for Telecommunications Pathways & Spaces

J. NFPA 70 – National Electrical Code (NEC)

K. CSA C22.2 No. 126. 1-02 – Metal Cable Tray Systems

L. IEC 61537 – Cable Tray Systems and Cable Ladder Systems for Cable Management

M. American Bureau of Shipping (ABS) Steel Vessel Rules, MODU Rules, Naval Vessel Rules

N. MIL-S-901D (NAVY) – Military Specification, Requirements for Shock Tests, High Impact; Shipboard Machinery, Equipment and Systems

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O. MIL-STD-167-1 (SHIPS) – Military Standards Mechanical Vibrations of Shipboard Equipment

P. TIA -942 Data Center Standard

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's product data, including UL/CSA Classification.

B. Drawings: Submit floor plans and sections drawn to scale with scaled cable basket layout and relationships between components and adjacent structural and mechanical elements. Data presented on these drawings are as accurate as preliminary surveys and planning can determine. Field verification of all dimensions/cable basket layout is recommended.

C. Quality Certification: Provide documentation showing certification to the following standard, ISO 9001:2000.

PART 2 - PRODUCTS

2.1 CABLE BASKET

A. Cable basket system shall include all straight sections, fittings and accessories required to provide a complete and functional installation.

B. Cable basket width and length as indicated on the drawings, manufactured with ASTM A510 steel, galvanized finish ASTM A123. Bend fittings shall have a minimum turn radius of 36". Welded wire spacing in basket shall be maximum 2" x 4". Depth shall be 4", width as noted on plans. Basket fittings are to be purchased precut from the manufacturer or field fabricated from straight basket sections, utilizing Cleanshear® cutting tool or Airshear cutting tool, according to manufacturers' instructions. Supports and Accessories should be purchased from the manufacturer of the straight basket sections.

C. Cable basket shall be attached to a support by mechanical means (e.g. nuts/bolts), or by use of support tabs.

1. Support shall be from a single overhead threaded rod to a Center Hanger. Built in tabs hold basket sections in place. Hanger assembly shall include a center pipe to isolates cables from threaded rod, and a full width support bracket (metal framing channel or pre-fabricated bracket) below the basket.
2. Accessories shall include:

    a. Ground Bolt for attachment or separate ground wire to basket sections.
    b. Ground Clip for support of a separate ground wire when used outside of basket sections.
    c. Rack Clamp for attachment of basket sections to a computer rack. Rack Clamp shall be powder coated black.
    d. Drop Out support to maintain cable radius where cables exit basket. Drop out shall be capable of mounting to sides, bottom or end of basket.

D. Provide cable basket expansion joints as required by NEMA standard VE-1 and as required to coordinate with building expansion joints.

E. Metallic cable basket systems shall be grounded per the NEC and shall be electrically continuous. Provide bonding jumpers at mechanically discontinuous joints and fittings.

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PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cable basket using center support brackets and channels as appropriate. Support intervals shall be provided to meet NEMA standards for 40 lb/ft loading plus a 115% safety factor. All mounting components shall be non-ferrous materials. Hanger rods shall be fastened to structural members with suitable clamps or to concrete inserts. Hanger rods shall be 3/8" diameter minimum. All beam clamps, inserts and hardware shall be protected from corrosion. Supports connected to structural steel shall be installed prior to application of fireproofing. Supports connected to existing fireproofed structural steel shall have fireproofing reapplied to damaged area after installation is completed.

B. Coordinate cable basket installation to avoid conflicts with, light fixtures, piping, duct work, or structural supports. Any conflict shall be adjusted before installation. In general, large pipe mains, waste, drain, and steam lines which pitch, large air ducts, mechanical equipment servicing requirements, and all structural steel shall be given priority over cable basket. Installed cable basket shall be easily accessible for cable above suspended ceilings and below any piping or ductwork. It shall be the responsibility of the Contractor to consult the other trades before installing cable basket.

C. Provide cable drop out support at sides, bottom or end of basket at each basket where the cables exit the basket system. Provide at interval of one per data rack section. At data racks, each drop out shall be the same width as the basket.

D. Provide warning tags on cable basket system at 12'-0" intervals stating "Warning: Do NOT use as ladder or personnel support. Use only as a mechanical support for cables."

E. Where cable basket must pass through fire rated walls, openings shall be sealed by fire stop materials to seal off cold smoke and toxic fumes. Fire seal material shall have an hourly fire rating equal to or higher than the wall through which the cable basket is installed.

F. Provide #6CU AWG ground conductor between electrically conductive discontinuous cable basket sections. Utilize listed grounding connectors. Make only one connection to the Data Room Ground Bus. Utilize listed grounding connectors.

G. Where basket is not listed for grounding, provide a continuous #6CU AWG ground conductor through basket system, mounted on the outside. Make only one connection to the Data Room Ground Bus. Utilize listed grounding connectors.

H. Provide bonding from cable basket to bonding bushings on telecommunications conduits where cable basket is discontinued at soffit locations.

END OF SECTION 26 05 37

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SECTION 26 05 43

UNDERGROUND DUCTS & RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install multi-cell conduit as shown on the drawings and as specified herein.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Multi-Cell conduit system shall be a standard 'C' size 4.350" nominal outer diameter shell with four interior cells with 1.194" nominal interior dimension and .063" nominal wall dimension. Carlon #Multi-gard MX-4 Way. Provide conduit system with 6" bell end housings with anti-reversing gaskets.

B. Multi-Cell conduit individual cells shall be smooth interior. Utilize prelubricated nylon pull cord throughout the system. If, because of document requirements, construction coordination, a larger radius conduit bend or sweep is required, the Contractor shall so furnish without further cost to the Owner. Rigid bends shall be Carlon #Multi-gard MX-4 Way with 4' radius minimum and degrees of bend as required. Flexible bends shall be Carlon #Multi-gard MX-4 Way with 4' radius minimum and degrees of bend as required.

C. The conduit shall conform to GTS-8343, NEMA TC-10 and Bellcore CAO-8546 standards. Nominal conduit system lengths shall be 20'. Provide the UL listing number on each section of conduit.

D. The Contractor shall be entirely responsible for the proper protection of this work from the other trades on the job. When conduit becomes bent, holes are punched through same or outlets moved after being roughed-in, the Contractor shall replace same, without additional cost to the Owner.

E. Each length of conduit shall be stamped with the name or trademark of the manufacturer and shall bear the UL label.

F. Conduit shall be as manufactured by Carlon or as prior approved. No substitutions will be allowed unless prior approved.

G. Rigid Galvanized outer shell shall be used in explosion-proof areas, for all conduits above grade or where rigid galvanized steel is specified.

H. All underground installation conditions shall utilize an outer shell consisting of PVC Schedule 40.

I. Utilize accessories as required. These shall include, but not limited to coupling kit, slip coupling kit, manhole terminator kit, line blowing kit, cable lubrication point and repair kit.

J. All multi-cell conduit joints shall be made up in accordance with the manufacturer's recommendations for the particular conduit and coupling selected. Conduit joint couplings shall be made watertight.

K. All underground multi-cell conduits shall be concrete encased unless noted otherwise. Each conduit shall be completely encased in sand not less than 3" all around. Separators or spacing blocks shall be made of

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plastic or other suitable nonmetallic, non-decaying material placed on not greater than 5 foot centers. Ducts shall be anchored to prevent movement during placement of sand.

L. Plastic conduit shall be stored on a flat surface and protected from the direct rays of the sun.

M. Conduit shall be continuous from outlet to outlet, cabinet or junction box, and shall be so arranged that wire may be pulled in with the minimum practical number of junction boxes.

N. All raceways which are not embedded in sand shall be supported by straps, clamps, or hangers to provide a rigid installation. Exposed conduit shall be run in straight lines at right angles to or parallel with walls, beams, or columns. In no case shall conduit be supported or fastened to other pipes or installed to prevent the ready removal of other pipe.

O. It shall be the responsibility of the Contractor to consult the other trades before installing conduit. Any conflict between the location of conduit and boxes, piping, ductwork, or structural steel supports shall be adjusted before installation. In general, large pipe mains, waste, drain, and steam lines which pitch, large air ducts, and all structural steel shall be given priority.

P. All empty conduits shall be provided with nylon pull cord.

Q. The ends of all conduits shall be securely plugged, and all non-installed conduits temporarily covered to prevent foreign material from entering the conduits. All conduit shall be kept clean throughout the installation process. The conduit is specified as prelubricated; therefore, conduit shall be replaced if conduit is contaminated with debris.

R. Supports: Conduits shall be supported at intervals no greater than 8 feet, within 3 feet of any bend, and within 3 feet of every outlet or junction box, panel, etc. This shall apply to vertical runs as well as horizontal runs. Where conduits are run individually, they shall be supported by approved conduit straps or beam clamps. Straps shall be secured by means of toggle bolts on hollow masonry; expansion shields and machine screws or standard preset inserts on concrete or solid masonry, machine screws or bolts on metal surfaces, and wood screws on wood construction. No perforated straps or wire hangers of any kind will be permitted. Where individual conduits are suspended from the ceiling, or above ceiling, they shall be supported by hanger rods and hangers. Conduits installed exposed in damp locations shall be provided with clamp backs under each conduit clamp, to prevent accumulation of moisture around the conduits. Where a number of conduits are to be run exposed and parallel, one with another, they shall be grouped and supported by trapeze hangers. Hanger rods shall be fastened to structural steel members with suitable beam clamps or to concrete inserts set through the opening provided in the concrete inserts. Beams clamps shall be suitable for structural members and conditions. Rods shall be galvanized steel 3/8" diameter minimum. Each conduit shall be clamped to the trapeze hanger with conduit clamps. In no case shall conduits be supported by the ceiling system support hangers or by caddy clips attached to the T-bar ceiling system.

S. All concrete inserts and pipe clamps shall be galvanized. All steel bolts, nuts, washers, and screw shall be galvanized or cadmium plated. Individual hangers, trapeze hangers and rods shall be prime-coated.

PART 3 - EXECUTION

3.1 CONDUIT

A. Applications:

1. PVC conduit may be used for all exterior underground systems, in slab, below slab on grade, and in concrete or masonry walls. PVC shall convert to rigid galvanized steel before stubbing out of

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earth or concrete, with a minimum of 18" of RGS in the slab or earth. All plastic conduit shall be rigid, Schedule 40, heavy wall PVC. All PVC conduit shall be UL listed. Install bell ends at all conduit terminations in manholes and pull boxes. All bends over 45 degrees shall be taped rigid galvanized steel. 30 degrees shall be made with wrapped intermediate metallic conduit. All plastic conduit, except that used for telephone, shall contain a code-sized bond wire.

2. Intermediate metallic conduit (IMC) shall be used for all conduit larger than 2", and for all underground or in-slab conduit, except where PVC is permitted or where rigid galvanized steel is specified. IMC conduit shall be used in explosion-proof areas.
3. Rigid galvanized steel (RGS) conduit shall be used in place of IMC or where it is specified on plans. RGS shall extend 3' beyond the building when penetrating exterior walls or footings. RGS shall be half-lap wrapped with Scotch Wrap #50 or approved equal when installed in concrete or earth.
4. PVC-coated rigid galvanized steel (PVC-RGS) conduit shall be used in corrosive areas where exposed to physical damage, or where specified on the plans.

B. Conduit shall be continuous from outlet to outlet, cabinet or junction box, and shall be so arranged that wire may be pulled in with the minimum practical number of junction boxes.

C. Provide sleeves and chases where conduit passes through floors as part of the work of this section. Core drilling will only be permitted where accepted by the Architect.

D. Conduit stubbed up/down or through floor slabs shall be wrapped RGS or wrapped IMC with a minimum of 6" of conduit exposed out of slab for connection of threaded or compression fitting. Where conduit bends extend out of slab, the conduit shall be placed at the maximum allowable distance from the exit surface and shall have a bend radius as allowed by code to provide as true and square a conduit exit as possible. Conduit deck flanges will be used where conditions allow and where the flange can be tightly secured flush to the face of a concrete form.

E. Openings through fire-rated floors and fire walls through which conduit passes shall be sealed by fire stop material to seal off cold smoke and toxic fumes. Fire-seal material shall have an hourly fire rating equal to or higher than the fire rating of the floor or wall through which the cable or conduit passes. Material used shall conform to the Authority Having Jurisdiction requirements. Openings through smoke walls through which cable or conduit passes shall be sealed with non-shrink, non-combustible material approved by the Authority Having Jurisdiction to seal off cold smoke and toxic fumes.

F. Conduit runs shall be installed to maintain the following minimum spacing wherever practical:

1. Water and Waste Piping: Not less than 12".
2. Steam and Condensate Lines: Not less than 12".
3. Radiation and Reheat Lines: Not less than 12".

G. All underground conduit outside of any buildings shall be a minimum of 24" below finished grade, except where noted otherwise on the drawings. Underground conduits outside of any buildings containing cables over 600V shall be a minimum of 36" below finished grade.

H. All underground feeder conduit outside of any buildings shall be concrete encased. Concrete shall be 3/8" aggregate with a nominal compressive strength of 2,500 PSI. The slump shall be 7" to 8". It shall have enough slump to flow to the bottom of the duct formation and not so wet as to cause the ducts to float. Each conduit shall be completely encased in concrete not less than 3" all around. Concrete shall not be poured until conduit has been inspected by the Architect. Separators or spacing blocks shall be made of plastic or other suitable non-metallic, non-decaying material placed on not greater than 5-foot centers beginning no more than 18" from termination at building or manhole. Ducts shall be anchored to prevent movement during placement of concrete.

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I. All underground feeder conduit outside of any buildings containing cables over 600V shall be concrete encased. Concrete shall be 3/8" aggregate with a nominal compressive strength of 3,000 PSI. The slump shall be 7" to 8". It shall have enough slump to flow to the bottom of the duct formation and not so wet as to cause the ducts to float. Concrete shall be integrally colored red, using one 50lb bag of dye per cubic yard of concrete. Each conduit shall be completely encased in concrete not less than 3" all around. Concrete shall not be poured until conduit has been inspected by the Architect. Separators or spacing blocks shall be made of plastic or other suitable non-metallic, non-decaying material placed on not greater than 5-foot centers beginning no more than 18" from termination at building or manhole. Ducts shall be anchored to prevent movement during placement of concrete.

J. Underground PVC conduit containing cables over 600V shall be surrounded with 6" of cinder sand shading all areas.

K. Provide 3" wide locatable marking tape with appropriate legend and a #12 stranded tracer wire above all buried conduits and duct banks 12" below finished grade. If duct bank is more than two conduits wide, use two marking tapes, one at each edge of the trench.

L. Provide corrosion protection for metallic conduit under concrete or in earth. Provide half-lap wrap of polyethylene 20-mil tape, factory PVC coating, or as accepted. Where PVC coating is provided, joints must be sealed in accordance with the coating manufacturer's published instructions.

M. PVC-coated rigid galvanized steel (PVC-RGS) joints must be sealed in accordance with the coating manufacturer's published instructions.

N. Empty conduit shall be provided with a nylon pull string installed in each.

O. Medical equipment conduit shall be provided with a calibrated pull string/measuring tape installed in each.

P. Bending: Changes in direction shall be made by bends in the conduit wherever possible, and these bends shall be made smooth and even without flattening the pipe or flaking the finish. Bends shall be of as long a radius as possible, but in no case less than shown in the NEC.

Q. Not more than four 90 degree bends will be allowed in one raceway run. Where more bends are necessary, a pull box shall be installed. All bends in 1" and smaller conduit shall be made with a conduit bender, and all larger conduit sizes shall have machine bends.

R. Plastic conduit joints shall be made up in accordance with the manufacturer's recommendations for the particular conduit and coupling selected. Conduit joint couplings shall be made watertight. Plastic conduit joints shall be made up by brushing a plastic solvent cement on the inside of a plastic coupling fitting and on the outside of the conduit ends. The conduit and fitting shall then be slipped together with a quick one-quarter turn twist to set the joint tightly. Transition from plastic to steel conduit shall be with PVC female threaded adaptors.

S. Plastic conduit shall be stored on a flat surface and protected from the direct rays of the sun.

T. The ends of all conduit shall be securely plugged, and all boxes temporarily covered to prevent foreign material from entering the conduit. All conduit shall be thoroughly swabbed out with a dry swab to remove moisture and debris before conductors are drawn into place.

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3.2 FITTINGS

A. Bushings and Locknuts: Where conduit enters boxes, panels, cabinets, etc., it shall be rigidly clamped to the box by locknuts on the outside and inside, and a bushing on the inside of the box. All conduit shall enter the box squarely.

B. Provide insulated bushings per the NEC on all conduit. The use of insulated bushings does not exclude the use of double locknuts to fasten conduit to the box.

C. Provide expansion fittings for all conduit where it crosses building expansion joints, or not to exceed 100 feet apart. Fittings shall be complete with bonding jumpers and clamps and shall be suitably bonded to conduit.

D. Provide weatherproof fittings in exterior installations or as noted on the plans.

3.3 SUPPORTS

A. All raceways that are not buried or embedded in concrete shall be supported by straps, clamps, or hangers to provide a rigid installation.

END OF SECTION 26 05 43

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SECTION 26 05 44

UNDERGROUND PULL BOXES & HANDHOLES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install underground pull boxes and handholes as specified herein and as required by the National Electrical Code, NFPA 70.

PART 2 - PRODUCTS

2.1 CONCRETE

A. The concrete for pull boxes and manholes shall be made from Portland Cement Concrete, using coarse aggregate and concrete psi based on the applicable listing category required.

B. All underground pullboxes and lids for 120VAC to 480VAC systems shall be polymer concrete.

2.2 STEEL

A. Reinforcing steel shall be deformed bars of intermediate grade steel.

2.3 FRAMES AND COVERS

A. Frames and covers shall be structural steel. Frames and covers shall be hot-dip galvanized.

2.4 GROUNDING

A. Ground rods shall be copper or copper-clad steel 3/4" diameter by 10-feet long. All non-current-carrying metallic components shall be bonded to the ground rods with minimum #6 copper wire.

PART 3 - EXECUTION

3.1 PULLBOXES

A. Underground pullboxes shall be installed a minimum of 6' behind back of curb or sidewalk.

END OF SECTION 26 05 44

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SECTION 26 05 48

VIBRATION & SEISMIC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provision 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 requirements for Electrical Identification for:

1. Conduits passing through seismic joints.
2. Seismic support wires for fixtures and devices mounted in acoustical lay in ceilings.
3. Transformer vibration isolation.
4. General spring isolation.
5. Equipment anchoring.
6. Seismic bracing for overhead conduits and cable tray.

B. Related Sections include the following:

1. Division 26 Section "Light fixture" for reference to fixture installations.
2. Division 26 Section "Transformers" for reference to transformer installations.
3. Division 26 Section "Generators" for references to the installation of generators.
4. Division 26 Section "Switchboards" for referencing anchoring free standing switchboards.
5. Division 26 Section "Conduits" for uses relating to conduit installations overhead.
6. Specification section for acoustical ceilings.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. NEC: National Electrical Code.

C. Definitions in related specification sections.

1.4 SUBMITTALS

A. Transformer Isolation Pads: Mason, Cal Dyn, or equal.

B. Overhead seismic submittals shop drawings: Mason, TOLCO, or equal.

C. Include submittals for spring isolators in generator submittal package.

D. Include information for anchoring of switchboards in switchgear submittals.

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1.5 REFERENCE PUBLICATIONS

A. ASCE: American Society of Civil Engineers.

B. IBC: International Building Code.

C. NEC: National Electrical code - NFPA 70.

D. SEI: Structural Engineering Institute.

1.6 QUALITY ASSURANCE

A. Brace per requirements of seismic zone as defined in the architectural/structural drawings.

1.7 COORDINATION

A. Coordinate layout and installation of seismic bracing for raceways, cable trays and support systems with the building structure, architectural full height walls and with other mechanical, electrical and plumbing trades.

B. Coordinate installation of inserts in concrete decks with affected trades.

C. Install all seismic bracing in a timely manner prior to the closing up of finish ceilings or loss of access due to the installation of equipment, ductwork, or piping by other trades.

D. Include seismic bracing inserts, rods, rod stiffeners, solid bracing and sway cables on signed off project coordination when required by the contract.

PART 2 - PRODUCTS

2.1 TRANSFORMER ISOLATION PADS

A. Rubber isolation pads: Mason, Cal Dyn, or equal.

B. Cork reinforced isolation pads: Mason, Cal Dyn, or equal.

2.2 SEISMIC COMPONENTS

A. Concrete inserts: Tolco, Tomarco, Powers, or equal.

B. Solid strut bracing: Tolco, T&B, or equal.

C. Expansion anchors and quick bolts: Remset, Powers, Hilti, or equal.

D. Bean attachments: Mason, Tolco or equal (include in shop seismic drawings).

E. Attachment components: Mason, Tolco or equal (include in shop seismic drawings).

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2.3 POST INSTALLATION ANCHORS

A. Post installed anchors shall be listed in a current evaluation report, issued by an evaluation agency:

1. International Code Council Evaluation Service (ICC-ES), or as accepted.

B. The compressive strength of the material in which the anchor will be installed, shall be or exceed the compressive strength of the material in which the anchor was tested.

2.4 SUPPORT WIRES

A. Description: "Galvanized soft annealed mild steel wires," as defined in ASTM A641 (Class 1 Coating) is the wire referred to in this section.

B. Diameter of Wire: #10 wire is 0.135 inches in diameter and a #12 wire is 0.106 inches in diameter as shown by the U.S. Steel Wire Gage.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. See specific specification section for more detailed information on installation guidelines.

3.2 CONDUITS PASSING THROUGH SEISMIC JOINTS

A. Install flexible conduit across all seismic joint to allow for expansion and deflection during seismic events. Install PVC expansion fittings for concrete embedded conduits passing through seismic joints in concrete decks. Conduits may be turned down through the decks to allow for flexible conduit to be installed on the underside of the decks (field coordinate locations and methodology). See structural and architectural drawings for exact location of seismic joints and the associated design deflection at each.

3.3 SUPPORT WIRES

A. Allowable load for support wires shall be:

Wire Size	Basic Load
#10 wire	343 lbs.
#12 wire	209 lbs.

B. Values are for tension only.

C. Twists on wire to develop the maximum allowable load:

1. Use a minimum of 4 twists within 1-1/2". Three twists may be used to develop not more than one half the above values.

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3.4 FIXTURES

A. Use flexible connection for all fixture and ceiling devices mounted in acoustical lay-in ceilings:

1. Use factory supplied 3/8" x 6' long whips for lay-in light fixtures (12' for master slave extension whips).
2. 1/2" flex with field installed conductors.
3. MC Cable as required.
4. Do not allow cables to rest on ceiling tiles.

B. Lighting fixture or ceiling device weighing up to 56 lbs may be supported from the lay-in ceiling support system with additional requirements as follows:

1. Attach 2 #12 AWG slack safety wires from the structure to opposite corners of lay-in fixtures. Coordinate any deviations from the contract reflected ceiling plan with wire installer.
2. Install lighting fixture manufacturer supplied seismic clips or screws at the two short sides of 2' x 4' lay-in lighting fixtures, two (2) per side.
3. Install lighting fixture manufacturer supplied seismic clips at sides of 4' x 4' lay-in lighting fixtures, two (2) per side.
4. Attach 2 #12 AWG slack safety wires from the structure to opposite corners of recessed down-light fixture cans/pans occurring on lay-in ceilings. Install lighting fixture manufacturer supplied bar hangers across 2' dimension of the lay-in grid. Attach each end to the grid as recommended for seismic support application by the fixture manufacturer. Coordinate any deviations from the contract reflected ceiling plan with wire installer.

C. Independently support any fixture or ceiling device weighing more than 56 lbs from the ceiling support system to the structure.

D. Pendant mounted lighting fixtures that are free to swing in the lateral direction, shall be installed so that they can swing at least 45° from the vertical in any direction without contacting an obstruction. Adjacent fixtures shall be separated by a distance equal to at least one and one half times the length of the pendant.

1. Safety Cables: Fixtures that are supported by cables shall have cables (including cable connections and supports) designed to support a load of at least 1.4 times the weight of the fixture acting simultaneously in the vertical and horizontal direction and applied at the point of lateral support. Fixtures supported by hollow rods, or other support mechanisms shall be provided with a "safety cable" attached directly to the fixture and directly to competent supporting structure above. The safety cable, its connections, and supports, shall be designed to support a load of at least 1.4 times the weight of the fixture acting simultaneously in the vertical and horizontal direction and applied at the point of lateral support.
2. Rigid Pendants: When a pendant mounted light fixture is supported by rigid (rod type) pendant, the pendant shall be attached to the structure above the device that allows movement in any direction (i.e. ball and socket joint). When a single fixture is supported by more than one rigid pendant, the pendants shall be attached to the structure above, and to the fixture, with devices that allow movement in any direction. Devices that allow rotation around only one axis (i.e. hinge type devices) are not acceptable.
3. Restrained Pendant Mounted Fixtures: When fixtures are restrained from lateral movement, all restraints, connections, and supports, shall be designed to resist all applicable code prescribed forces.
4. Pendant Mounted Fixtures with Pendants Penetrating Suspended Acoustic Tile Ceilings: Where pendants penetrate acoustic ceilings, they shall be braced horizontally in two orthogonal directions.
5. Support pendant mounted light fixtures directly from the structure above the hanger wires or cables passing through each pendant hanger and capable of supporting two (2) times the weight of the fixture. A bracing assembly is required where the pendant hanger penetrates the ceiling. Provide specialty fittings to attach the pendant hanger to the bracing assembly to transmit

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horizontal force. If the pendant mounted light fixture is directly and independently braced below the ceiling, i.e., aircraft cables to walls, then brace assembly is not required above the ceiling.

3.5 LIGHT WEIGHT MISCELLANEOUS DEVICES

A. All light weight miscellaneous devices, such as strobe lights, speakers, etc., shall be attached to the ceiling grid. In addition, devices weighing more than 10 lbs., shall have a #12 AWG slack safety wire anchored to the structure above. Devices weighing more than 20 lbs., shall be supported from the structure above.

3.6 TRANSFORMER VIBRATION ISOLATION

A. Transformers are to have internal vibration isolation from the metal housing to the core of the transformer.

B. Use rubber isolation pads type Mason Cal Dyn or equal for transformer housing isolation from the concrete structure.

C. Use flexible metal conduit or rubber isolated gutters for final raceway connections to transformers where conduits are not brought up through the slab under the transformer. Install rubber wire guard on all edges of the gutter cut out to allow for conductor entrance in the transformer, panel or switchgear.

D. When stubbing up under ground or through slabs for connections to transformers, cut out metal grating under transformers to allow for conduit entrances under the transformer. Remove sharp edges from the PVC or install bell adapters prior to installation of conductors. Where metal conduits enter from the bottom through the metal grating, isolate the metal from the conduit and use bond bushings to protect the cable and to bond the conduit to the transformer. Add additional grating as needed to prevent rodent intrusion into the transformer. Gratings are to be installed in a workmanlike manner and are to be painted to match the transformer factory color.

E. Install a ground wire through all raceways entering into transformer and bond per the NEC.

3.7 POST INSTALLATION ANCHORS

A. Expansion Type Anchors:

1. Expansion type anchors may be used, provided the allowable shear and tension loads are determined by test in accordance with the following:

   a. The allowable values listed in an ICC-ES Evaluation Service Report, with special inspection, may be used for allowable stress design, provided the report states that the anchors were tested in accordance with AC01, latest revision, including the seismic qualification test of AC01 Section 5.6. Strength design values may be used, provided the anchors have been tested in accordance with AC193 latest revision, including the seismic qualification tests of ACI 355.2 Sections 9.6 and 9.7 and Annex 1 of AC193. For anchors installed in the underside of a beam/slab, the allowable tension load design values should be based on the tabulated value for the anchors installed without special inspection (special inspection is still required), unless allowable load values for anchors installed in cracked concrete are provided in the ICC-ES Report, or the anchors have been tested in accordance with ACI 355.2, latest revision, Table 5.2 and Annex 1 or AC-193, or ACI-318-05 Appendix D. Shear values are based on the tabulated values in

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the ICC-ES Report. Once an ICC-ES Report complying with AC-193 has been issued, it shall take precedence over any previous report.

b. If anchors have not been tested in accordance with the requirements for seismic qualification tests of AC01, Section 5.6, the allowable load values listed in the ICC-ES Report may be used with the following modifications:

1) Allowable shear and tension design loads shall be limited to 80% of the tabulated allowable values for anchors installed with special inspection.

2) For anchors installed in the underside of a beam/slab, the allowable tension load should be based on 80% of the tabulated allowable value for anchors installed without special inspection (special inspection is still required). Allowable shear values should be based on Section 2.1 above.

B. Epoxy Type Anchors:

1. Epoxy type (adhesive) anchors include anchors that rely on organic and inorganic compounds (include epoxies, polyurethanes, methacrylate's and vinyl esters) to develop the bond to the concrete. The use of shallow epoxy type (adhesive) anchors are those with an embedment to diameter ration less than 8. Epoxy type (adhesive) anchors shall only be installed in conditioned, interior spaces. Exception: Where epoxy type anchors are used as shear dowels at the perimeter of an existing opening (slab or wall) to be filled with concrete, or are being used to connect new concrete elements to existing concrete elements to existing concrete elements (e.g. gunite), they may be installed in exterior locations with prior approval of the DSA. If epoxy type (adhesive) anchors are exposed to fire, all anchors in the affected area shall be inspected and evaluated by a qualified person to ensure their load carrying capability has not been compromised. The design shear and tension capacities of epoxy type anchors must be determined in accordance with the following:

a. The allowable loads may be based on the values listed in an ICC ES Report that complies with the requirements of AC58 for a specific anchor in the same configuration tested. Supporting data shall include the Seismic Qualification test performed in accordance with the procedures of Section 5.3.7 of AC58.

b. Where epoxy type (adhesive) anchors are used for structural applications, such as dowels between new and existing concrete, the anchors shall be installed in a manner such that the ultimate tensile capacity is controlled by the ultimate strength of the steel element. Exception: Epoxy type (adhesive) anchors which cannot develop the tensile capacity of the steel element may be used to transfer shear forces only, provided that the loads on the anchor are amplified by factor of 4.0. Alternatively, allowable shear capacity may be based on bolt shear capacities from Table 19A-D, 2002 CBC. When epoxy type (adhesive) anchors are used to resist tensile forces in structural applications, the minimum depth of embedment shall be greater than or equal to the development length Id, determined in Section 1912A.1 for a cast-in-place reinforcing bar of the same diameter and grade when considering a tensile splitting failure mode. Where tensile splitting need not be considered, the depth of embedment may be determined in accordance with Appendix D of ACI 318-02 as amended by Section 3.3 of AC 308.

C. Screw Anchors:

1. The fastener is produced from hardened steel with threads, similar in appearance to a lag bolt. Screw anchors may be used, provided the allowable shear and tension loads are determined in accordance with the following:

a. The allowable values listed in the ICC ES Report, with special inspection, may be used for allowable stress design, provided the report states that the anchors were tested in accordance with AC106, latest revision, include the seismic qualification tests of AC106 Section 4.6.

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b. Welding to these anchors is not permitted.

c. Screw anchors may be used to attach components, such as equipment, mechanical vibration isolators or snubbers, to structural (reinforced) concrete, or for sill bolting applications. All screw anchors installed through a wood will plate requires a plate washer in conformance with Section 1806A.6.3, Item 2.

d. The use of screw anchors is not permitted in overhead applications or for discrete hold down forces, such as shear walls.

D. Power Actuated Fasteners:

1. Power actuated fasteners (shot pins) may be used for limited applications provided the allowable shear and tension loads are determined in accordance with the following:

a. The allowable values listed in an ICC ES Evaluation Service Report, with special inspection, may be used for allowable stress design, provided the report states that the anchors were tested in accordance with AC70, latest revision.

3.8 ANCHORS

A. Embedment, Spacing and Edge Distance:

1. All anchors shall meet the minimum embedment, spacing, edge distance, and slab thickness criteria established by the relevant ICC-ES Report.

a. Unless otherwise noted in the report, the edge distance should be a minimum of ten (10) bolt diameters from the free edge of the slab and center-to-center spacing should be a minimum of twelve (12) bolt diameters. If the edge distance is less than ten (10) diameters, and the load is directed toward the free edge, the allowable shear load should be reduced per Section 1923A.3.3.

3.9 EQUIPMENT ANCHORING

A. Anchor equipment per switchgear manufacturer's instructions.

B. Install anchors with the proper depth per manufacturer's instructions of the anchors.

C. If edge of pad distance is not achievable, drill through the pad into the concrete floor below the pad.

D. Move anchor location farther away from the edge of the pad as required and add clips to the anchors to secure the rail of the switchgear where there are not convenient holes to anchor through.

E. Multi-section equipment shall be bolted together to form a single unit. Attachment shall be in conformance with the equipment manufacturers seismic testing for such equipment, no deviations will be accepted.

F. Panelboards flush mount, shall be anchored between wall studs, minimum four 3/8" diameter bolts, two per side with flat washers and nylock nuts.

G. Panelboards surface mount to masonry, shall be anchored through factory punched mounting holes in back of the panel can. Use Hilti "Quick Bolt 3" anchors with minimum 3-1/2" embedment and install per ICC ESR-1385. Panels up to 300 lbs., minimum four, one per corner. Panels greater than 300 lbs., minimum six, one per corner and two in middle.

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H. Transformers pad mount, shall be anchored through factory punched mounting holes. Use Hilti "KB-TZ" anchors with minimum 3-1/4" embedment and install per ICC ESR-1917. Allow extra anchor length to accommodate vibration isolation pad thickness.

3.10 CONDUIT AND RACEWAY ANCHORING

A. Provide seismic restraints as follows:

1. Conduits 2-1/2" trade size and larger.
2. Conduits, cable trays, and trapeze assemblies weighing 10 lbs./ft., or greater.

B. Exceptions to A above:

1. Conduit or cable trays suspended by individual hanger rods 12 inches or less in length from the top of the conduit to the bottom of the support structure where hanger is connected.
2. Trapeze supported systems suspended 12 inches or less from the top of the trapeze to the bottom of the support structure where trapeze is connected, provided that any changes in direction allow for flexibility in the system. Examples would be flexible connections to equipment or long offsets.

    a. Additional Requirements: In both exceptions above, the hangers of a run must comply with the 12 inch rule or bracing is required. The 12 inch rod rule exception has additional requirements as follows:

        1) Lateral motion of the electrical system shall not cause damaging impact with other systems (e.g. other electrical systems, piping, ducts, equipment, structural members, etc., or fragile appurtenances such as sprinkler heads or lighting fixtures) or loss of system vertical support.
        2) Electrical system must be made of ductile material with ductile connections.
        3) Vertical hanger top connection to the building structure cannot develop moments (this can be accomplished by using a swivel connection at the building structure connection.

C. Transverse bracing shall be provided at 40 ft. maximum spacing.

D. Longitudinal bracing shall be provided at 80 ft. maximum spacing.

E. Conduits constructed of non-ductile materials shall have the brace spacing reduced to one half of the maximum spacing for transverse and longitudinal braces listed above.

F. All braces shall be located at or within 4" of a vertical support, which may require a rod stiffener.

G. When bracing trapeze supports, the bracing shall be attached directly to the trapeze, with conduits or cable trays secured to the trapeze with straps, conduit clamps, or cable tray clips bolted to strut. A minimum of one transverse brace and/or two longitudinal braces is required.

H. Stacked trapezes supported by the same rods shall be braced independently from one another. The rod supports in each section may require stiffening.

I. At conduit risers, provide lateral restraint at the top and bottom of the riser, and intermediate points not to exceed 30 ft. Individual vertical and lateral supports shall be designed for conduit risers in buildings with 6 or more floors.

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J. Maximum brace member length when using 1" sch. 40 pipe is 7'-0"; 1-1/4" sch. 40 pipe is 9'-0"; 1-1/2" sch. 40 pipe is 10'-4"; 2" sch. 40 pipe is 13'-1".

3.11 FIELD QUALITY CONTROL

A. Install all equipment and components per manufacturer's instructions.

B. Visually inspect and field verify all connections and attachments for proper tightness.

C. Coordinate inspections with the authority having jurisdiction.

END OF SECTION 26 05 48

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SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.2 ACTION SUBMITTALS

A. Product Data: From each electrical identification product indicated.

1.3 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive attached labeling materials, including label stocks, laminating adhesives, and inks use by label printers, shall comply with UL 969.

PART 2 - PRODUCTS

2.1 FACTORY RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors of raceways carrying circuits at 600 V or less:

1. Conduit shall be factory anodized in color as stated below. Where conduit system is painted, all junction boxes shall be required to be painted to match system color. On junction boxes that are larger than 16" square, only the cover of the box need be painted.

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System	Conduit Color
Power – Normal	Natural
Power – Emergency NEC 700 & Standby NEC 701	Orange
Communications / Data/ Voice/ Video	Yellow
HVAC controls	White
Fire Alarm	Red
Public Information Paging System (PIPS)	Blue
Access Control and Monitoring (ACAMS)	Green
Security	Orange

C. Self-adhesive vinyl labels for raceways carrying circuit at 600 V or less: Preprinted, flexible label laminated with a clear, weather and chemical resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Snap around labels for raceways carrying circuits at 600 V or less: Slit, pre-tensioned, flexible, pre-printed, color coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap around, color coding bands for raceways carrying circuits at 600 V or less: Slit, pre-tensioned, flexible, solid colored acrylic sleeve 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

F. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for tags: Machine printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 FACTORY RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Comply with power raceway identification materials for raceways color requirements in this section.

C. Self-adhesive vinyl labels: Pre-printed, flexible label laminated with a clear, weather and chemical resistant coating and matching wraparound adhesive tape for securing ends of lend label.

D. Self-adhesive vinyl tape: Colored, heavy duty, waterproof, fade resistant, and 2 inches wide; compounded for outdoor use.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-adhesive vinyl labels: Preprinted, flexible label laminated with a clear, weather and chemical resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Write-On Tags: Polyester tag, 015 inch thick, with corrosion resistant grommet and cable tie for attachment to conductor or cable.

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1. Marker for tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for tags: Machine printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

D. Snap around labels: Slit, pre-tensioned, flexible, pre-printed, color coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Snap around, color coding bands: Slit, pre-tensioned, flexible, solid colored acrylic sleeve 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

A. Color coding conductor tape: Colored, self-adhesive vinyl tape not less than 0.15 inch thick by 1 to 2 inches wide.

B. Self-adhesive vinyl labels: Pre-printed, flexible label laminated with a clear, weather and chemical resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Marker Tapes: Vinyl or vinyl cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

D. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for tags: Machine printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.5 FLOOR MARKING TAPE

A. 2 inch wide, 0.125 mm pressure sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 UNDERGROUND LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red colored tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange colored tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE OR OPTICAL

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C. Type I:

1. Pigmented polyolefin, bright colored, compounded for direct burial service.
2. Thickness: 4 mils.
3. Weight: 18.5 lb/1000 sq.ft.
4. 3 inch Tensile according to ASTM D 882: 30 lbf, and 2500 psi.

D. Type II:

1. Detectable three layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright colored, compounded for direct burial service.
2. Overall thickness: 5 mils.
3. Foil Core Thickness: 0.35 mil.
4. Weight: 28 lb/1000 sq. ft..
5. 3 inch Tensile According to ASTM D 882: 30 lbf, and 2500 psi.

2.7 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. Metal Backed, Butyrate Warning Signs:

1. Weather-resistant, non-fading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES".

2.8 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.

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3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label

2.9 EQUIPMENT IDENTIFICATION LABELS

A. Plastic Laminate Adhesive Film Label with Clear Protective Overlay: Machine printed by thermal transfer or equivalent process. Provide black label with white lettering for normal power, red label with white lettering for emergency power. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label. Label shall contain designation and voltage. Additionally, CT cabinets shall be marked with the CT ratio. Adhesive Type Labels are unacceptable.

B. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Apply identification devices to surfaces that require finish after completing finish work.

C. Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

D. Attach signs and plastic labels that are not self-adhesive type with self-tapping screws mechanical fasteners appropriate to the location and substrate.

E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands 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.

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F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

G. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 20A, and 120V to ground: Install labels at 10-foot maximum intervals.

B. Conduits containing cables rated over 600 V for Service, Feeder, and Branch Circuits More Than 20A: Install labels at 20-foot maximum intervals.

C. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
2. Power.
3. UPS.

D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

   a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
   b. Colors for 208/120-V Circuits:

      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.

   c. Colors for 480/277-V Circuits:

      1) Phase A: Brown.
      2) Phase B: Orange.
      3) Phase C: Yellow.

   d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum 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. Locate bands to avoid obscuring factory cable markings.

E. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

F. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

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G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.
2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

I. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

    a. Power transfer switches.
    b. Controls with external control power connections.

K. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

L. Equipment and boxes having voltages of more than 600V shall be identified as to the voltage of the system within. Letter and numbers shall be a minimum of 2 inches and are to be highly visible contrasting colors. "DANGER - HIGH VOLTAGE - KEEP OUT" signs shall be permanently attached to the primary section door on transformers and on doors of sectionalizing switches of 600V or more. Signs shall be bilingual Spanish/English, and sized according to OSHA codes.

M. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

    a. Indoor Equipment: Plastic laminate labels. Adhesive film label, Adhesive film label with clear protective overlay, Self-adhesive. Unless otherwise indicated, provide a single line of text with 1/2-inch high letters on 1-1/2-inch high label; where two lines of text are required, use labels 2 inches high.

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b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION 26 05 53

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SECTION 26 09 13

POWER SYSTEM METERING-FEEDER & DWELLINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install electric power sub-meters as specified herein and as indicated on the drawings.

B. Acceptable manufacturers for feeder power meters are Veris, Enhance Power, Energy Meter Square D (PM710), Cutler Hammer (IQ200), Siemens (9200 Series), Power Measurement Inc., or as accepted.

C. Submittals: Submit power sub-metering equipment data.

PART 2 - PRODUCTS

2.1 FEEDER POWER METERS

A. Meter shall provide true RMS ±1.0% accuracy peak KW or KVA or current recorder capable of retaining a one-year history of peaks. History shall update at a minimum of 15-minute intervals. History shall reside in non-volatile memory with no power applied for a minimum of 30 days. Recorder shall evaluate the peak for all phases present and include a digital readout of values, and shall be panel-mounted within the switchboard or panelboard. Readout shall include reset capabilities with one level of physical protection against accidental reset. Include all related components for a complete installation.

B. Meter shall be permitted to be integral with the circuit breaker in lieu of panel mounting.

C. Meter shall have an Ethernet connection to internet supports either static or DCHP IP address. The data shall be exportable to E-Mon Energy software or CSV files for billing, profiling, and interface with or software packages.

D. Medium voltage switchgear meter shall be provided with integral bus voltage and current metering and switch position monitors. Meter shall have a fiber optic connection.

E. Meter shall include the following:

1. Fully electronic with digital LCD display for kW-hr and peak demand readings.
2. Rate of consumption indication and also a segment test button (CPU) to insure integrity of the display.
3. Load indicator to indicate real-time power consumption levels for field testing and certification.
4. Non-volatile memory to maintain reading during power failures.
5. Current Sensors shall be accurate with up to 2000ft of paired conductor between sensor and meter. CT's shall be rated to match the upstream overcurrent device for the feeder being monitored.
6. Heavy duty steal JIC enclosure, NEMA 1, with anti-tamper locking hasp.
7. Multiple Meter Unit (MMU) configuration up to 24 meters in one assembly. Each assembly shall include wire gutters for CT conductors. The assembly shall require only (1) power connection for all meters contained within.

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8. Energy monitoring and tracking software for Microsoft XP operating system. Software shall gather all data from other meters in a campus style environment and tabulate in an user friendly format.
9. Network interface capability for connection to a campus style environment data network. Verify network configuration prior to ordering.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide current transformers of size required to enable full-scale readout for each meter.

B. Provide fusing for potential leads.

C. Feeder power meters shall be located within the switchboard or panelboard where the feeder originates. Where switchboard configuration will not physically accept these meters and fit into the space allotted on the floor plan, meters may be group mounted in a single separate enclosure adjacent to the equipment metered.

D. Medium voltage switchgear shall report to the central metering system at the system North Plant via fiber optic pathway.

E. Submetering for HVAC systems and other building systems shall be provided where indicated.

3.2 TRAINING

A. Provide 8 hours of on-site training on the use and operation of the feeder power meters and related software.

B. Provide 8 hours of on-site training on the use and operation of the Dwelling Unit Meters and related software.

C. Trainers shall be factory trained and certified on the installation, use, and operation of the equipment and related software.

END OF SECTION 26 09 13

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SECTION 26 09 24

LIGHTING CONTROL DEVICES - RELAY PANEL BASIC SYSTEM

PART 1 - GENERAL

1.1 INTRODUCTION

A. The work covered in this section is subject to all of the requirements in the General Conditions of the specifications.

B. Contractor shall coordinate all of the work in this section with all of the trades covered in other sections of the specification to provide a complete and operable system.

C. The work included in this section shall be the installation of the networked low voltage lighting control panels fully coordinated with the BAS contactor. Reference Section 26 09 25 for additional information. Each relay shall provide status to the BAS and control of each relay through BAS scheduling, shall be fully coordinated.

1.2 DESCRIPTION OF WORK

A. Extent of lighting control system work is indicated by drawings and by the requirements of this section. It is defined to include, but not by way of limitation:

1. Low voltage switching system with a lighting automation relay panel(s), associated low voltage switches, and interior/exterior photocell daylight compensation.
2. Panel Master ON/OFF control capability.
3. Programmable panel intelligence cards with:

    a. Photocell.
    b. Factory Service:

        1) Documentation.
        2) Programming.
        3) Startup.
        4) Training.
        5) Extended Warranty.

B. Types of lighting control equipment and wiring specified in this section include the following:

1. Low Voltage Lighting Automation Relay Panel(s).
2. Master ON/OFF Panel Automation Cards.

C. Requirements are indicated elsewhere in these specifications for work including, but not limited to, raceways and electrical boxes and fitting required for installation on control equipment and wiring.

D. Conduit stub-outs from switches and other devices shall be required to accessible ceilings. Where no ceilings are utilized, conduit must be routed back to the relay panel.

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1.3 APPROVED MANUFACTURERS

A. Approved Manufacturers:

1. WattStopper, or Owner approved equal.

1.4 QUALITY ASSURANCE

A. Firms regularly engaged in manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than five years.

B. All components and assemblies are to be factory pre-tested and burned-in prior to installation.

C. Factory-trained technicians shall be available to functionally test each component in a programmable system after installation to verify proper operation and confirm that the panel wiring and addressing conform to the wiring documentation.

D. System Support: Factory applications engineers shall be available for on-site training as well as telephone support.

E. Comply with NEC as applicable to electrical wiring work.

F. Comply with applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.

G. All components shall be UL listed as a system under UL 916 Energy Management Equipment.

H. All assemblies are to be in compliance with FCC Emissions Standards specified in Part 15, Subpart J, for Class A application.

1.5 SUBMITTALS

A. Submit manufacturer's product data for the lighting control system and components.

B. Submit dimensioned shop drawings at a minimum of 1/8" = 1'-0" scale indicating all lighting the location control system components and accessories.

C. Submit a one-line diagram of the system configuration proposed if it differs from that illustrated in the riser diagram included in these specifications and drawings.

D. Submit typical wiring diagrams for all components including, but not limited to, relay panels, relays, input devices such as low voltage switches, vacancy & occupancy sensors, photocells, global switching/annunciation, and wire. Show BAS interface requirements.

E. Include all conduit requirements within the submittal. Where conduits are indicated on the Division 26 drawings, the quantity and size shall be a minimum. The vendor shall confirm all quantities and sizes on the submittal.

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PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

A. Low Voltage Relay Switching System:

1. Description:

a. The low voltage relay switching system shall consist of preassembled relay panel(s), low voltage switches, time controllers with astronomic feature and their associated wiring.

b. The relay panels shall be mounted in locations as indicated on the drawings. The numbered relays in the panel shall be wired to control the power to each load as indicated on the Panel Wiring Schedules included in the drawings. All power wiring shall be identified with the number of relay controlling it at the load.

c. Low voltage switches shall be mounted in the spaces as indicated on the plans. Low voltage wiring from the switches to the relay panel shall be Class 2 or Class 2P (plenum rated) as required by the National Electrical Code and local standards. Each low voltage wire shall be labeled with the relay number as indicated in schedules at each switch. Use only properly color-coded, stranded #20 AWG (or larger) wire or as indicated on the drawings. All relays and switches shall be tested after installation to confirm proper operation and the loads recorded on the directory card in each panel. Switches shall be installed in a single gang box with 1/2" conduit stub-out to above an accessible ceiling. Where no ceiling is present, route 1/2" conduit to relay panel.

d. The panel(s) shall provide expansion slots for the addition of automation cards. These cards shall be totally compatible with the manual operation of the low voltage switches and occupancy sensors; and, in the event of a card failure, these devices shall continue to operate to provide relay control.

e. The plans shall indicate the relay number that shall be located below or adjacent to the circuit number for individual relay devices, i.e., Example Homerun LA-1, 3 (RP-1, 2, 3, 4). Refer to lighting panel and relay panel schedules for cross-reference control requirements.

2. Hardware Features:

a. Modular relay panels shall consist of the following:

1) Tub: NEMA 1 enclosure sized to accept an interior with either 1-8. 1-24 or 1-48 SPST or HDR SPST relays as indicated. Mounting of the tub shall be flush or surface as indicated on the drawings.

2) Interior: Bracket and circuit board backplane with pre-mounted SPST or HDR SPST relays as indicated. Interiors shall be sized to accept either 8, 24, or 48 relays and will provide true ON/OFF indication of relay status through LED's mounted on the circuit board. Each relay shall be capable of direct ON/OFF control by a low voltage switch or occupancy sensor. The relays shall be momentary-pulsed mechanically latching contactors rated at 20 amps, 120/277 VAC. They shall attach to the interior by a single plug-in connector.

3) Power Supply: Transformer assembly with one 40VA transformer with separate secondaries providing power to relays, LED's, and associated low voltage switches. Transformers include internal overcurrent protection with automatic reset and metal oxide varistor protection against powerline spikes. 120/277 VAC, 50/60 Hz. 10%.

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4) Cover: Standard tub with hinged, lockable configuration. Surface hinged locking covers shall provide an LED status viewing window and a lockable door for access to Low Voltage wiring compartment. A wiring schedule directory card shall be affixed to the rear of the cover to allow ready identification of circuits-relays-loads controlled when the door is open.

b. Switches and Cover Plates:

1) Provide specification grade, heavy-duty, center off toggle switches, #5935-2G (white or color specified by the Architect), as shown on the plans for overriding the relays.
2) Provide specification grade cover plate material and color(s) to match the Division 26 requirements.

c. Low Voltage Wire:

1) All low voltage wiring shall be color coded to match the relays, switches, and sensors. It must also be UL listed as conforming to Class 2 or Class 2P wiring requirements.
2) Switch color codes as follows: Red / Black / White.
3) Remote relay color-coding: Red / Black / Blue / Yellow / Yellow.

d. Photocells: Each photo control point shall consist of an architecturally compatible sensor mounted in the appropriate location for measuring the available daylighting. Each sensor will have a separate control/calibration module mounted in an enclosure in the electrical closet. The sensor shall connect to the control/calibration unit via a single 20/4 shielded conductor with a maximum distance of 500 ft. The control unit shall be powered by 24 VAC.

1) Control / Calibration Unit:

a) Control unit shall allow for either direct control of up to three separate devices. These devices can be a relay, or any other device that allows control by a three wire momentary contact.
b) Control unit shall be a standard device that can work with any of the four possible sensor devices. The unit shall be switchable between four footcandle measurement ranges (1-10 FC, 10-100 FC, 100-1,000 FC, and 1,000-10,000 FC), depending on the sensor head and application.
c) Control unit shall have separate trip points for the high and low response settings. These settings will be entered via easily readable dial switches, and will not require a separate meter or look-up table to insure a reliable footcandle setting. LED's shall be provided to illustrate whether the sensor is below the low setting, above the high setting, or in the deadband range.
d) Control unit shall allow for a momentary contact device to act as a master ON/OFF override of the photocell relays. This master override will only be in effect until the next change in light level or the next master override.
e) Control device shall employ a three-minute time delay between switching outputs to avoid nuisance tripping. It shall be possible to disable the time delay to aid in initial setup and troubleshooting.
f) Sensor Devices: Four different sensors shall be available to match the specific application. Each sensor shall employ photodiode technology to allow a linear response to daylight in its given footcandle range.

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g) For Exterior Lighting: A hooded sensor that can be horizontally mounted on a 1/2" KO or threaded conduit. Sensor shall employ a flat lens, and work with a footcandle range between 1-10 or 10-100, in 10% increments. The entire sensor shall be encased in optically clear epoxy resin.

2.2 LOW VOLTAGE SWITCHING SYSTEM WITH SOFTWIRED GROUPING CAPABILITY

A. System Description:

1. Softwired grouping capability will be enabled by adding a single relay driver card for each 12 relays and a single learn mode card per panel into the base panel's expansion slots. Each relay driver card also serves to enable three separate programmable system switches.
2. Any group of relays can be softwired to any programmable system switch by:

   a. Turning every relay that is to be part of a softwired group on, and all others off.
   b. Pressing the Learn button on the learn mode card. The Learn LED will start blinking rapidly.
   c. Pressing either the on or off side of programmable system switch. At this point the Learn LED will stop blinking, and the programmable system switch has been assigned control of that group of relays.

B. Hardware Features:

1. Relay Driver Cards:

   a. The softwired grouping function shall be enabled by plug-in relay driver cards controlling 8 relays each. The 8-relay panel shall have one relay bank (1-8) and accept one relay driver card. The 24-relay panel shall have two relay banks (1-8, 9-16 & 17-24) and accept up to two relay driver cards. The 48-relay panel shall have four banks and accept up to six cards.
   b. Each card shall include three associated programmable system switches which signal the learn card to control its associated relays ON/OFF according to the different scenarios listed above while still allowing direct switch control of each relay. These switch inputs may be either a 2- or 3- wire, maintained or momentary dry contact closure.
   c. Programmable switch inputs within a panel or in different panels shall be capable of being paralleled for common control. This requires that all panels be powered by circuits on the same phase.
   d. Each output shall be capable of operating three relays in parallel.

2. Learn Mode Card:

   a. The learn card shall provide two momentary contact switches mounted on its front. The right switch is a relay All On/All Off override. The left button, when pushed, puts the card into the Learn Mode. The next programmable system switch that is triggered will be assigned to control all the On relays. If no programmable switch is pressed within 30 seconds, the card will cancel out of the Learn Mode and go back to its normal state.
   b. The learn mode card shall provide two LED's for visual status feedback. The right LED indicates that the learn card has power and can function. The second LED is used to show memory status: Rapidly flashing means nothing in memory; slow flashing means that the Learn button has been pressed and the next programmable system switch

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that is hit will be assigned to control all the On relays; steady on means that the card has been at least partially programmed.

c. The learn card shall use an EEPROM to record the user-defined switch assignments, thus insuring a 40-year backup of information in case of power failure. Systems that require a changeable battery with less than a 10-year life for information backup shall not be allowed.

C. Programmable System Switches:

1. System Description:

a. Programmable system switch modules shall be added to the dataline to provide system-wide switching.
b. Each unit shall have an address setting from 01-99 and 16 physical switch inputs. These inputs may be either 3-wire maintained or momentary.
c. The system switch modules shall transmit the switch ID (address/input) and the action (ON/OFF) whenever a switch changes state.
d. The intelligent panels shall monitor these messages and actuate their associated relays to the appropriate state. This state to be determined by the scenario assigned to the system switch - Master ON/OFF, Photocell.

2. Hardware Features:

a. Universal power supply.
b. Sixteen independent 3-wire switch inputs.
c. 18/3 switchleg wiring, 1,000 ft.
d. Maximum of 1,584 programmable system switches per system.

PART 3 - EXECUTION

3.1 SUPPORT SERVICES

A. System Startup: Manufacturer shall provide a factory authorized technician to confirm proper installation and operation of all system components.

B. Training: Manufacturer shall provide factory authorized Application Engineer to train Owner personnel in the operation and programming of the lighting control system.

C. Documentation: Manufacturer shall provide system documentation including:

1. System one-line showing all panels, number and type of switches and sensors, dataline, and programmable system switches.
2. Drawings for each panel showing hardware configuration and numbering.
3. Panel wiring schedules.
4. Typical wiring diagrams for each component.

D. Programming:

1. Manufacturer shall provide system programming including:

a. Wiring documentation.
b. Programmable panel and system switch operation.
c. Operating Schedules.

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E. Extended Warranty: Manufacturer shall provide a 5 year extended warranty in addition to a required one-year warranty for all system components.

END OF SECTION 26 09 24

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SECTION 26 09 25

LIGHTING CONTROL DEVICES - DIGITAL OCCUPANCY SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Digital Occupancy and Daylighting Sensor Control.
2. Emergency Lighting Control (if applicable).

B. Reference relevant Specification Sections in Division 26 for additional requirements.

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

C. Control Intent – Control Intend includes, but is not limited to:

1. Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.
2. Initial sensor and switching zones.
3. Initial time switch settings.
4. Task lighting and receptacle controls.
5. Emergency lighting control (if applicable).
6. Recalibration.

1.2 REFERENCES

A. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE).

B. Underwriters Laboratories of Canada (ULC).

C. International Electrotechnical Commission.

D. International Organization of Standardization (ISO).

E. National Electrical Manufacturers Association (NEMA).

F. WD1 (R005) – General color requirements for wiring devices.

G. Underwriters Laboratories, Inc. (UL)

1. 916 – Energy Management Equipment.
2. 924 – Emergency Lighting.

1.3 SYSTEM DESCRIPTION & OPERATION

A. The Lighting Control and Automation system as defined under this section covers the following equipment:

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1. Digital Room Controllers – Self configuring, digitally addressable one, two or three relay controllers with 0-10v control for ballasts (if applicable) and single relay application specific plug load controllers.
2. Digital Occupancy Sensors – Self configuring, digitally addressable and calibrated occupancy sensors with LCD screens and two way active infrared (IR) communications.
3. Digital Switches – Self configuring, digitally addressable pushbutton switches, dimmers and scene switches with two-way active infrared (IR) communications.
4. Analog and digital closed loop daylighting sensors – Self calibrating daylighting sensors that provide closed loop control to room controllers. Sensors and room controllers can provide single or multi-zone, on/off or dimming control for daylight harvesting.
5. Hand held remotes for room configuration – Provides two-way infrared communications to digital devices and allows complete configuration and reconfiguration of the device/room from 30 feet away. Unit to have Organic LED display, simple pushbutton interface, and allow send/receive/store of room variables.
6. Hand held remotes for personal control – One, two, or four (scene) button remotes provide infrared communications to a room. Remote controls will support ON/OFF, dimming, scene control and may be configured in the field to provide specific occupant requirements without special tools.
7. Digital Lighting Management (DLM) local network – Free topology, plug in wiring system (CAT 5e) for power and data to room devices.
8. Native BACnet Module (if applicable) – Provide MS/TP communications for room-to-room, or room to server communications.
9. Emergency Lighting Control Unit (ELCU) – Allows any standard lighting control device to control emergency lighting in conjunction with normal lighting in any areas within a building.

1.4 LIGHTING CONTROL APPLICATIONS

A. Unless relevant provisions of the applicable local Energy Codes are more stringent, provide a minimum application of lighting controls as follows:

1. Space Control Requirements – Provide occupancy/vacancy sensors with manual on functionality in all spaces except toilet rooms, storerooms, library stacks, or other applications where hands free operation is desirable and automatic on occupancy sensors are more appropriate. Provide manual ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room. For spaces with multiple occupants or where line-of-site may be obscured, provide ceiling or corner mounted sensors with manual on switches.
2. Bi-Level Lighting – Provide multi-level switched dimming controls in all spaces except toilet rooms, storerooms, library stacks, or applications where variable dimming is used.
3. Task Lighting/Plug Loads – Provide automatic shut off of non-essential plug loads and task lighting in all spaces except toilet rooms and storerooms. Provide automatic ON of plug loads whenever spaces are occupied. For spaces with multiple occupants, a single shutoff consistent with the overhead lighting may be used for the area.
4. Daylighted Areas – All luminaries within 15' of windows or within 7' of skylights (the daylighted zone) shall be separately controlled from luminaries outside of daylighted zones. Luminaires closest to the daylight aperture shall be separately controlled from luminaries farther from the daylight aperture, within the daylight zone.
5. Daytime setpoints for total illumination (combined daylight and electric light) level that initiate dimming shall be programmed to be not less than 125% of the nighttime maintained designed illumination levels.
6. Multiple leveled switched daylight harvesting controls may be utilized for areas marked on drawings.
7. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylight system may be designed to turn off ambient lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full on prior to dimming.

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B. Additional Controls:

1. Provide occupancy/vacancy sensors for any enclosed office, conference room, meeting room, and training room. For spaces with multiple occupants or where line-of-site may be obscured, provide ceiling or corner mounted with manual on switches per drawings.
2. Conference, meeting, training, auditoriums, and multipurpose rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four (4) pre-set lighting scenes unless otherwise specified. Occupancy/Vacancy sensors shall be provided to extinguish all lighting in the space per drawings.

1.5 SUBMITTALS

A. Submittals Package: Submit the shop drawings, and the product data specified below at the same time as a package.

B. Shop Drawings (for Sensor Systems):

1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed (standard diagrams will not be accepted).
2. Scale drawing for each area showing exact location of each sensor, switching module, and on-off-auto switch.

C. Product Data: Catalog sheets, specifications and installation instructions.

D. Include data for each device which:

1. Indicates where sensor is proposed to be installed.
2. Provide that the sensor is suitable for the proposed application.

1.6 QUALITY ASSURANCE

A. Manufacturer: Minimum 10 years' experience in manufacture of lighting controls.

1.7 PROJECT CONDITIONS

A. Do not install equipment until following conditions can be maintained in spaces to receive equipment:

1. Ambient temperature: 0° to 40°C (32° to 104°F).
2. Relative humidity: Maximum 90 percent, non-condensing.

1.8 WARRANTY

A. Provide a five year complete manufacturer's warranty on all products to be free of manufacturer's defects.

1.9 MAINTENANCE

A. Spare Parts: Provide 5% of each product to be used for maintenance.

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PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer:

1. Watt Stopper:

a. System: Digital Lighting Management (DLM).

2. Basis of design product: Watt Stopper Digital Lighting Management (DLM) or subject to compliance with prior approval with specified requirements of this section, one of the following:

a. Watt Stopper.
b. Owner approved equal

B. Substitutions:

1. All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the design professional a minimum of 10 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of this specification noting compliance on a line-by-line basis.
2. By using pre-approved substitutions, the contractor accepts responsibility and associated cost for all required modifications to circuitry, devices, and wiring. The contractor shall provide complete engineered shop drawings (including power wiring) with deviations for the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

2.2 SINGLE/DUAL RELAY WALL SWITCH VACANCY SENSORS

A. Type PW: Manual ON, Automatic OFF Wall switch type passive infrared occupancy sensor with built-in override control (off-auto). Furnish the Company's model which suits the electrical system parameters, and accommodates the square footage coverage and wattage requirement for each area (and type of lighting) controlled; Watt Stopper PW-100, PW-200.

B. Type UW: Manual ON, Automatic OFF Wall switch type ultrasonic occupancy sensor with built-in override control (off-auto). Furnish the Company's model which suits the electrical system parameters, and accommodates the square footage coverage and wattage requirement for each area (and type of lighting) controlled; Watt Stopper UW-100, UW-200.

C. Type DW: Manual ON, Automatic OFF Wall switch type dual technology, passive Infrared and ultrasonic occupancy sensor with built-in override control (off-auto). Furnish the Company's model which suits the electrical system parameters, and accommodates the square footage coverage and wattage requirement for each area (and type of lighting) controlled; Watt Stopper DW-100, DW-200.

D. Vacancy sensors shall be installed in all offices, conference rooms, meeting spaces, classrooms, closets, and, break rooms, storage rooms, janitorial spaces.

2.3 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR SYSTEM

A. Wall or ceiling mounted (to suit installation) passive infrared, ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor. Furnish the Company's system which accommodates

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the square footage coverage requirements for each area controlled, utilizing Room Controller modules and accessories which suits the lighting and electrical system parameters.

B. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:

1. Digital calibration and LCD entry for the following variables:

   a. Sensitivity: 0-100% in 10% increments.
   b. Time Delay: Fixed (1-30 minutes in 1 minute increments), and automatic.
   c. Test mode – Five second time delay.
   d. PIR, Ultrasonic or Dual Technology activation and/or reactivation.
   e. Walk-through mode.
   f. Load parameters including auto/manual ON, blink warning, and daylight enable/ disable.

2. RJ-45 digital connections for DLM local network.
3. Two-way infrared communications port to allow remote programming through hand held commissioning tool.
4. Self-contained pushbuttons for programming and control of room devices.
5. Device Status LED's including:

   a. PIR Detection.
   b. Ultrasonic detection.
   c. Configuration mode.
   d. Load binding.

6. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.

C. Units will provide for digital calibration and commissioning and will not have any dip switches or potentiometers for field settings.

D. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

E. Watt Stopper product numbers: LMPX, LMDX, LMPC, LMUC and LMDC.

F. Occupancy sensors shall be installed in all toilet rooms, corridors, electrical/mechanical rooms, and stairwells.

2.4 DIGITAL WALL SWITCHES

A. Low voltage (RJ-45 ports) momentary pushbutton switches in 1, 2, 3, 4 and 8 button configuration, decorator opening. Wall switches will include the following features:

1. Two way infrared communications port for use with personal and configuration remote controls.
2. Engraveable buttons.
3. Dimming switches shall include seven LED's to indicate load levels.
4. Scene switches shall include pilot indication of scene selection.
5. Device Status LED's including:

   a. One pilot LED for each button.
   b. Power Indication.

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c. One locator LED per switch.
d. Network status LED to indicate data transmission.
e. Power LED to indicate the device has power.
f. Configuration mode.

B. Switches shall have two RJ-45 ports to allow connection to any other digital room device.

C. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required to achieve multi-way switching.

D. Watt Stopper products numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104 and LMSW-108.

2.5 ROOM CONTROLLERS

A. Room controllers automatically bind the room loads to the connected devices in the space without any tools or configuration requirements. Room controllers shall be provided to match the room lighting load and control requirements and sequences. The controllers will be simple to install and will have screw type connections, dip switches, potentiometers or require special mounting or configuration. The control units will include the following features:

1. Automatic room configuration to the most energy efficient sequence of operation based upon the devices in the room.
2. One or two relay configuration.
3. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an Off-the-Shelf unit without requiring any configuration or setup.
4. Device Status LED's to indicate:

   a. Data transmission.
   b. Device has power.
   c. Status for each load.
   d. Configuration status.

5. Quick installation features including:

   a. Standard junction box mounting (inside or outside).
   b. Quick low voltage connections using standard RJ-45 patch cable.

6. Plenum rated.
7. Manual override and LED indication of each load.
8. Universal voltage (120/230/w277 VAC, 50-60 Hz).
9. Zero cross circuitry for each load.
10. Efficient 150 ma switching power supply.
11. Three RJ-45 DLM local network ports.
12. Watt Stopper product numbers: LMRC-101 / LMRC-102.

B. 0-10 Volt enhanced room controllers shall include all the features of the room controller plus the following enhancements:

1. One, two or three relay configuration.
2. Efficient 250 ma switching power supply.
3. Four RJ-45 DLM local network ports.
4. One zero to 0 volt analog output per relay for control of dimmable ballasts.
5. Optional BACnet MS/TP communications port.
6. Current monitoring.

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7. Wall Stopper product numbers: LMRC-301 / LMRC-302 / LMRC-303.

C. Plug load room controllers provide dedicated control of plug loads within the space. The controllers plug into the DLM local network using the RJ-45 free topology network. The room controllers include the following features:

1. One relay configuration only.
2. Automatic ON/OFF configuration.
3. Default 30 minute (adjustable) time delay from lighting shut off to allow for electronic component use after an area is vacant.
4. Watt Stopper product number: LMPL-101.

2.6 DIGITAL PHOTOSENSORS

A. Provide automatic daylight harvesting capabilities to the room controllers. The photo sensor/room controller configuration automatically configures the daylighting set points for ON/OFF or dimmer control. Using the automatic configuration replacing a photo sensor or room controller can be done without any special tools, programming or configuration. Photosensors include the following features:

1. The digital photosensor shall utilize an internal photodiode that measures light in a 100 degree angle cutting the unwanted light from bright sources outside of this cone.
2. The digital photosensor shall be capable of turning lighting on and off or raise/lower depending on the bonding to the room controller. Sensor range shall be from 1 – 1400 fc.
3. For ON/OFF daylight harvesting the controller provides a "hold on while occupied" feature that prohibits high levels from turning OFF the controlled lights as long as the space remains occupied.
4. The sensor has a threaded nipple that mounts on a ceiling tile and for more challenging applications such as a side wall or hard rock ceiling the nipple pops off and the unit can be screwed down.
5. The digital photo sensor shall have a maximum of a 10 minute dead-band time setting.

B. Watt Stopper Product Numbers: LMLS-105, LMLS-305.

2.7 ROOM NETWORK

A. The DLM local network is a free topology lighting control network and protocol designed to control a small area of a building. Digital room devices connect to the network using RJ-45 patch cords which provide both data and power to room devices. Features of the DLM local network include:

1. Automatic configuration and binding of sensors, switches, and lighting loads to the most energy efficient sequence of operation based upon the device attached.
2. Simple replacement of any device in the network is required with a standard off the shelf unit without requiring commissioning, configuration or setup.
3. Push and learn configuration that can change the automatic binding process and load parameters by using only the digital devices in the room.
4. Two-way infrared communications that allow load parameters, sensor configuration and binding operations to be configured through a hand held configuration tool up to 30 feet from any device.

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2.8 EMERGENCY LIGHTING

A. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure, the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:

1. 120 – 277 volts, 50/60 Hz., 20 amp ballast rating.
2. Push to test button.
3. Auxiliary contract for test/fire alarm system.

2.9 RELAY PANELS

A. Lighting Control Description:

1. Lighting Control Panels shall be UL listed and consist of the following:

   a. Enclosure/Tub: NEMA 1.
   b. Cover: Surface or Flush as required, hinged, lockable and shall restrict access to line voltage section.
   c. Interior: Barrier for separation of high voltage (class 1) and low voltage (class 2) wiring. It shall include intelligence boards, power supply and control relays. Clock display and keypad shall be mounted on interior cabinet door for easy user access and programming.

B. Features:

1. Panel shall accept up to eight single pole relays. Relays shall be individual latching relays with 20 Amp load contacts for ballast (including HID, magnetic or electronic type ballasts), tungsten and general purpose loads. Provide isolated auxiliary contacts for pilot light switching. Relays shall use quick connectors and be individually replaceable to facilitate ease of use.
2. Where indicated, panels shall provide space within the high voltage section of the enclosure to accommodate up to 12 multi-pole contactors. Two sections of DIN rail mounting shall be provided as standard. No field drilling or fabrication shall be required for mounting contactors or other accessories within the enclosure.
3. The lighting control panel shall provide a stagger up delay, override push buttons, pilot light outputs, and LED status light indicators for each relay or contactor control channel.
4. The clock shall have a backlight display, user keypad and shall provide 8 channels of time or astronomical control. Preprogrammed lighting control scenarios shall include: scheduled on/off, manual on/scheduled off, manual on/automatic switch sweep off, astronomic or photocell on/off and astronomic or photocell control with scheduled on/off. Time clock shall provide up to 42 holidays, automatic daylight savings adjustment, astronomic coordinates by major cities, and help screens. Program memory shall be non-volatile and clock shall retain time keeping during power outages for at least 48 hours.
5. The panel shall have 8 universal switch inputs that are low voltage, self-configuring and shall not require programming to accept momentary on/ momentary off switch, push button switch (cycling), maintained switch or 24VDC signals from occupancy sensors, photocells or other interfacing devices.
6. Occupancy sensor and time control shall be integrated to allow occupancy sensor control after hours with hold on of lighting during occupancy scheduled time. During occupied time, control scenarios shall be selectable for time schedule of lighting on or occupancy sensor detection of lighting on initially and then hold on of lighting during occupied hours. Control shall provide selectable occupancy sensor blink warning prior to shut off and adjustable occupancy sensor time delay from the time clock keypad.

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7. After-hour interior lighting shut off control shall provide a full duration override time of 1 to 240 minutes with a warning blink five minutes prior to shutting the lighting off. An impending shut off will be cancelled and the override period re-initialized through the operation of any assigned switch input.
8. After-hour interior lighting shut off control may be by line voltage power interrupt control to automatic control switches. The lighting control relay panel shall provide a warning blink signal to automatic control switches, thus allowing a five-minute delay prior to shutting off lighting. The lighting shut off event may be cancelled by pressing the automatic control switch push button. The lighting control panel time clock shall provide periodic lighting sweep signals to shut off automatic control switches.

PART 3 - EXECUTION

3.1 INSTALLATION

A. When using wire other than RJ-45 connections provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colors to simplify contactor termination requirements.

B. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated.

C. Calibrate all sensor time delays and sensitivity to guarantee proper coverage of occupants and energy savings.

1. Adjust time delay so that controlled area remains lighted for 5 minutes after occupant leaves area.
2. Recalibrate all systems after 90 days of operation.

D. Provide written or computer generated documentation on the commissioning of the system including room by room description including:

1. Sensor parameters, time delays, sensitivities, daylighting setpoints.
2. Sequence of operations, manual on, auto off, etc.
3. Load parameters – Blink warning, etc.

E. Re-Commissioning: After 30 days from occupancy, re-calibrate all sensors time delays and sensitivities to meet the Owner's Project Requirements. Provide a detailed report to the Architect/Owner of re-commissioning activity.

3.2 FACTORY COMMISSIONING

A. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system.

B. The electrical contractor shall provide both the manufacturer and the electrical engineer with ten working days written notice of the system startup and adjustment date.

C. Upon completion of the system, commissioning the factory authorized technician, shall provide the proper training to the Owner's personnel on the adjustment and maintenance of the system.

END OF SECTION 26 09 25

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SECTION 26 12 00

MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following types of transformers with medium-voltage primaries:

1. Liquid filled distribution and power transformers.
2. Dry type distribution and power transformers.
3. Pad mounted liquid filled transformers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of transformer indicated.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with IEEE C2 and NFPA 70.

C. Comply with ANSI C57.12.28, IEEE C57.12.10, IEEE C57.12.70, and IEEE C57.12.80.

1.5 PROJECT CONDITIONS

A. Service Conditions: IEEE C37.121, usual service conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acme Electric Corporation; Power Distribution Products Division.
2. Cooper Industries; Cooper Power Systems Division.
3. Cutler-Hammer.

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4. GE Electrical Distribution & Control.
5. Hammond Manufacturing; Transformer Group.
6. Kuhlman Electric Corporation.
7. Pauwels Transformers.
8. Pioneer Transformers Ltd.
9. Siemens Energy & Automation, Inc.
10. Square D/Group Schneider NA.
11. Uptegraff, R.E. Mfg. Co.
12. Virginia Transformer Corp.

2.2 LIQUID FILLED DISTRIBUTION AND POWER TRANSFORMERS

A. Description: Comply with IEEE C57.12.00 and UL 1062 for liquid filled, 2-winding transformers. Primary section shall be dead-front with integral loop-feed switching and penta-head door bolts.

B. Insulating Liquid: Mineral oil, ASTM D 3487, Type II; tested according to ASTM D117.

C. Insulating Liquid: Less flammable, edible seed oil based, and listed by a NRTL acceptable to authority having jurisdiction as complying with NFPA 70 requirements for fire point not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and non-toxic.

D. Insulating Liquid: Less flammable, dielectric, and listed by a NRTL acceptable to authority having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and non-toxic.

E. Insulating Liquid: Less flammable, silicone based dielectric, and listed by a NRTL acceptable to authority having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D92. Liquid shall have low toxicity and be non-hazardous.

F. Insulation Temperature Rise: 65/55 deg C, based on an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C.

G. Basic Impulse Level: Comply with UL 1062.

H. Full Capacity Voltage Taps: Four, 2.5 percent taps, 2 above and 2 below rated primary voltage; with externally operable, de-energized tap changer; position indicator and padlock hasp.

I. Cooling System: Class OA, self-cooled.

J. Impedance: 5.1 percent maximum.

K. Accessories:

1. Grounding pads, lifting lugs, and provisions for jacking under base.
2. Insulated, low-voltage, neutral bushing with removable ground strap.
3. Liquid level gage.
4. Pressure vacuum gage.
5. Liquid temperature indicator.
6. Drain and filter valves.
7. Pressure relief device.

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2.3 PAD MOUNTED, LIQUID FILLED TRANSFORMERS

A. Description: Comply with ANSI C57.12.13, IEEE C57.12.00, IEEE C57.12.22, and IEEE C57.12.26 for pad mounted, 2-winding transformers. Stainless steel tank base and cabinet. Primary section shall be dead-front with integral loop-feed switching and penta-head door bolts.

B. Insulating Liquid: Mineral oil, ASTM D 3487, Type II; tested according to ASTM D117.

C. Insulating Liquid: Less flammable, edible seed oil based, and listed by a NRTL acceptable to authority having jurisdiction as complying with NFPA 70 requirements for fire point not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and non-toxic.

D. Insulating Liquid: Less flammable, dielectric, and listed by a NRTL acceptable to authority having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and non-toxic.

E. Insulating Liquid: Less flammable, silicone based dielectric, and listed by a NRTL acceptable to authority having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D92. Liquid shall have low toxicity and be non-hazardous.

F. Insulation Temperature Rise: 55 deg C, based on an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C.

G. Basic Impulse Level: 95 kV.

H. Full Capacity Voltage Taps: Four, 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable, de-energized, tap changer; position indicator; and padlock hasp.

I. High Voltage Switch: A, make-and-latch rating of 10kA RMS, symmetrical, arranged for loop feed with 4 - position, gang operated, load break switch, oil immersed in transformer tank with hook stick operating handle in primary compartment.

J. Primary Fuses: 150-kV fuse assembly with fuses complying with IEEE C37.47. Rating of current limiting fuses shall be 50-kA RMS at specified system voltage.

1. Current limiting type in dry fuse holder wells, mechanically interlocked with liquid-immersed switch in transformer tank to prevent disconnect under load.
2. Bay-O-Net liquid-immersed fuses in series with liquid-immersed current-limiting fuses. Bay-O-Net fuses shall be externally replaceable without opening transformer tank.

K. Surge Arresters: Distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1. Transformers shall have six arresters for loop-feed circuits.

L. High-Voltage Terminations and Equipment: Dead front with universal type bushing wells for dead front busing well inserts, complying with IEEE 386 and including the following:

1. Bushing Well Inserts: One of each high voltage bushing well.
2. Surge Arresters: Dead front, elbow type, metal oxide varistor units.
3. Parking Stands: One of each high voltage bushing well.
4. Portable Insulated Bushings: Arranged for parking insulated, high voltage, load break cable terminators; one of each primary feeder conductor terminating at transformer.

M. Accessories:

1. Drain Valve: 1 inch (25 mm), with sampling device.

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2. Dial type thermometer.
3. Liquid level gage.
4. Pressure vacuum gage.
5. Pressure Relief Device: Self-sealing with an indicator.
6. Mounting provisions for low-voltage compartment.
7. Alarm contacts for gages and thermometer listed above.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated plastic or metal nameplate for each transformer, mounted with corrosion resistant screws.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and anchor transformers on concrete bases according to manufacturer's written instructions and according to seismic codes applicable to Project.

1. Construct concrete bases of dimensions indicated, but not less than 6 inches larger in side and rear, and 36 inches larger in front, and 3 inches high.
2. Use 3000 psi, 28-day compressive strength concrete and reinforcement as Specified in Section 033000 "Cast-in-Place Concrete."
3. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch centers around full perimeter of base.
4. Anchor equipment with epoxy embedded anchor bolts that extend through concrete base and anchor into structural concrete floor.
5. Provide bollards to protect transformer. Quantity determined by transformer location.

B. Maintain minimum clearances according to manufacturer's written instructions and NFPA 70.

3.2 IDENTIFICATION

A. Identify components and provide warning signs as Specified in Section 260553 "Identification for Electrical Systems".

3.3 FIELD QUALITY CONTROL

A. Perform electrical test and visual and mechanical inspection state in NETA ATS, Section 7.2. Certify compliance with test parameters.

B. Test and adjust controls and safeties.

3.4 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: Perform the following voltage monitoring after Substantial Completion, but not more than six months after Final Acceptance:

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1. During a period of normal load cycles, perform seven days of continuous three-phase voltage recording at secondary terminals of each transformer. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:

    a. Adjust transformer taps.
    b. Prepare written request for voltage adjustment by electric utility.

3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.
4. Report: Prepare written report covering monitoring and corrective actions performed.

END OF SECTION 26 12 00

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SECTION 26 22 13

LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install, where indicated on the drawings, dry type transformers with the voltages and phases as shown on the drawings. Transformers shall be 60 Hz with KVA rating as shown on the drawings.

B. Acceptable manufacturers are Cutler-Hammer, Siemens, and Square D.

PART 2 - PRODUCTS

2.1 GENERAL

A. Transformers shall comply with the latest NEMA and ANSI standards.

B. Transformers shall be encased in a sheet steel enclosure; 10 KVA and smaller shall be non-ventilated, and above 10 KVA shall be ventilated, self-cooled. The core and coil assembly shall be completely isolated from the enclosure by means of neoprene rubber isolation pads or other acceptable vibration isolators. In addition, all transformers shall be mounted on vibration isolators. Acceptable transformer manufacturers are General Electric, Siemens, Square D, Cutler-Hammer.

C. Transformer(s) for non-linear loads shall be UL listed and labeled for (K-4). Neither the primary nor the secondary temperature shall exceed 220 deg C at any point in the coils while carrying their full rating of non-sinusoidal load. All cores shall be constructed with low hysteresis and eddy current losses. The core flux density shall be well below the saturation point to prevent overheating and excessive sound level caused by harmonic noise distortion. Three phase transformer secondary neutral terminals shall be sized for 200% of the secondary phase current.

D. Transformer windings shall be copper.

E. Where applied for drive isolation, the transformer shall be horsepower rated for the specific motor and drive combination.

F. Drive isolation transformers shall be configured with delta primary and wye secondary.

2.2 INSULATION

A. Transformers up to 30 KVA shall have a 185 deg C insulation system and shall not exceed 115 deg C rise above a 40 deg C ambient under full load conditions. Above 30 KVA, transformers shall have a 220 deg C insulation system and shall not exceed 150 deg C rise above a 40 deg C ambient under full load condition.

B. Transformer insulation for non-linear loads shall be a UL recognized 220 deg C system. Transformer(s) evaluated by the K-factor evaluation shall be listed for 115 deg C average temperature rise only. Transformers with K-factor temperature rise of 150 deg C shall not be acceptable.

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C. Transformers shall be capable of operating at 100% of nameplate rating continuously while in an ambient temperature not exceeding 40 deg C.

2.3 TAPS

A. Transformers rated 25 KVA and below shall have two 5% taps below normal. Transformers rated 30 KVA and larger shall have six 2-1/2% taps, four below, and two above normal.

2.4 SOUND OUTPUT

A. Sound outputs of transformers shall not exceed the following levels, based on NEMA standard testing procedures:

KVA Rating	Decibel Sound Output
0 - 9	40
10 - 50	45
51 - 150	50
151 - 300	55
301 - 500	60

PART 3 - EXECUTION

3.1 INSTALLATION

A. Dry type transformers smaller than 300 KVA rating shall have a minimum of 9" clearance between transformer ventilation openings and adjacent structure. For ratings 300 KVA and larger, provide a minimum clearance of 15" between transformer and adjacent structure on all sides. All transformer connections shall be made with flexible metallic conduit.

END OF SECTION 26 22 13

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SECTION 26 24 12

SERVICE ENTRANCE SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install service entrance switchboards as herein specified and as shown on the drawings.

B. Acceptable manufacturers are Cutler-Hammer, General Electric, Siemens, and Square D.

C. Submit to the serving utility for approval of metering and underground pull sections prior to releasing order for manufacture.

D. Plant of manufacture shall be ISO 9001 or 9002 certified.

PART 2 - PRODUCTS

2.1 GENERAL

A. Service entrance switchboards shall be of the dead-front safety type with voltage and ampere capacity as indicated on the drawings. NEMA 1 for indoor and NEMA 3R for outdoor applications.

B. Switchboard framework shall be fabricated on die-formed steel base or assembly consisting of formed steel and commercial channel welded or bolted together to rigidly support entire shipping unit for moving on rollers and floor mounting. The framework is to be formed code gauge steel, rigidly welded and bolted together to support all cover plates, bussing and component devices during shipment and installation. Each switchboard section shall have an open bottom and individual removable top plate for installation and termination of conduit. Top and bottom conduit area is to be clearly shown and dimensioned on the shop drawings. All front plates used for mounting meters, selector switches or other front devices shall be hinged with all wiring installed and laced with flexibility at hinged side. All closure plates shall be screw-removable and small enough for easy handling by one man. Side wiring gutter covers on all switchboards shall be hinged for access to wiring space. Paint finish shall be enamel over a rust-inhibiting phosphate primer.

C. Switchboard bussing shall be copper or tin-plated aluminum. Bus bars shall be rigidly braced to comply with the integrated equipment rating of the switchboard. Main horizontal bus bars between sections shall be full size for their entire length and located on the back of the switchboard to permit a maximum of available conduit area. End sections shall have bus bar provisions for future addition of a switchboard section as indicated on the drawings. Provisions shall include bus bars installed to the extreme side of the switchboard and pre-punched to facilitate future bolted splice plates. Vertical bus bars shall extend the full height of each section and be pre-drilled on universal centers to allow connections to any standard sized branch unit. Provide a 25 percent minimum ground bus running the full length of the switchboard, but in no case smaller than 1/4" x 2" copper. Provide a 25 percent minimum isolated ground bus running the full length of the switchboard, but in no case smaller than 1/4" x 2" copper when the distribution board is indicated to serve isolated ground feeders.

D. Switchboards shall be listed for front access only, except as noted otherwise on the plans.

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E. Each switchboard as a complete unit shall be given a single integrated equipment short circuit rating by the manufacturer. Such rating shall be established by actual tests by the manufacturer on similar equipment construction as subject switchboard. This test data shall be available and shall be furnished upon request.

F. All bussing shall be braced for a minimum integrated equipment short circuit current rating of 65,000A RMS symmetrical amperes, or as shown on the drawings.

G. Switchboards shall be provided with digital ammeter, voltmeter, and power system metering for each main as indicated on the drawings. Reference Specification Section 26 09 13. Stated functions may be combined into one device. Switchboards with only one main may omit customer power meter function.

2.2 CIRCUIT BREAKERS

A. Main circuit breakers shall be stationary type with static trips, UL listed for 100 percent continuous current rating in a switchboard, minimum 65,000 amperes interrupting capacity at 480 volts, except where noted otherwise on the drawings. The trip mechanism shall be ambient insensitive, and shall have adjustable long time delay (60 to 100 percent), adjustable short time delay, and instantaneous trips. Circuit breakers shall be manually operated to provide quick-make, quick-break operation, and shall be equipped with an electrical shunt trip capable of operation at 55 percent of rated voltage. Main load current contacts to be of multi-fingered construction.

B. Manual closing operation shall be by means of a handle located on the front of the circuit breaker, with a clearly visible push-to-open button.

C. A panic button shall be installed adjacent to the electrical service room exit which shall be wired to the shunt trip main breaker and in parallel with the ground fault trip where applicable. Panic button shall be Allen Bradley #800T-BGA or approved equal with extended head red push button unit with extra-long guard ring, Allen Bradley #800-N13 or approved equal. Mushroom head push buttons are not acceptable.

D. Branch circuit breakers shall be equipped with individually insulated, braced and protected connectors. The front faces of all circuit breakers shall be flush with each other. Large, permanent, individual circuit numbers shall be affixed to each breaker in a uniform position. Tripped indication shall clearly be shown by the breaker handle taking a position between ON and OFF. Breaker interrupting capacities shall be as indicated on the drawings and adequate for the available fault current.

E. Reference Specification Section 26 28 16 for additional requirements.

2.3 GROUND FAULT PROTECTION

A. Ground fault protection (GFP) shall be provided at the service mains operating at greater than 150 volts to ground and rated over 800 amps, or where indicated on the drawings.

B. Reference Specification Section 26 28 16 for specification of equipment and devices.

2.4 POWER SYSTEM METERING

A. Reference Specification Section 26 09 13.

B. Provide a meter as follows:

1. Where noted within the specifications, on the drawings, and One-Line Diagram(s).

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PART 3 - EXECUTION

3.1 MOUNTING

A. Circuit breakers and fusible switches 800 amperes and larger shall be individually mounted.

3.2 INSTALLATION

A. Arrange for delivery and installation of each switchboard prior to construction of major walls and/or roof, or provide for suitable openings to properly install switchboard. No allowance will be made for failure to comply with this requirement. All necessary corrections shall be the responsibility of the Contractor at no additional cost to the Owner.

B. Move each switchboard in sections to the location indicated on the drawings. Completely assemble the switchboard, shim the entire structure level with metal stock, securely bolt to concrete pad, caulk or grout any gaps at the floor line. Prior to final inspection, apply factory touch-up paint to any scratches, scrapes, etc., on switchboard enclosure.

END OF SECTION 26 24 12

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SECTION 26 24 13

DISTRIBUTION SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install distribution switchboards as herein specified and as shown on the drawings.

B. Acceptable manufacturers are Cutler-Hammer, General Electric, Siemens, and Square D.

C. Plant of manufacture shall be ISO 9001 or 9002 certified.

PART 2 - PRODUCTS

2.1 GENERAL

A. Distribution switchboards shall be of the dead-front, safety type, with voltage and ampere capacity as indicated on the drawings. NEMA 1 for indoor and NEMA 3R for outdoor applications.

B. Distribution switchboard framework shall be fabricated on a die-formed steel base or assembly consisting of formed steel and commercial channel welded or bolted together to rigidly support the entire shipping unit for moving on rollers and floor mounting. The framework is to be formed code gauge steel, rigidly welded and bolted together to support all cover plates, bussing and component devices during shipment and installation. Each switchboard section shall have an open bottom and individual removable top plate for installation and termination of conduit. Top and bottom conduit area is to be clearly shown and dimensioned on the shop drawings. All front plates used for mounting meters, selector switches, or other front devices shall be hinged with all wiring installed and laced with flexibility at hinged side. All closure plates shall be screw-removable and small enough for easy handling by one man. Paint finish shall be enamel over a rust-inhibiting phosphate primer.

C. Distribution switchboard bussing shall be copper or tin-plated aluminum. Bus bars shall extend the full height of the switchboard and shall be rigidly braced to comply with the integrated equipment rating of the switchboard. Main horizontal bus bars between sections shall be full size for their entire length and located at the back of the switchboard to permit a maximum of available conduit area. End sections shall have bus bar provisions for future addition of a switchboard section as indicated on the drawings. Provisions shall include bus bars installed to the extreme side of the switchboard and prepunched to facilitate future bolted splice plates. Vertical bus bars shall extend the full height of each section and be predrilled on universal centers to allow connections to any standard-sized branch unit. Provide a 25 percent minimum ground bus running the full length of the switchboard, but in no case smaller than 1/4" x 2" copper. Provide a 25 percent minimum isolated ground bus running the full length of the switchboard, but in no case smaller than 1/4" x 2" copper when the distribution board is indicated to serve isolated ground feeders.

D. Distribution switchboards shall be listed for front access only, except as noted otherwise on the plans.

E. Each distribution switchboard, as a complete unit, shall be given a single integrated equipment short circuit rating by manufacturer. Such rating shall be established by actual tests by manufacturer on equipment construction similar to subject switchboard. This test data shall be available and shall be furnished upon request.

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F. All bussing shall be braced for a minimum integrated equipment short circuit current rating of 65,000A RMS symmetrical amperes, or as noted on the drawings.

G. Distribution switchboards shall be provided with digital ammeter, voltmeter, and power system metering for each main as indicated on the drawings. Reference Specification Section 26 09 13. Stated functions may be combined into one device. Switchboards with only one main may omit customer power meter function.

2.2 CIRCUIT BREAKERS

A. Main circuit breakers shall be stationary type with static trips, UL listed for 100 percent continuous current rating in a switchboard, minimum 65,000 amperes interrupting capacity at 480 volts, except where noted otherwise on the drawings. The trip mechanism shall be ambient insensitive, and shall have adjustable long time delay (60 to 100 percent), adjustable short time delay, and instantaneous trips. Circuit breakers shall be manually operated to provide quick-make, quick-break operation, and shall be equipped with an electrical shunt trip capable of operation at 55 percent of rated voltage. Main load current contacts to be of multi-fingered construction.

B. Manual closing operation shall be by means of a handle located on the front of the circuit breaker, with a clearly visible push-to-open button.

C. A panic button shall be installed adjacent to the electrical service room exit which shall be wired to the shunt trip main breaker and in parallel with the ground fault trip where applicable. Panic button shall be Allen Bradley #800T-BGA or approved equal with extended head red push button unit with extra-long guard ring, Allen Bradley #800-N13 or approved equal. Mushroom head push buttons are not acceptable.

D. Branch circuit breakers shall be equipped with individually insulated, braced and protected connectors. The front faces of all circuit breakers shall be flush with each other. Large, permanent, individual circuit numbers shall be affixed to each breaker in a uniform position. Tripped indication shall clearly be shown by the breaker handle taking a position between ON and OFF. Breaker interrupting capacities shall be as indicated on the drawings and adequate for the available fault current.

2.3 GROUND FAULT PROTECTION

A. Ground fault protection (GFP) shall be provided at the service mains operating at greater than 150 volts to ground and rated over 800 amps, or where indicated on the drawings.

B. Reference Specification Section 26 28 16 for specification of equipment and devices.

2.4 POWER SYSTEM METERING

A. Reference Specification Section 26 09 13.

B. Provide a meter as follows:

1. Where noted within the specifications, on the drawings, and One-Line Diagram(s).

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PART 3 - EXECUTION

3.1 MOUNTING

A. Circuit breakers 800 amperes and larger shall be individually mounted.

3.2 INSTALLATION

A. Arrange for delivery and installation of each switchboard prior to construction of major walls and/or roof, or provide for suitable openings to properly install the switchboard. No allowance will be made for failure to comply with this requirement. All necessary corrections shall be the responsibility of the Contractor at no additional cost to the Owner.

B. Move each switchboard in sections to the location indicated on the drawings. Completely assemble the switchboard, shim the entire structure level with metal stock, securely bolt to the concrete pad, caulk or grout any gaps at floor line. Prior to final inspection, apply factory touch-up paint to any scratches, scrapes, etc., on switchboard enclosure.

END OF SECTION 26 24 13

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SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install branch circuit panelboards as specified herein and as indicated on the drawings.

B. Acceptable manufacturers are Cutler-Hammer, General Electric, Siemens, and Square D.

C. Submit sample circuit directory with material submittals.

PART 2 - PRODUCTS

2.1 GENERAL

A. All bus bars shall be copper, located in the rear of the panelboard cabinet. Circuit breakers shall be mounted into suitable supporting members at the front of the cabinet that are connected with suitable lugs to the bus bars in the rear of the cabinet. Individual circuit breakers shall be removable from the cabinet without disturbing adjacent units or supporting members.

B. Feeder lug sizes shall accommodate the specified conductor size and quantities. Coordinate with one-line diagrams on the plans.

C. The minimum interrupting rating of circuit breakers shall be 10,000 amps. Refer to the drawings for higher interrupting rating requirements.

D. Locks shall be provided on all panelboards. All locks shall be keyed alike.

E. Panelboards shall be equipped with 100% rated neutral bus bar and an equipment ground bar.

F. Where specified on the plans, provide panelboards listed for use with non-linear loads and include a 200% rated neutral bus bar.

G. Where specified on the plans, provide panelboards equipped with isolated ground bars in addition to the equipment ground bars. Each isolated ground bar shall include termination positions matching the number of single circuit poles in the panelboard. The isolated ground bus shall be 100% rated.

H. Each panelboard shall be identified as outlined in Specification Section 26 05 00.

I. Each panelboard shall have a two-column circuit index card set under glass or glass equivalent on the inside of the door. Minimum size of 5" x 8" for panels up to 20 circuits; two 5" x 8" cards for panels above 20 circuits or 6" x 11".

J. All panelboards shall have full hinged cover trim to allow access to wireways and line/load lugs without removing front covers.

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K. All panelboards shall have door-in-door trim to allow access to wireways and line/load lugs without removing front covers. Surface-mounted type may have the entire cover hinged in lieu of a second door for access to wiring.

L. All panelboard enclosures shall have blank end-walls. The use of knockout type end-walls is prohibited.

PART 3 - EXECUTION

3.1 SUMMARY

A. Install panelboards straight and true. Properly support, secure and adjust enclosures, interiors and trims. Unless otherwise indicated, mount panelboards with centerline 5'-0" above floor, but with top edge of trim not to exceed 6'-0" above floor. Align tops of panelboards at the same height.

B. Locate panelboards in such a way as to comply with working clearances described in the NEC.

C. Flush-Mounted Panelboards: Stub two 3/4" conduits and one 1" conduit into the nearest accessible ceiling space.

END OF SECTION 26 24 16

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SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install all wiring devices as shown on the drawings and as herein specified.

B. Manufacturer:

1. Unless otherwise noted, device and plate numbers shown are Hubbell and shall be considered the minimum standard acceptable.
2. Other acceptable manufacturers are Bryant, Leviton, and P&S.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Switches:

1. All LINE VOLTAGE switches shall be of the quiet mechanical type, specification grade, 20 amperes, 120/277 volt AC as follows:

Single pole	1221
Two pole	1222
Three-way	1223
Four-way	1224
Pilot light	1221-PL - 120V
1221-PL7 - 277V	

Single pole – Double throw	HBL1385
Double pole – Double throw	HBL1386
Single pole – weatherproof neoprene cover	HBL1785

2. All LOW VOLTAGE switches shall be of the quiet mechanical type, specification grade, three-position, two-circuit momentary contact, center off, 20 amperes, 120/277 volt AC as follows:

Toggle type – Center position	HBL1556

3. Switch color shall be selected by the Architect. Nylon plates shall match.
4. All LINE VOLTAGE switches shall have the ON and OFF positions indicated on the handle.
5. If switches of higher ampere ratings are required, they shall be of similar type and quality to those shown above.
6. Switches shall be located at 46" centerline above finish floor, except where otherwise indicated. Groups of switches shown at one location shall be installed under a single plate having the proper number of openings, and appropriate to the location.

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B. Wall Box Dimmers:

1. Incandescent dimmers shall be slide-to-off control. Provide wattage rating based on load to be controlled x 125%. Lutron Model Nova T-star or as accepted by Architect.
2. Fluorescent dimmers shall be slide-to-off control. Wattage ratings shall be sized for the load to be controlled. Dimmer shall be listed for use with ballast provided. Lutron #NTF Series and where 3-way or 4-way control is shown on drawings, matching Lutron #NT-3PS 3-way switch or #NT-4PS 4-way switch as appropriate. Submit data with ballast literature for acceptance by the Architect.
3. Low voltage dimmers shall be slide-to-off control. Dimmer shall be rated for use for with magnetic transformers. Provide wattage rating based on load to be controlled x 125%. Lutron #NTLV Series and where 3-way or 4-way control is shown on drawings, matching Lutron #NT-3PS 3-way switch or #NT-4PS 4-way switch as appropriate. Submit data with ballast literature for acceptance by the Architect.
4. Coordinate all fluorescent and low voltage dimmers with the controlled load voltage interface requirements.
5. All requirements of "switches" apply.

C. Receptacles:

1. All convenience receptacles and special outlets throughout shall be grounding type.
2. Generally, convenience receptacles shall be specification grade, back- or side-wired, parallel slot, two-pole, three-wire, 20-amp as follows:

Single	5361
Duplex	5362
Duplex	5553
Ground Fault Circuit Interrupters	GFR5362

3. If receptacles of higher ampere ratings are required, they shall be of similar type and quality to those shown above.
4. Receptacles on emergency power shall be red. All other receptacle colors shall be selected by the Architect.
5. Receptacles shall be located at 18" centerline above finish floor, except where otherwise indicated.
6. Special receptacles shall be as noted on the drawings. Furnish caps for all special outlets.
7. SNAPConnect type device connections are acceptable.

D. Spring-Wound Timers:

1. Spring-wound time switches shall be of the quiet mechanical type, specification grade, 20 amperes, 250 volt AC, DPDT, 12-hour duration (unless noted otherwise on the drawings), without Hold feature. Intermatic FF Series, or Paragon SWPD Series.
2. Where noted as weatherproof (WP), provide "weatherproof while in use" cover consisting of cast aluminum material, NEMA 3R rated. Intermatic #WP1010MC or as accepted.

E. Cover Plates:

1. Provide wall plates for all wiring devices and outlet boxes, including special outlets, sound, signal, and telephone outlets, etc., as required. All cover plates shall be appropriate for type of device.
2. All plates throughout shall be type 302 stainless steel or specification grade nylon, color to match wiring devices.
3. In use weatherproof covers, provide Taymac MX Series, deep metal enclosure and cover appropriate for the device indicated.
4. Weatherproof plates for switches shall be single cover, Hubbell HBL7420.

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F. Multi-Outlet Assemblies:

1. Devices within the multi-outlet assembly shall meet criteria of "Receptacles."
2. Assemblies shall be metallic, single-compartment, listed for grounding as a raceway, and shall accept full size wiring devices. Receptacles shall be provided at 24" on center, unless otherwise noted on the drawings. Provide all components necessary for a complete installation.
3. The product provided shall be Walker/Wiremold G4000 Series or as accepted by the Architect.
4. Mounting height is generally above cabinet tops. Where not occurring above work surfaces, mount at +3'-6" to centerline.
5. Coordinate finish color with the Architect prior to ordering.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify location and mounting height of all receptacles, wall mounted fixtures, switches, and other equipment before roughing in. See drawings for pertinent information. Refer questionable cases to the Architect.

B. Horizontal receptacles shall be installed so that the neutral is at the top. Vertical receptacles shall be installed so that the ground is at the top.

END OF SECTION 26 27 26

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SECTION 26 28 13

FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install fuses and circuit breakers as specified herein and as indicated on the drawings.

B. Acceptable fuse manufacturers are Bussmann, LittelFuse, and Ferraz.

C. Circuit breakers shall be manufactured by the same manufacturer as the equipment within which they are installed.

D. Submittals: Submit short circuit interrupting data for all overcurrent devices. Include UL series combination rating data, where applicable, with equipment submittals. Clearly indicate each rating and/or combination being utilized.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide termination lug quantities to accommodate conductor sizes and quantities shown on the drawings. Increase circuit breaker frame sizes as required.

B. Fuses:

1. Fuses protecting lighting and appliance branch circuit panelboards shall be UL Class RK-1, current-limiting, time-delay, rejection-type, 600- or 250-volt, with interrupting rating of 200,000 amperes RMS symmetrical (Bussmann LPS-RK or LPN-RK). Ampere ratings as noted on plans.
2. Fuses protecting motor control centers and transformers shall be UL Class RK-1, current-limiting, time-delay, rejection-type, 600- or 250-volt, where interrupting duty is over 200,000 amperes RMS symmetrical (Bussmann LPS-RK or LPN-RK), and UL Class RK-5, time-delay for up to 100,000 amperes RMS symmetrical (Bussmann FRS-R or FRN-R). Ampere ratings as noted on plans.
3. Fuses protecting motor branch circuits shall be UL Class RK-5, time-delay, 600- or 250-volt, 200,000 amperes RMS symmetrical interrupting rating, sized at 125% of motor nameplate full load amperes (Bussmann FRS-R or FRN-R).
4. Fuses shall be applied considering upstream devices, in accordance with their UL series combination ratings. All applications of fuses shall be on a single fuse per phase leg basis.
5. Furnish and deliver spare fuses to the Owner as follows:

    a. Three spares for each type and size, in excess of 60 amperes, used for initial fusing.
    b. Ten percent or minimum of three spares for each type and size, up to and including 60 amperes, used for initial fusing.

6. Provide a NEMA -12 spare fuse cabinet with appropriate shelving, and size as required to accommodate spare fuses supplied. Hoffman, Hammond, or as accepted. Provide 1" x 4", laminated, black text on white micarta nameplate with script "SPARE FUSES."

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C. Ground Fault Protection:

1. Furnish and install UL listed ground sensor relay system with ground break components for each of the protective devices indicated on the drawings. Each unit shall consist of a coordinated ground sensor with integral test winding, solid-state relay to operate the shunt trip circuit on the circuit protective device, and monitor/test panel. System shall be zero sequence type.
2. Where the overcurrent protection device for which ground fault has been specified includes integral current transformers necessary for phase overcurrent protection, the ground fault functionality may be provided by vector summation of the load current in the phase conductors and neutral conductor(s) ("differential current" or "residual current" method). In such instances, provide a neutral current transformer and associated wiring back to the ground fault relay.
3. The relays shall be of the standard time-delay type and have continuously- adjustable current pickup settings of 100-1,200 amperes and continuously adjustable time-delay setting from instantaneous (0.03 second) to 1 second. The monitor panel shall indicate relay operation and provide means for testing the system with or without interruption of service, and must not permit the ground fault system to be inadvertently left in an inactive or OFF state.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fuses:

1. Install fuses in such a manner as to expose manufacturer's label indicating model number and ratings.
2. Legibly write the design fuse type on the inside of the switch cover with an indelible ink marker.
3. Coordinate installation location of the spare fuse cabinet with the Owner, and install prior to Project Closeout.

3.2 OVERCURRENT SIZE VERIFICATION

A. Confirm maximum overcurrent protective device (MOCP) ratings with mechanical accepted shop drawings for equipment supplied PRIOR TO ORDERING. The Contractor shall adjust the supply circuit breaker and/or fuse ratings to match accepted shop drawing MOCP data per the NEC.

B. Where equipment includes an adjustable speed drive, upstream overcurrent device and feeder size shall be adjusted to match the rated input current to the accepted drive furnished. In no case shall the overcurrent setting be less than 125% of the nameplate load. Refer to the NEC and Division 23 for requirements. Confirm accepted adjustable speed drives to be supplied PRIOR TO ORDERING related overcurrent device(s) and installing underground conduit.

C. Prior to project completion, the Contractor shall verify that MOCP ratings match nameplate data for installed equipment. Correct MOCP device sizes as required by the NEC.

END OF SECTION 26 28 13

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SECTION 26 28 16

ENCLOSED SWITCHES & CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install all safety switches as shown on the drawings and as required by the NEC.

B. Acceptable manufacturers shall be Cutler-Hammer, General Electric, Siemens, or Square D.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All switches shall be heavy-duty type, externally operated with interlocking cover, quick-make, quick-break, rated 240 or 600 volts, as applicable, with the number of poles and ampacity as noted. All switches for motors shall be horsepower rated. Switches used indoors shall have NEMA-1 enclosures unless noted otherwise. All switches outside the building shall have NEMA-3R enclosures. Generally, switches shall be fused, except where noted to be non-fused (NF) on the drawings. Fusible switches shall be capable of accepting Class R rejection fuses, but shall be set up for the fuse class indicated on the drawings.

B. Disconnect Switches for Fractional Horsepower, 120 Volt, Single-Phase Motors:

1. With Built-In Thermal Overload Protection: Single-pole, manual motor starter with pilot light unless noted otherwise. Starter ampere rating shall match branch circuit breaker.
2. Without Built-In Thermal Overload Protection: Single-pole, manual motor starter with thermal overload protection and pilot light, unless noted otherwise. Starter ampere rating shall match branch circuit breaker. Overload elements shall be sized per motor manufacturer's recommendations and the NEC. Maximum ambient temperatures shall be considered when sizing overload elements.

C. Disconnect switches for fractional horsepower motors larger than 1/2 horsepower, for integral horsepower motors, and for equipment of similar capacity shall be provided as heavy-duty type, externally operated with interlocking cover, quick-make, quick-break, rated 240 or 600 volts, as applicable, with the number of poles and ampacity as noted. All switches for motors shall be horsepower rated. Switches used indoors shall have NEMA-1 enclosures unless noted otherwise. All switches outside the building shall have NEMA-3R enclosures. Generally, switches shall be fused, except where noted to be non-fused (NF) on the drawings. Fusible switches shall be capable of accepting Class R rejection fuses, but shall be set up for the fuse class indicated on the drawings.

D. Disconnect switches for small 120V equipment 12 amps or less, shall be specification grade, single-pole, 15-amp toggle switch with pilot light.

E. Where a local disconnect switch for an item of equipment is remotely located on the load side of a variable frequency drive (VFD), provide the disconnect switch with a factory-installed electrical interlock kit. The interlock kit contact shall be wired into the VFD shutdown control to prevent damage to the VFD in the event of operation of the switch while equipment is under load. The interlock kit shall be field adjusted to insure the interlock contact operates before switch blades open.

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F. Provide a manual bypass feature for all disconnect switches serving VFD systems. The system components shall provide complete manual bypass around the VFD so that the VFD components can be serviced while keeping the system in operation.

2.2 CIRCUIT BREAKERS

A. Enclosed circuit breakers (ECB) shall be externally operated with interlocking covers. Provide with sheet metal enclosure with ANSI 61 finish. Surface mount, except where shown recessed on the drawings. NEMA-1 for indoor applications, unless noted otherwise. All switches outside the building shall have NEMA-3R enclosures.

B. Circuit Breakers:

1. Circuit breakers shall be molded-case, trip-free, quick-make, quick-break, thermal-magnetic type, with handles clearly indicating rating and position - ON, OFF or TRIPPED. Where series combinations are noted to be applied on the plans, UL series combination ratings shall be maintained with upstream overcurrent device(s).
2. For power panels, lighting panels, or for individual mounting, circuit breakers shall have an interrupting rating no less than the available duty at the breaker. The following minimum duties shall apply where not otherwise specified:

	RMS-Symmetrical	
100A Frame		
15A to 100A	14,000A @ 277V	10,000A @ 120/240V
225A Frame		
70A to 225A	22,000A @ 480V	25,000A @ 240V
400A Frame		
250A to 400A	30,000A @ 480V	42,000A @ 240V

3. Circuit breakers in 120/208V branch circuit panels shall have an interrupting rating of 10,000A RMS symmetrical, unless noted otherwise.
4. Circuit breakers in 120/208V and 277/480V panelboards shall be bolt-on breakers. Breaker numbers shall be stamped on the deadfront, decal numbering is unacceptable.
5. Where "L", "S", "I", "G" or "GFP", is noted on drawings, provide circuit breakers which include the corresponding features:

    a. Adjustable long time delay (L).
    b. Adjustable short time delay (S).
    c. Adjustable instantaneous pickup (I).
    d. Adjustable instantaneous ground fault trip pickup and time delays (G or GFP).

6. Where ampere frame (AF) and ampere trip (AT) sizes are noted on drawings, provide circuit breakers with interchangeable rating plugs (non-adjustable) for instantaneous rating.
7. Circuit breakers of frame size larger than 600 ampere shall be UL listed for application at 100% of their continuous ampere rating in their intended enclosure, and shall include the following features:

    a. Adjustable long time delay (L).
    b. Adjustable short time delay (S).
    c. Adjustable instantaneous pickup (I).
    d. Interchangeable rating plugs for instantaneous rating.
    e. Where GFP is noted, include adjustable instantaneous ground fault trip pickup and time delays.

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C. Ground Fault Protection:

1. Furnish and install UL listed ground sensor relay system with ground break components for each of the protective devices indicated on the drawings. Each unit shall consist of a coordinated ground sensor with integral test winding, solid-state relay to operate the shunt trip circuit on the circuit protective device, and monitor/test panel. System shall be zero sequence type.
2. Where the overcurrent protection device for which ground fault has been specified includes integral current transformers necessary for phase overcurrent protection, the ground fault functionality may be provided by vector summation of the load current in the phase conductors and neutral conductor(s) ("differential current" or "residual current" method). In such instances, provide a neutral current transformer and associated wiring back to the ground fault relay.
3. The relays shall be of the standard time-delay type and have continuously- adjustable current pickup settings of 100-1,200 amperes and continuously adjustable time-delay setting from instantaneous (0.03 second) to 1 second. The monitor panel shall indicate relay operation and provide means for testing the system with or without interruption of service, and must not permit the ground fault system to be inadvertently left in an inactive or OFF state.

PART 3 - EXECUTION

3.1 EQUIPMENT SIZE VERIFICATION

A. Confirm disconnect ratings with mechanical shop drawings for equipment supplied PRIOR TO ORDERING. The Contractor shall adjust minimum sizes provided based on nameplate data per the NEC.

3.2 INSTALLATION

A. Install switches at locations indicated on the drawings, using approved fastening methods, and maintaining proper working clearances and mounting parameters per the NEC.

B. Where it is not possible to install switches on a wall, structure or item of equipment, provide rigid, freestanding supports of galvanized angle or channel. Supports shall be primed and painted.

C. Circuit Breakers: Set adjustable circuit breakers per the engineered coordination settings. Reference Section 26 05 00.

D. Ground Fault Protection: Set trip unit per the engineered coordination settings. Reference Section 26 05 00.

3.3 OVERCURRENT SIZE VERIFICATION

A. Confirm maximum overcurrent protective device (MOCP) ratings with mechanical accepted shop drawings for equipment supplied PRIOR TO ORDERING. The Contractor shall adjust the supply circuit breaker and/or fuse ratings to match accepted shop drawing MOCP data per the NEC.

B. Where equipment includes an adjustable speed drive, upstream overcurrent device and feeder size shall be adjusted to match the rated input current to the accepted drive furnished. In no case shall the overcurrent setting be less than 125% of the nameplate load. Refer to the NEC and Division 23 for requirements. Confirm accepted adjustable speed drives to be supplied PRIOR TO ORDERING related overcurrent device(s) and installing underground conduit.

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C. Prior to project completion, the Contractor shall verify that MOCP ratings match nameplate data for installed equipment. Correct MOCP device sizes as required by the NEC.

END OF SECTION 26 28 16

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SECTION 26 32 13

DIESEL ENGINE DRIVEN GENERATOR SETS

PART 1 - GENERAL

1.1 SUMMARY

A. This section of the specification covers the furnishing and installation of a diesel-driven, radiator-cooled emergency generator with enclosure and automatic transfer switches as specified herein and as indicated on the project drawings.

1.2 APPLICABLE CODES AND STANDARDS

A. All material and workmanship shall comply with the applicable portions of the latest edition enforced of the following codes and standards:

1. National Fire Protection Association NFPA-37, 20, and 110.
2. National Electrical Code NEC (NFPA-70) with local amendments.
3. National Electrical Manufacturers Association (NEMA).
4. NEMA MG1 and MG2 - Motors and Generators.
5. Underwriters' Laboratories Inc. Standards (UL) or Canadian Standards Association (CSA) Listed and Labeled if UL is not available.
6. UL 1008 Standard for Safety for Automatic Transfer Switches.
7. . International Fire Code (IFC) with local amendments.
8. U.S. Environmental Protection Agency (EPA) Regulations for Non Road Diesel Driven Engines.

1.3 SYSTEM RESPONSIBILITY

A. It is the intent of this specification that the engine generator and automatic transfer switch be supplied by one manufacturer who shall furnish all wiring diagrams for all equipment which shall constitute the emergency/standby power system.

B. A manufacturer's representative shall conduct a complete system operation test for the Engineer and the Owner's operating personnel. The test shall be certified as 100% operational and installed per their specifications.

1.4 SUBMITTAL DATA

A. Submittal data shall include the following:

1. Make and model of engine and generator.
2. Makes and models of switchgear and other major auxiliary equipment, including automatic transfer switch, vibration isolators, and radiator, if included in the bid.
3. Manufacturer-produced dimension drawings of the complete engine generator set clearly showing entrance points for each of the interconnections required.
4. Manufacturer-published kilowatt output curve and published fuel consumption curve.
5. Unit ventilation and combustion air requirements.
6. Manufacturer-published transient response data of the complete engine generator set upon 50%, 75%, and 100% block loads at 1.0 p.f. Data shall include maximum voltage dips, maximum

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frequency dips, recovery time periods, and generator motor starting curves showing the voltage dips versus starting KVA.

7. Locations and descriptions of the supplier's parts and service facilities within a 50-mile radius of the project site, including parts inventory and numbers of qualified generator set service personnel.
8. Actual electrical diagrams, including schematic diagrams and inter-connection wiring diagrams for all equipment to be supplied.
9. Drawings showing fuel tank connection points. Manufacturer warranty statements.
10. Engine altitude duration curve.
11. EPA Tier 4 compliance certification.
12. Comply/deviate statement for each specification section paragraph.
13. Written warranty document.
14. Copy of standard maintenance contract.

1.5 OPERATION AND MAINTENANCE MANUALS

A. Provide operating and maintenance manuals covering the engine-generator and auxiliary equipment that may require special operating instructions or periodic maintenance.

1.6 WARRANTY

A. Additional requirements per Specification Section 26 05 00: Equipment furnished under this section shall be guaranteed against defective parts or workmanship under the terms of the manufacturer's and dealer's standard warranty for a period of three years, and shall cover full parts and labor as specified.

1.7 SYSTEM SERVICE CONTRACT

A. The supplier of the standby power system must provide a copy of and make available to the Owner his standard service contract which, at the Owner's option, may be accepted or refused. This contract will accompany any documents, drawings, catalog cuts, specification sheets, wiring or outline drawings, etc., submitted for approval to the Designing Engineer. The contract shall be for the complete services rendered over a period of one year.

PART 2 - PRODUCTS

2.1 ENGINE GENERATOR SET

A. General:

1. Furnish and install a complete system for emergency power consisting of one diesel engine driven generator set with automatic controls, automatic transfer controls and all accessory items as hereinafter specified and detailed on the drawings. The engine generator set shall be the published and catalogued products of one company. That company shall have sole responsibility for the performance and service of the diesel engine generator set and the accessories. The unit shall be factory assembled and tested as a set, UL 2200 listed and EPA Tier 3 compliant.
2. It is essential that the engine generator supplier maintain a local parts and service facility within 50 miles of this installation. The supplier must carry sufficient inventory to cover no less than 80% of the parts required for service within 24 hours and 95% within 48 hours. Further, the supplier shall have factory-trained service representatives to furnish all installation, test, and

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startup supervision necessary for final approval and acceptance as well as to perform maintenance and repairs on all components as required.

3. Service Conditions:

   a. Ambient Temperature: 0 to 110°F.
   b. Altitude: 6000 feet.

4. Acceptable Manufacturers (Engine Generator): Caterpillar as required by the Owner.

B. Rating:

1. Rating of the diesel engine generator set shall be based on operation of the set when equipped with all necessary operating accessories such as radiator, fan, air cleaners, alternating current generator, exciter, and any attachments required for continuous operation. The generator set shall be rated for continuous standby service at kW, kVA, voltage, phase, and power factor noted on plans. Output shall be Wye connected. Ratings shall be corrected for ambient temperature and altitude. Ratings must be substantiated by manufacturer's standard published curves. Special ratings or maximum ratings are not acceptable.
2. The specified engine generator set shall be for continuous electrical service during interruption of the normal utility source.
3. The unit shall be arranged for automatic unattended and remote starting, complete with all accessories and auxiliaries necessary for normal operation.
4. NFPA 110 ratings: Type 10, Class 12, Level 1.

C. Diesel Engine:

1. The engine shall be water-cooled in-line or vee-type, four-stroke cycle compression ignition diesel. The engine shall meet the specifications when operating on No. 2 domestic burner oil. Diesel engines requiring premium fuels will not be considered. The engine shall be equipped with fuel, lube oil and intake air filters, lube oil coolers, fuel transfer pump, fuel priming pump, and gear-driven water pump.
2. The engine shall be equipped with fuel filter, lube oil and intake air filters, lube oil coolers, and jacket water pump.
3. The engine shall be equipped with the following accessories: battery charging alternator, lube oil filter, dry type air cleaner, radio suppression, jacket water heater, exhaust silencer, electric gas solenoid(s), oil drain extension.
4. The engine shall be offered only at a speed and rating no higher than that for which it has been designed. The engine rotative speed shall be standard revolutions per minute (rpm) indicated in catalog data and shall not exceed 1,800 rpm.
5. Rotating or reciprocating parts, or other parts that may present a hazard to operating personnel, shall be insulated or shielded so as to minimize danger in accordance with OSHA regulations.
6. Speed Governing System: The engine governor shall maintain isochronous frequency regulation from no load to full rated load. Steady-state operating band shall be ±0.25%. The governor shall be capable of remote speed adjustment at the generator control panel.
7. Overspeed Shutdown Device: The overspeed shutdown device shall be entirely independent of the engine speed governing system, but shall shut the fuel supply should the engine speed exceed 125% of synchronous speed. The overspeed device shall require manual resetting after emergency tripping.

D. Cooling System:

1. The engine shall be furnished with a cooling system having sufficient capacity for cooling the engine when the diesel generator is delivering full rated load in the ambient temperature specified.

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2. The engine shall be equipped with a gear-driven, centrifugal-type water circulating pump and thermostatic valve to maintain the engine at recommended temperature level. The cooling system shall be filled with a 50% solution of permanent-type antifreeze (glycol), rated for altitude.
3. The engine shall be equipped with a radiator and blower fan of a type and capacity recommended by the engine manufacturer, frame-mounted type. Total airflow restriction from the radiator shall not exceed 0.5" H_20, at both inlet and outside.
4. A unit-mounted thermal-circulation type water heater shall be furnished to maintain engine jacket water to be 190°F in minimum ambient temperature. Thermostat shall not be an integral part of the heater. Provide isolation valves in supply and return lines between jacket heater and engine. The heaters shall be single phase, 60 Hz, 208 Voltage, single Phase, and shall be as recommended by the engine manufacturer.

E. Exhaust System:

1. A critical exhaust silencer, muffler companion flanges, and flexible stainless steel bellows-type exhaust fitting, properly sized (minimum 36 inches in length), shall be furnished. The silencer shall be designed for roof mounting and constructed of high quality carbon steel to withstand temperatures in excess of 1,100°F. All workmanship shall comply with ANSI/AWS Standards Section D1.3; welding shall qualify under ASME Codes Section IX. Silencer body shall be double-wrap laminated steel. Silencer shall be multi-chamber, reactive type, frequency tunes, non-automotive, high temperature gas processing vessel. Exhaust pipe size shall be sufficient to ensure that exhaust back-pressure does not exceed the maximum limitations specified by the engine manufacturer. Condensate traps shall be provided at low points in the piping. Silencer and flexible bellows shall have 150# ASA flanges. Furnish section of exhaust pipe converting engine exhaust outlet(s) to 150# ASA flanges.
2. Exhaust silencer shall provide minimum sound attenuation of 37dB at 500Hz and 35dB at 2KHz with exhaust gas velocity per engine operation at 1,800 rpm. Provide with rain caps or angle-cut horizontal discharges.
3. The complete exhaust system shall be installed and mounted on the generator enclosure by the engine generator supplier.

F. Fuel System:

1. The fuel system shall be that which is normally used by the diesel engine manufacturer. It shall include a replaceable element fuel filter conveniently located for servicing, fuel pressure gauge, and engine fuel priming pump.
2. A ready supply "package day tank" shall be skid base mounted to provide an immediate fuel supply to the pump upon engine startup. The tank shall have a minimum capacity indicated by the NFPA 110 "Class" at full load operation.
3. The tank assembly shall be UL 142 listed and compliant with the UFC requirements. The tank shall be of double-wall construction and be equipped with a fuel gauge, vent line, 4" fill, low fuel contact, and leak detection in secondary containment.

G. Generator Mounting:

1. The engine generator assembly shall be equipped with factory-installed vibration isolators to prevent distortion of alignment between generation alternator and engine. Vibration isolators shall be mounted between the engine generator and fabricated steel skid base, or spring-type isolators may be installed between the frame and support pad. Size per the isolator manufacturer's recommendations.
2. All associated exhaust and fuel piping and control wiring, as well as other control connections to the isolated equipment, shall be made flexible.
3. Isolators shall be installed in accordance with the manufacturer's provisions of a minimum 90% theoretical isolation efficiency at rated operational RPM, which will afford the greatest reduction in vibration transmissibility.

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4. Provide concrete equipment support pad of sufficient mass to prevent equipment from walking. Pad shall enclose the complete floor for the drop over enclosure and extend above the finish grade by 3 inches. That portion of the pad directly under the engine generator, the equipment support pad, shall be isolated from the remainder of the pad by cork or similar material.
5. The equipment support pad shall be sized by a structural engineer registered in the State of Arizona. Submit sealed shop drawings in submittal package.
6. Mounting assembly in its entirety shall comply with Seismic Zone 3 requirements.

H. Engine Starting System:

1. The engine shall be equipped with a 24V electric starting system designed to crank the engine at a speed which will allow full diesel starting of the engine at the ambient temperature as specified, and shall be in accordance with the requirements of NFPA 110.
2. Storage batteries of the lead-acid type shall have sufficient capacity (minimum 220 ampere hours) for cranking the engine at firing speed for nine 10-second cranking periods at the ambient temperature specified without being recharged. They shall be of domestic manufacture in plastic containers.
3. Battery charger shall be wall mounted, automatic dual rate, float at 2.20V per cell and equalize at 2.17V per cell with ±1% output from no load to full load with an AC variance not to exceed 10 percent. Charger shall have automatic line compensation, current overload protection, DC voltage regulation, surge suppression, AC power failure relay with remote indicator terminal, DC ammeter, DC voltmeter, fused AC and DC input/output, and battery failure alarm connections. Charger shall be rated 120V AC, 60 Hz input and output sized to provide full recharge from complete discharge in 24 hours. LaMarche, Master or as accepted.

I. Safety Shutdown Controls and Alarms:

1. Controls shall be provided that will function to immediately shut off delivery of fuel to the engine cylinders when actuated by a condition described in NFPA 110.
2. The values at which the controls for low lubricating oil pressure and high water temperature are actuated shall be as recommended by the manufacturer, and the overspeed governor shall be set to actuate at the value specified herein. The low lubricating oil pressure shutdown control shall be provided with a means to make it inoperative during the period of low oil pressure when the engine is started.
3. Provide a remote-mounted emergency stop station consisting of a break glass station for emergency engine shutdown. The unit shall include two extra glass rods and be labeled "Generator Emergency Stop." Equal to Detroit Diesel #A-222654.
4. Each shutdown shall initiate its individual light and sound an alarm within the generator control panel, and shall require manual reset to release each indicating light. Normal startup and shutdown shall not actuate the indicator system.
5. NFPA 110 pre-alarm safeties shall be provided and wired to alarm lights in the generator control panel. Dry contacts for all NFPA 110 alarm signals shall be provided for the remote annunciator panel.

J. Automatic Starting Controls:

1. Starting Motor: The engine shall be equipped with a 24V electric starting system with positive engagement drive and of sufficient capacity to crank the engine at a speed which will start the engine under operating conditions. The starting pinion will disengage automatically when the engine starts. The starting system shall incorporate an automatically reset circuit breaker for anti-butt engagement.
2. Automatic Controls: Fully automatic generator set start-stop controls in the generator control panel shall be provided. Controls shall provide shutdown for low oil pressure, high water temperature, overspeed, overcrank, and one auxiliary contact for activating accessory items. Controls shall include a 10-second cranking period followed by a 10-second rest period. If the

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engine has not started in approximately 60 seconds or three cranking tries, the engine starting controls shall lock out and the overcrank signal shall so indicate.

3. Generator Controls: Generator controls and meters shall be panel mounted on the generator and include the following as minimum components:

   a. Voltmeter, 3/4" Digital LCD, 2% accuracy.
   b. Ammeter, 3/4" Digital LCD, 2% accuracy.
   c. Ammeter, phase selector switch.
   d. Frequency meter, 3/4" Digital LCD.
   e. Automatic starting controls.
   f. Panel illumination lights and switch.
   g. Voltage-adjustment rheostat.
   h. Engine oil pressure gauge.
   i. Engine water temperature gauge.
   j. Dry contacts for remote alarm wired to terminal strips.
   k. Fault indicators for low oil pressure, high water temperature, overspeed, overcrank, and ground fault current present.
   l. Four-position function switch marked "auto", "manual", "off/set" and "stop."
   m. Pre-alarm panel with visual and audible warning devices per NFPA 110.
   n. Hour meter.

K. Remote Annunciator Panel: Suitable for remote mounting in a flush manner. Panel shall provide audible and visual warning of fault or alarm conditions in the generator set. Points of annunciation shall be provided per NFPA 110 and the NEC. As a minimum, include the following indications:

1. Low oil pressure.
2. Overspeed.
3. Low water temperature.
4. High water temperature.
5. Low fuel.
6. Overcrank.
7. Low battery voltage.
8. High battery voltage.
9. Generating.
10. Ground fault indication (audible and visual).
11. Alarm silencer.
12. Lamp test.

L. Generation Alternator:

1. Type: Alternator shall be four-pole, revolving-field, 12-lead, reconnectable, of drip-proof construction with amortisseur windings, single bearing, synchronous type built to NEMA standards. Class F insulation shall be used on the stator and rotor, and both shall be further protected with 100% epoxy impregnation and overcoat of resilient insulating material to reduce possible fungus and/or abrasion deterioration. The generator shall incorporate reactive drop compensation and shall include a resettable thermal protector for exciter/regulator protection against extended low power factor loads.
2. Rating: The alternator shall have a rating as noted on the drawings at 0.8 power factor, 60 hertz. The generator shall operate at rated voltage and frequency while running at 1,800 rpm, and shall be capable of operation at 125% of rated speed without damaging unit. Alternator rating shall be adjusted to compensate for line harmonics induced by SCR type electronic equipment (i.e., uninterruptible power supplies (UPS), variable frequency drives (VFD's), etc.). Review plans for quantities and KW/Hp ratings prior to bid and adjust alternator size accordingly.
3. Start KVA (SKVA): Alternators operating under a no load condition at rated speed, rated voltage shall be sized for a single step load application equal to the calculated load noted on the plans, without incurring a transient voltage dip of more than 25% of nominal rating. For the

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purpose of SKVA calculation, motor starting loads shall be considered at 6x full load amps. Oversizing the alternator compared with the rated power output of the engine is permissible to meet specified performance.

4. Alternator-exciter-automatic voltage regulator package shall provide ±2% voltage regulation. Voltage regulation shall apply to any load from no load to rated load (.8 pf lagging to unity) and is defined as the band width within which the unit's output voltage shall be maintained after all transients due to load change have decayed to zero. Steady-state voltage regulation shall be ±0.25% and is defined as the band width within which the alternator's output shall be maintained under conditions of any constant load from no load to full load with temperature stabilized.

    a. Regulator: The regulator shall be solid-state volts-per-hertz type and provided to match the characteristics of the generator and engine. Provide readily accessible voltage drop, voltage level, and voltage gain controls. Voltage level adjustment shall be a minimum of ±5%. The regulator module shall be generator mounted, shock protected, epoxy encapsulated for protection against vibration and atmospheric deterioration.
    b. Excitation: Alternator shall be separately excited, permanent magnet generator (PMG) type.

5. Radio interference suppression meeting commercial standards shall be supplied.

M. Main Line Circuit Breaker:

1. A generator-mounted main-line molded-case circuit breaker shall be installed as a load circuit interrupting and protection device. It shall operate both manually for normal switching function and automatically during overload and short circuit conditions. Size shall be according to manufacturer's recommendation.
2. The trip unit shall have instantaneous, short time delay, short time pickup, long time delay adjustments, in addition to inverse time delay. Main line circuit breaker(s) on 277/480V wye systems rated at 1,000 amps or more shall include ground fault indication (GFI) only per the NEC. The GFI shall include audible and visual annunciation at the engine generator control panel and remote annunciator. The circuit breaker shall be UL listed.
3. Generator exciter field circuit breakers do not meet the above electrical standards and are unacceptable for line protection.

N. Weatherproof Sound Attenuated Enclosure: Reference Specification Section 26 32 15.

2.2 AUTOMATIC TRANSFER SWITCHES

A. General:

1. Automatic transfer switches (ATS's) shall be provided with ratings as shown on the plans. Switches shall be listed under UL 1008 for use on emergency systems. The transfer switch shall be capable of switching all classes of load and shall be rated for continuous duty when installed in a non-ventilated enclosure constructed in accordance with Underwriters' Laboratories, Inc., Standard UL 508.

2. ATS's shall include a bypass/isolation feature to allow for complete removal of the automatic switch mechanism for service. The bypass switch mechanism shall have ratings equal to the automatic switch portion of the assembly. The bypass/isolation feature shall be manually operable.
3. Acceptable Manufacturers are: Russelectric, Zenith, ASCO, Cummins, or as accepted.

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B. Construction and Performance:

1. The automatic transfer switch (ATS) shall be double throw, actuated by a single electrical operator momentarily energized and connected to the transfer mechanism by a simple over-center linkage with a minimum transfer time of 500 msec.
2. The ATS shall be a true 4-pole switch supplied with all four poles mounted on a common shaft. The continuous current rating and the closing and withstand rating of the fourth pole shall be identical to the rating of the main poles.
3. ATS's shall be mounted in a NEMA 1 enclosure, unless otherwise indicated. Enclosures shall be fabricated from 12 gauge steel. The enclosure shall be sized to exceed minimum wire bending space required by UL 1008. The enclosure shall include adequate lifting means for ease of installation.
4. The transfer switch shall be completely isolated from the bypass/isolation switch by means of insulating barriers and separate access doors to positively prevent hazard to operating personnel while servicing the automatic transfer switch.
5. The transfer switch shall be capable of transferring successfully in either direction with 70% of rated voltage applied to the switch terminals.
6. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in position in both the normal and emergency positions without the use of hooks, latches, magnets, or springs, and shall be silver alloy protected by arcing contacts and barriers.
7. Interlocked molded-case circuit breakers will not be acceptable.
8. The transfer switch shall be equipped with a safe manual operator designed to prevent injury to operating personnel if the electrical operator should suddenly become energized during manual transfer. The manual operator shall provide the same contact opening and closing speed as the electrical operator to prevent a flashover from switching the main contacts slowly.
9. If the emergency power source should fail, the switch shall return immediately to the normal source if normal is available; however, it shall be possible to manually switch to the emergency power source for testing purposes even when the normal source is available. All relays, timers, control wiring, and accessories shall be front accessible.
10. The transfer switch shall be equipped with an internal welded steel pocket, housing operations and maintenance manuals.
11. The bypass/isolation switch construction, electrically and physically, shall be identical to the associated automatic transfer switch construction.
12. The combination automatic transfer bypass/isolation switch shall be top and bottom accessible. The ATS assemblies shall be listed for front access.
13. The main contacts shall be visible for inspection without any major disassembly of the transfer bypass/isolation switch. Contact replacement shall not require removal of main power cables.
14. All bolted bus connections shall have Belleville compression-type washers.
15. Provide a fully rated neutral bar with required AL-CU neutral lugs.
16. Control components and wiring shall be front accessible. All control wires shall be multi-conductor, 18 gauge, 600 volt, SIS switchboard type point-to-point harness. All control wire terminations shall be identified with tubular sleeve-type markers.
17. Pilot lights shall be long life LED type.
18. The switch shall be equipped with 90°C rated copper/aluminum solderless mechanical type lugs
19. The transfer switch, complete with timers, relays and accessories, shall be listed by UL in their Electrical Construction Materials Catalog under Standard UL 1008 (Automatic Transfer Switch) and approved for use on emergency systems.
20. When conducting temperature rise tests in accordance with UL 1008, the manufacturer shall include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rate current after completing the overload and endurance test.

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21. The transfer switch shall have a short-circuit withstand capability in excess of the protection devices used in conjunction with them. To establish conformance, the manufacturer shall produce certified test reports from an independent testing laboratory to verify that identical samples have been subjected to 3-phase short-circuit currents at applicable project AC voltage levels for a minimum of three cycles duration without contact damage or contact welding and without the use of current limiting fuse protection. Oscillograph traces are to be supplied to verify that the test parameters have been met.
22. The transfer switch, including all parts and supports, shall meet a seismic loading equal to their weights multiplied by a force factor, Cp. The directions of force, simultaneously and separately, shall be in any horizontal and vertical planes. The switches shall be capable of normal operation during and after seismic loading. Seismic loading shall not cause false operation. The force factor, Cp, shall be as defined in the Uniform Building Code.

C. Sequence of Operation:

1. Engine starting contacts shall be provided to start the generating plant should the voltage of the normal source drop below 70% on any of two phases, or 80% on the third phase, after a non-adjustable time delay of 3 seconds to allow for momentary dips. The transfer switch shall transfer to emergency as soon as the voltage and frequency have reached 90% of rated levels.
2. After restoration of normal power to 90% of rated voltage, an adjustable time delay period of 0-30 minutes shall delay retransfer to normal power until it has had time to stabilize. If the emergency power source should fail during the time delay period, the time delay shall be bypassed and the switch shall return immediately to the normal source.
3. After the switch has retransferred to normal, the engine generator shall be allowed to operate at no load for an adjustable period of time to allow it to cool before shutdown.

D. Accessories: Each transfer switch shall contain the following accessories:

1. Normal 0- to 3-second adjustable time delay to override harmless normal dips and outages. Set at two seconds.
2. Adjustable time delay on retransfer to normal (0-30 minutes). Set at 30 minutes.
3. Adjustable engine cool-down timer (0-30 minutes). Set at five minutes.
4. Relays which prevent transfer to emergency until voltage of generating plant has reached 90% of rated value and frequency has reached 97% of rated value.
5. To avoid excessive inrush currents, an integrally mounted in-phase monitor shall be provided where so indicated on the plans and drawings to prevent transfer or retransfer until the phase angle between the two power sources is within 10 electrical degrees and the frequency differential is within 2 Hz. The monitor shall not require any control wiring to the generator. The monitor shall be bypassed if the load-carrying source fails and the alternate power source is available.
6. Two pilot lights to indicated transfer switch position, normal and emergency.
7. Pilot-type indicator lights for both normal and emergency source.
8. Two auxiliary contacts, one opens and one closes after normal power fails for engine starting.
9. Four auxiliary contacts, two normally open and two normally closed, mounted on the same shaft as the main contacts, for remote indicating and/or control.
10. The transfer switch shall include a test switch to simulate normal power failure, pilot lights on the cabinet door to indicate the switch closed on normal or emergency, and four auxiliary contacts (25A at 120V AC) on the main shaft, two closed on normal and two closed on emergency.
11. Manual test switch to transfer to emergency source and back to normal with normal source available.
12. Generator exerciser clock, programmable for hours, days, or weeks between starts, and run time duration. Clock shall maintain historical record of exercises in non-volatile memory.

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PART 3 - EXECUTION

3.1 RECEIVING, HANDLING AND STORAGE

A. The Contractor shall be responsible for receiving and unloading the emergency generator set and automatic transfer switch at the project site according to manufacturer's instructions and recommendations. All equipment shall be protected from damage during handling or installation. If equipment is not to be installed immediately upon delivery, it shall be stored in a dry location and protected from extreme temperatures, moisture and accidental damage.

3.2 INSTALLATION

A. The Contractor shall install all equipment in accordance with manufacturer's instructions and recommendations. All equipment shall be completely wired according to manufacturer's wiring diagram, including power and control wiring.

B. The exhaust system shall be installed in accordance with NFPA 37 requirements. Provide approved thimbles when passing through combustible walls or roof.

C. Locate the remote annunciator panel as indicated on the plans. Size conduit per the NEC and provide wiring per manufacturer's wiring diagrams.

D. Provide permanent identification plaque(s) per the NEC. Plaques shall consist of laminated plastic plates with text and building outlines as required. Letters shall be vertical, 1/4-inch high white letters on black background. If required, use multiple lines, each containing as many as 45 letters and/or spaces. Submit sketch, including text for each specific plaque, to the Engineer for review prior to fabrication. Affix plaques to equipment with pop rivets or self-tapping screws at 9" O.C. intervals. Use caution to avoid filings and other metal from falling into the electrical enclosure.

3.3 SYSTEM CHECKOUT AND STARTUP

A. The engine generator supplier shall furnish service for the installation supervision, system checkout, and startup, all at the Owner's convenience.

B. Adjust the transfer switch and generator controls to specified parameters.

C. Where multiple transfer switches are installed, defeat all but one exerciser clock. Set controlling exercise clock per the Owner's desired time schedule.

D. Insert a copy of the instruction manual and any special tools or testing devices in the cabinet provided within the enclosure.

3.4 TESTING

A. Additional Requirements per Specification Section 26 05 00:

1. Dealer/Factory Testing: Before the equipment is shipped from the authorized dealer's place of business, a test log of the generator set showing testing at 100% rated load, continuously, at not less than 1,200 feet altitude, shall be submitted to the Engineer. The test log shall include readings taken at 30-minute intervals for four hours, noting engine oil pressure, water temperature, ambient air temperature and voltage and current of each phase. Voltage and current

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data shall be verifiable through the use of strip chart or digital recorders. Submit strip chart or spreadsheet copies with test log.

2. Acceptance Testing: At the completion of the installation of the emergency power system, an acceptance test of at least four hours at full load shall be run using resistive load banks. Fuel shall be included in the bid. During this test, all controls and safety devices will be tested. All tests and operations must be made to the complete satisfaction of the Owner and Engineer. Provide four sets of certified test reports to Engineer within two weeks of completion of the test.

3.5 TRAINING

A. A qualified company representative shall provide the Owner's operating personnel with four hours of instruction. Include training on maintenance and operation of the system supplied. The supplier shall permanently affix a 24-hour emergency phone number to both the generator set and the transfer switch.

END OF SECTION 26 32 13

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SECTION 26 32 15

WEATHERPROOF SOUND ATTENUATED ENCLOSURE

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers prefabricated, sound-attenuated weatherproof enclosure for engine generators specified in other sections, as specified herein.

1.2 APPLICABLE CODES AND STANDARDS

A. All material and workmanship shall comply with the applicable portions of the latest enforced edition of the following codes and standards:

1. National Fire Protection Association, NFPA-37, NFPA-20, and NFPA-110.
2. National Electrical Code (NEC) with Authority Having Jurisdiction amendments.
3. Uniform Building Code (UBC), with Authority Having Jurisdiction amendments.

1.3 SHOP DRAWINGS / SUBMITTALS

A. Submit per Specification Section 26 05 00 requirements and include the following additional items:

1. Plan, elevation, side, and front view arrangement drawings, including overall dimensions, weight and clearances, as well as mounting or anchoring requirements. Include an outline of the specific generator superimposed on the plans.
2. Locate electrical panel, lights, switches, receptacles, charging equipment, etc.
3. Include statements of conformance to "Design Criteria" on manufacturer's letterhead.
4. Weatherproof Sound Attenuated Enclosure: Weatherproof enclosure shall be provided and totally enclose the engine generator set.

PART 2 - PRODUCTS

2.1 ENCLOSURE

A. Enclosures shall be vandal-resistant, weather-resistant, walk-in type, fully assembled, prepainted, and shall consist of a roof, two side walls, and two end walls. The enclosure shall totally enclose the engine generator set, output "main line" circuit breaker, engine start batteries, and charger. Construction shall be such that the enclosure will not generate excessive noise due to vibrations and air movement. Design criteria shall be as follows:

1. Airflow of less than 0.5 inches of water gauge, based on applicable engine data.
2. Rigidity wind test equal to 100 mph.
3. Roof load equal to 40 lbs. per square foot, plus exhaust silencer.
4. Rain test equal to 2.0" per hour.
5. Acceptable manufacturers are Chillicothe Metal Co. Inc., International Supply Company, ACS, All Metal Fabrication Co., and Wedlake.

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6. The supplier shall include complete design drawings for erection of this enclosure. The drawings shall meet the permitting requirements of the City of Flagstaff Where drawings are required to be sealed by a registered professional, drawings shall be furnished as such. Revisions to the design drawings required for permitting shall be included at no additional charge to the Owner.
7. Clearances: Except where access doors are provided at all service points, the enclosure footprint shall include a minimum of 36" clear working area along both sides and rear (alternator end) of engine generator set.
8. Walls: The walls shall be of adequate depth to accommodate sound attenuating material, shall be of fabricated design, and shall be of heavy gauge metal.
9. Roof: The roof shall be tapered design for moisture runoff. Lifting eyes shall be supplied. The exhaust outlet(s) shall be precut in the roof with insulating sleeves as required by NFPA 37.
10. Exhaust silencers shall be mounted on the roof of the enclosure. Silencers shall be screened from view. Roof design shall include support for silencer and screening material.
11. Base: The base of the enclosure shall be designed for a drop-over installation, and shall include a means for fastening to the concrete slab. The drop-over style shall have a structural channel perimeter.
12. Louvers: The air openings shall include fixed louvers sized to allow proper airflow. The frames shall be manufactured of heavy gauge metal and the fronts shall be covered with expanded metal screen.
13. Doors: Adequate doors shall be installed for sufficient access to the generator set and all accessories. Single doors shall be 30" wide and 72" high. Double doors shall be 60" wide and 72" high; if center stop/casing is provided, it shall be removable. As standard, doors shall include stainless steel hinges with brass pins, rain-rail moldings above all door openings, recessed, keyed, chrome-plated handles with positive rod locking assemblies, and shall be fully weatherstripped. Doors shall be removable.
14. Paint: All seams shall be caulked with body sealer. Enclosures shall be metal prepped, primed with two coats of self-etching primer, and finished with two coats of automotive grade acrylic enamel with hardener or baked. Finish color shall be a single tone as selected by the Architect.
15. Lights, Receptacles, and Equipment: Include one 2-lamp (T-8) fluorescent strip for each 120 square feet of floor area. Provide with wire guard and switch(es) at main door(s). Locate fixtures to maximize visibility during service operations. Provide one duplex receptacle on each of three walls (not at radiator end) for maintenance. Provide circuit(s) and connection(s) to battery charger(s). Prewire to service entrance rated panelboard (60/3 MCB 120/208V, 3-phase, 4-wire) for single point connection.

B. Sound attenuation system shall limit exterior sound levels from generator equipment to 75dBA at 23 ft. Where the following materials are required, provide as indicated:

1. Sound Insulation for the Wall and Ceiling Enclosure: Insulation medium shall be of the closed-cell type and shall be retained in removable frames.
2. Sound Baffle Tube Assemblies for Air Inlet Locations: Assemblies shall consist of baffle tubes set in sturdy frames, similar to the radiator baffle assembly. Free airflow shall be a minimum of 1.2 times the total air requirement for the generator set.
3. Washable Sound Filters for Air Inlet Positions: Filters shall be a fiber type material set in sturdy frames, with the filter element to be easily removable for cleaning. These filters shall fully cover the air inlet locations and serve as a combination sound, dirt, and sand filter.
4. Radiator Sound Baffle Tubes: There shall be a bank of tubes covering at least the square foot area of the radiator in use. These tubes shall be designed to absorb the high power, low frequencies of generator set noise, without seriously impeding the flow of radiator exhaust air.
5. Radiator Turning Plenum: Plenum shall be fabricated of minimum 24 gauge galvanized steel, suitably reinforced to prevent excessive vibration or rattling. Such plenum shall include a bird screen at the top, and suitable drains. The unit shall be sized to handle the full volume of exhaust air required for rated engine operation.

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2.2 GENERAL WIRING

A. Provide an electrical feed and/or branch circuits for all equipment in accordance with the NEC as amended by the City of Flagstaff. All wiring shall be copper with type XHHW or THHN/THWN insulation. Minimum conductor size shall be #12 and conduit size 1/2".

B. Provide an equipment grounding conductor in all conduits, size per the NEC. Provide a grounding lug on the structure for grounding the structural frame of the enclosure per the NEC.

2.3 IDENTIFICATION OF EQUIPMENT

A. All electrical equipment supplied with the enclosure shall be labeled, tagged, stamped, or otherwise identified in accordance with the following schedule:

1. Branch Circuit Panelboards:

   a. Panel identification shall be stenciled with 2" high white paint letters on inside face of door. In addition to panel designation, panels on emergency power shall also be stenciled to indicate the branch of the emergency system to which they are connected.

   b. The circuit directory shall be a two-column, typewritten card under a plastic cover inside the door. Each odd-numbered circuit shall be in sequence in the left column and each even-numbered circuit shall be in sequence in the right column (e.g., 1, 3, 5 . . . , 2, 4, 6 . . .). Each circuit shall be identified as to the use and room name(s) or area(s). Confirm room names and/or room numbers with the Architect prior to project completion. Circuit breaker identification shall be by permanently installed metal numbers or plastic numbers under acrylic plastic. "Paste-on" numbers will not be accepted. Reference Specification Section 26 24 16 for additional requirements.

2. Miscellaneous equipment (electrical), such as individually mounted starters, step-down transformers, pull boxes, junction boxes, etc., shall be identified as required by the use of such equipment, with plates as for distribution panelboards.

3. In general, the installed nameplates as herein called for shall also clearly indicate the equipment's use, area served, circuit identification, voltage, and any other useful data.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 26 32 15

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SECTION 26 41 13

LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. The Contractor shall provide a complete lightning protection system. The system shall comply with the specifications and standards of the following:

1. Underwriters' Laboratories Inc., Subject 96A, Ninth Edition.
2. Lightning Protection Institute, LPI 175.
3. National Fire Protection Association, NFPA No. 780.

1.2 QUALIFICATIONS

A. The installation shall be accomplished by an experienced installer who shall apply for and deliver to the Owner a Lightning Protection Institute system certification, showing that the system complies with all LPI, UL, and NFPA codes. If the system or its components do not comply with these specifications, such items shall be replaced at no additional cost to the Owner. All work shall be done under the complete supervision of a Certified Master Installer furnished by the equipment manufacturer. This Master Installer shall be locally available at all times during the installation of the lightning protection system. It shall be the responsibility of this Master Installer to supervise all unit location and connections and he shall completely check the system after completion for strict conformance with UL, NFPA, and LPI code requirements.

1.3 QUALITY CONTROL

A. The lightning protection system shall be UL Master Labeled.

1.4 MANUFACTURERS

A. The materials used shall be manufactured by ERICO "Eritech" System 2000, Thompson Lightning Protection, Inc., or Harger Lightning Protection, Inc. Manufacturers shall be accredited firms listed as a manufacturer of lightning protection systems by Underwriters' Laboratories, Inc., and the Lightning Protection Institute, in their latest edition of "Electrical Equipment List." Alternate manufacturers shall meet the same criteria.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials shall be listed by Underwriters' Laboratories Inc., with UL label "A" affixed to main and secondary cables every 10 feet and UL label "B" applied to each air terminal point.

B. The system shall consist of air terminals, interconnecting conductors down conductors with their groundings and bonding of extended metal objects designed to appear as a part of the building.

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Conductor runs shall be concealed within the column, wall, and roof construction where possible and practical. Exposed roof circuits cables shall be placed so as to require a minimum of displacement for future repair and maintenance of roofing.

C. System components shall be of copper or aluminum complying with the codes of UL, NFPA, and LPI for the type and height of the building. Structures less than 75 feet in height shall utilize Class I materials, while structures over 75 feet in height shall utilize Class II materials.

D. Air terminals shall have a safety tip and be 24" tall. Where copper is provided, tips shall be nickel plated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Air terminals shall be mounted to extend a minimum of 10 inches above the object to be protected. Spacing of air terminals on ridges or edges of roofs shall not exceed 20 feet on centers nor be more than 24 inches from ridge ends or roof edges. On flat or gently sloping roofs, additional air terminals shall be located at intervals not exceeding 50 feet on centers.

B. Conductors of the size required by building Class, I or II, shall interconnect all air terminals and provide a two-way path to ground from each air terminal. Conductors shall maintain a horizontal and/or downward path from the air terminals to ground without forming "U" or "V" pockets.

C. Each downlead cable from roof circuits shall terminate in a properly made ground connection. Groundings shall consist of an acceptable electrode extended vertically 10 feet into the earth. Where soil conditions will not allow this depth, an alternate method shall be used employing ground plates, a ground field, or encircling counterpoise as required by the codes.

D. Metal bodies permanently affixed to a structure shall be bonded to the main conductor system in accordance with their size and relative location. Sizeable metal objects such as ventilators, fans, air handlers, masts, flues, ducts, and cooling towers shall be bonded to the system, regardless of their locations on the roof. Smaller metal such as flashing, gravel stops, insulation vents, ridge vents, roof drains and metal soil pipe vents shall be bonded to the system if they are located within six feet of the main or secondary conductor runs or within six feet of another grounded object.

E. Fasteners shall be placed on each run of exposed conductor not more than three feet apart. Concealed runs of conductor shall be anchored as necessary to maintain position and hold permanently in place.

F. Splices in main conductor runs and connections to branches shall be made with pressure type bolted or compression type connections. Underground connections shall be pressure type bolted or exothermic welded connectors.

END OF SECTION 26 41 13

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SECTION 26 43 13

SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SCOPE

A. The Contractor shall furnish and install the Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein and as shown on the contract drawings. To maximize performance and reliability and to obtain the lowest possible let-through voltages, the ac surge protection shall be integrated into electrical distribution equipment such as switchgear, switchboards, panelboards, or motor control centers.

1.2 REFERENCES

A. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449 3rd Edition).

1.3 SUBMITTALS – FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Engineer:

1. Provide verification that the SPD complies with the required ANSI/UL 1449 3rd Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL's website or on any other NRTL's website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (In).
2. For side mount mounting applications (SPD mounted external to electrical assembly), electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.

B. Where applicable the following additional information shall be submitted to the engineer:

1. Descriptive bulletins
2. Product sheets

1.4 SUBMITTALS – FOR CONSTRUCTION

A. The following information shall be submitted for record purposes:

1. Final as-built drawings and information for items listed in Section 1.04 and shall incorporate all changes made during the manufacturing process.

1.5 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

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B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

1.6 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of manufacturer's instructions shall be included with the equipment at time of shipment.

1.7 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance manuals shall be provided with each SPD shipped.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The following listing of specific manufacturers does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed below are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

1. Eaton Cutler-Hammer
2. Square-D
3. Liebert
4. United Power
5. APT
6. As approved

2.2 VOLTAGE SURGE SUPPRESSION – GENERAL

A. Electrical Requirements

1. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
2. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 125% of the nominal system operating voltage.
3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.

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4. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

	Protection Modes			
Configuration	L-N	L-G	L-L	N-G
Wye	●	●	●	●
Delta	N/A	●	●	N/A
Single Split Phase	●	●	●	●
High Leg Delta	●	●	●	●

5. Nominal Discharge Current (I_n) – All SPDs applied to the distribution system shall have a 20kA I_n rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an I_n less than 20kA shall be rejected.

NSI/UL 1449 3RD EDITION VOLTAGE PROTECTION RATING (VPR) – THE MAXIMUM ANSI/UL 1449 3RD EDITION VPR FOR THE DEVICE SHALL NOT EXCEED THE FOLLOWING:			
Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	700	1200	1500
L-L	1200	2000	3000

B. SPD Design:

1. Maintenance Free Design – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
2. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.
3. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.
4. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
5. Monitoring Diagnostics – Each SPD shall provide the following integral monitoring options:

   a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.

      1) For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
      2) For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.

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3) The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.

b. Remote Status Monitor – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.

c. Audible Alarm and Silence Button – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.

d. Surge Counter – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.

1) The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.

6. Overcurrent Protection: The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

7. Fully Integrated Component Design – All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

8. Safety Requirements

a. The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

b. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.

c. Side mount SPDs shall be factory sealed in order to prevent access to the inside of the unit. Side mount SPDs shall have factory installed phase, neutral, ground and remote status contact conductors factory installed and shall have a pigtail of conductors protruding outside of the enclosure for field installation.

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2.3 SYSTEM APPLICATION

A. The SPD applications covered under this section include distribution and branch panel locations, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

B. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

Minimum Surge Current Capacity Based on ANSI/IEEE C62.41 Location Category			
Category	Application	Per Phase	Per Mode
C	Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)	250 kA	125 kA
B	High Exposure Roof Top Locations (Distribution Panelboards)	160 kA	80 kA
A	Branch Locations (Panelboards, MCC's)	120 kA	60 kA

C. SPD Type – all SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

2.4 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.

1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
3. The panelboard shall be capable of re-energizing upon removal of the SPD.
4. The SPD shall be interfaced to the panelboard via a direct bus bar connection. Alternately, an SPD connected to a 30A circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 30A circuit breaker.
5. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.
6. The SPD shall be of the same manufacturer as the panelboard.
7. The complete panelboard including the SPD shall be UL67 listed.

B. Side mount Mounting Applications Installation (SPD mounted external to electrical assembly):

1. Lead length between the breaker and suppressor shall be kept as short as possible to ensure optimum performance. Any excess conductor length shall be trimmed in order to minimize let-through voltage. The installer shall comply with the manufacturer's recommended installation and wiring practices.

C. Switchgear, Switchboard and MCC Requirements:

1. The SPD application covered under this section is for switchgear, switchboard, and MCC locations. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
2. The SPD shall be of the same manufacturer as the switchgear, switchboard, and MCC.

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3. The SPD shall be factory installed inside the switchgear, switchboard, and MCC at the assembly point by the original equipment manufacturer.
4. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.
5. The SPD shall be connected through a disconnect (30A circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.
6. The SPD shall be integral to switchgear, switchboard, and MCC as a factory standardized design.
7. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.5 ENCLOSURES

A. All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:

1. NEMA 1 – Constructed of a polymer (units integrated within electrical assemblies) or steel (side mount units only), intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects (falling dirt).
2. NEMA 4 – Constructed of steel intended for either indoor or outdoor use to provide a degree of protection against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (dirt and windblown dust); to provide a degree of protection with respect to the harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); and that will be undamaged by the external formation of ice on the enclosure. (side mount units only).
3. NEMA 4X – Constructed of stainless steel providing the same level of protection as the NEMA 4 enclosure with the addition of corrosion protection. (side mount units only)

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of NEMA and UL standards.

3.2 INSTALLATION

A. The Contractor shall install all equipment per the manufacturer's recommendations and the contract drawings.

3.3 WARRANTY

A. The manufacturer shall provide a full ten (10) year warranty from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local code.

END OF SECTION 26 43 13

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SECTION 26 51 00

INTERIOR LIGHTING FIXTURES & LAMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install all interior lighting fixtures with lamps as specified and as shown on the drawings. Fixtures shall be complete including canopies, hangers, diffusers, ballasts, etc.

1.2 SHOP DRAWINGS

A. Shop drawings shall be furnished for each fixture type. Catalog cuts illustrating conformance with specifications will be acceptable for standard units. Drawings shall indicate materials, assembly, finish, and dimensions.

B. Photometric data shall be furnished for all fixtures listed on the lighting fixture schedule, and shall include the following:

1. A computer-generated printout for interior spaces where fluorescent linear direct, indirect, direct/indirect fixtures or as specifically noted on the drawings are specified. Obtain design data and generate a computer model for review by the Engineer. Provide horizontal footcandles at 1.5' x 1.5' grids, at 30" above finished floor elevation unless noted otherwise.
2. Lamp type used in photometric tests.
3. Lamp candela curve with perpendicular and parallel sections.

C. Lamp, Driver, and Ballast Data Matrix shall include the following:

1. Lamp type, wattage, dimensions, and color rendition for each type of lighting fixture.
2. Ballast type, quantity per fixture, wattage/amperage, voltage, switching criteria, and dimensions for each type of lighting fixture. Clearly indicate ballast power factor and compliance to the specifications.

PART 2 - PRODUCTS

2.1 GENERAL

A. All catalog numbers are given for manufacturer's identification and do not relieve the Contractor from responsibility of full conformance to all applicable written description requirements governing material and fabrication, either in the general or specific sections. Where conflicts occur, the most expensive option shall be enforced. Where catalog numbers are indicated as modified, no modification will be required if the standard unit fully conforms to descriptive requirements in the specifications and matches specified ceiling.

B. All fixtures of the same type shall be of one manufacturer and of identical finish and appearance.

C. All fixtures and component parts shall bear the UL label.

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D. All lamps installed within the same lighting fixture type shall be of the same manufacturer.

E. All drivers/ballasts installed within the same lighting fixture type shall be of the same manufacturer.

F. Where intrusion protection (IP) ratings are specified, provide documentation indicating compliance.

G. Clearly indicate any deviations to dimensions of specified fixture.

2.2 CONSTRUCTION

A. All steel parts shall be phosphate treated in multi-stage power spray system for corrosion resistance and paint adhesion. Standard final finish shall be electrostatically applied, baked white enamel of not less than 87% reflectance on reflecting surfaces. Refer to the Lighting Fixture Schedule and/or the drawings for other finish types.

B. Each recessed/flush-mounted fixture shall have a continuous light-seal gasket seated in such a manner as to prevent any light leakage through any portion or around any edge of the trim frame.

C. Lenses/diffusers shall be framed in a hinged continuous assembly. Lens/diffuser frame latches shall be loaded or cam operated. Where noted on the drawings, provide tamper-resistant latches.

D. All fixture sockets shall be securely fastened to the fixture body to prevent movement during relamping.

E. All recessed fixtures shall be provided with frames appropriate for the type of soffit/ceiling involved. No fixtures shall be submitted for review or ordered until the soffit/ceiling construction and mounting method have been verified by the Contractor.

F. The finish of all lighting fixtures is subject to final approval by the Architect and Engineer. Furnish paint chips to the Architect and Engineer for selection for all non-standard finishes. Color selection shall be reviewed by the Architect prior to the review of submittals by the Engineer.

G. All electrical requirements for fixtures shall be verified with the drawings, catalog number, and Lighting Fixture Schedule prior to ordering.

H. The Contractor shall provide multi-level switching as indicated on the plans. The ballast-per-lamp quantities shall be determined by the switching criteria. It shall be an option to provide master/slave ballast configurations.

2.3 BALLASTS

A. LED Drivers: Reverse polarity protection, open circuit protection, require no minimum load. Minimum 80 percent efficiency. Class A noise rating.

B. LED Dimming: LED system capable of full and continuous dimming.

C. Fixtures located within low temperature, damp, and wet environments shall have ballasts designed for proper operation.

D. The Contractor shall be responsible for the replacement of all drivers/ballasts due to excessive noise or failure for one year after final acceptance.

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2.4 LENSES / DIFFUSERS / LOUVERS / REFLECTORS

A. Lenses/diffusers shall be furnished as indicated on the drawings.

B. Lenses/diffusers shall be 100% virgin acrylic with a minimum thickness of 1/8" (.125"), pattern A19, unless noted otherwise on the drawings.

C. No lens/diffuser shall be manufactured with polystyrene, copolymer (mixture of polystyrene and acrylic), or reclaimed or recycled acrylic plastic.

D. All reflector or louver striations deemed unacceptable by the Engineer shall be replaced prior to project closeout.

E. Align lenses/diffusers/louvers/reflectors for all fixtures in a like manner, unless noted otherwise.

F. Clean luminaire reflector systems, lenses, and enclosures after all construction dust has been removed from the area.

2.5 SUPPORT

A. Surface or pendant-mounted fixtures shall be supported as follows:

1. From the outlet box by means of a metal strap, where its weight is less than 5 pounds.
2. From its outlet box by means of a hickey or other threaded connection, where its weight is from 5 to 50 pounds.

B. Lighting fixtures shall be supported independently of the ceiling system or additional ceiling suspension must be added to support the weight of the lighting fixtures. It is the responsibility of the Electrical Contractor to coordinate all support requirements with the ceiling system installer. Recessed lighting fixtures supported from ceiling grid tee systems shall be furnished with hold-down clips in conformance with NEC 410-16(c). Recessed lighting fixtures shall be supported to the building structure and supported on at least two points (opposite corners) with #gauge ceiling wire with a minimum of 3 twists of wire at each point of attachment. Two or more fixtures shall not be supported by a single wire. Install strut channel as necessary to provide support between building structural points.

C. Lighting fixtures mounted in plaster or drywall shall be rigidly supported with channel supports across plaster framing. Mount all fixtures with a minimum of three 1/4" bolts for 1' x 8' fixtures, two 1/4" bolts for 1' x 4' fixtures, and four 1/4" bolts for 2' x 4' fixtures.

D. Furnish and install supplementary blocking and support as required to support fixtures from structural members. This blocking may include multiple members and shall be coordinated with the Structural Engineer prior to rough-in.

E. Suspended fixtures shall be stem-mounted and shall be free to swing 20 degrees in any direction. Ceiling swivels shall be of the ball aligner type.

F. Fixtures installed in rows, continuous or spaced apart, shall be attached to a unistrut-type backbone. This backbone shall align all fixtures true, straight and level. Provide 1/4" diameter all-thread nickel or cadmium-plated rod.

G. All supports, where not concealed, shall be painted. Coordinate paint requirements with the Architect.

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2.6 LAMPS

A. LED (Light Emitting Diode):

1. LED manufacturer will include, but no be limited to, light source, luminaire, power supply and control interface with added components as needed for complete and functioning system.
2. Comply with ANSI chromaticity standard for classifications of color temperature. Reference luminaire schedule for specified LED lamp color and color temperature. UL or ETL listed and labeled.
3. Luminaire tested per IESNA LM-79 and LM-80 requirements.
4. Lamp life for white LED's: 50,000 plus hours with lamp failure occurring when LED produces 70% of initial rated lumens.
5. Lamp life for color LED's: 30,000 plus hours with lamp failure occurring when LED produces 50% of initial rated lumens.
6. LED light source manufacturers: Nichia, CREE, Osram Sylvania, GE lighting, Philips or approved equal.

B. Lamp color temperatures shall be 3,000, 3,500, 4,100 or 5,000K as indicated on the drawings. A minimum C.R.I. of 82 shall be provided. Minimum lamp efficacy shall be 85 lm/W.

C. Lamps that fail during the initial 12 month warranty period will be replaced and installed at no cost to the Owner. Lamps that fail during the second 12 months will be replaced, but not installed by the manufacturer.

PART 3 - EXECUTION

3.1 LIGHTING FIXTURE OPERATION

A. Test for proper operation of all lighting fixtures, including control requirements for each. This may include local switching, low voltage switching and/or dimming requirements. Verify that BPB's have not been wired as default night lights unless specified.

3.2 INSTALLATION

A. Wiring for fixtures in accessible ceilings shall be accessible after fixture installation, without requiring removal of fixture from ceiling.

END OF SECTION 26 51 00

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SECTION 26 56 00

EXTERIOR LIGHTING FIXTURES & LAMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install all exterior lighting fixtures with lamps as specified and as shown on the drawings. Fixtures shall be complete including poles, bases, canopies, hangers, diffusers, ballasts, etc.

1.2 SHOP DRAWINGS

A. Shop drawings shall be furnished for each fixture type. Catalog cuts illustrating conformance with specifications will be acceptable for standard units. Drawings shall indicate materials, assembly, finish, and dimensions.

B. Photometric data shall be furnished for all fixtures listed on the lighting fixture schedule, and shall include the following:

1. A computer-generated printout for exterior spaces. Obtain design data and generate a computer model for review by the Engineer. No maintenance factor shall be applied unless specifically noted otherwise. Provide horizontal footcandles on a 10' on center grid dimension and at 0" AFF, except for sports lighting which shall be at 30" AFF.
2. Lamp type used in photometric tests.
3. Lamp candela curve with perpendicular and parallel sections.

C. Lamp, Driver, and Ballast Data Matrix shall include the following:

1. Lamp type, wattage, dimensions, and color rendition for each type of lighting fixture.
2. Ballast type, quantity per fixture, wattage/amperage, voltage, switching criteria, and dimensions for each type of lighting fixture. Clearly indicate ballast power factor and compliance to the specifications.

PART 2 - PRODUCTS

2.1 GENERAL

A. All catalog numbers are given for manufacturer's identification and do not relieve the Contractor from responsibility of full conformance to all applicable written description requirements governing material and fabrication, either in the general or specific sections. Where conflicts occur, the most expensive option shall be enforced. Where catalog numbers are indicated as modified, no modification will be required if the standard unit fully conforms to descriptive requirements in the specifications and matches specified ceiling.

B. All fixtures of the same type shall be of one manufacturer and of identical finish and appearance.

C. All fixtures and component parts shall bear the UL label.

D. All drivers installed within the same lighting fixture type shall be of the same manufacturer.

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E. Where intrusion protection (IP) ratings are specified, provide documentation indicating compliance.

F. Clearly indicate any deviations to dimensions of specified fixture.

2.2 CONSTRUCTION

A. Each recessed/flush-mounted fixture shall have a continuous light-seal gasket seated in such a manner as to prevent any light leakage through any portion or around any edge of the trim frame.

B. Lenses/diffusers shall be framed in a hinged continuous assembly. Lens/diffuser frame latches shall be loaded or cam operated. Where noted on the drawings, provide tamper-resistant latches.

C. All fixture sockets shall be securely fastened to the fixture body to prevent movement during relamping.

D. For recessed fixtures, provide a through-wiring junction box set to the side, where it shall be accessible when the fixture reflector assembly is removed from the fixture housing. Connect the box to the fixture housing with flexible conduit. Clearly indicate when a fixture requires above-soffit/ceiling access.

E. All recessed fixtures shall be provided with frames appropriate for the type of soffit/ceiling involved. No fixtures shall be submitted for review or ordered until the soffit/ceiling construction and mounting method have been verified by the Contractor.

F. The finish of all lighting fixtures is subject to final approval by the Architect and Engineer. Furnish paint chips to the Architect and engineer for selection for all non-standard finishes. Color selection shall be reviewed by the Architect prior to the review of submittals by the Engineer.

G. All electrical requirements for fixtures shall be verified with the drawings, catalog number, and Lighting Fixture Schedule prior to ordering.

2.3 BALLASTS

A. LED Drivers: Reverse polarity protection, open circuit protection, require no minimum load. Minimum 80 percent efficiency. Class A noise rating.

B. Fixtures shall have ballasts designed for 0 deg F (-17.7 deg C) operation.

C. Fixtures located within low temperature, damp, and wet environments shall have ballasts designed for proper operation.

D. The Contractor shall be responsible for the replacement of all ballasts due to excessive noise or failure for one year after final acceptance.

2.4 LENSES / DIFFUSERS / LOUVERS / REFLECTORS

A. Lenses/diffusers shall be furnished as indicated on the drawings.

B. No lens/diffuser shall be manufactured with polystyrene, copolymer (mixture of polystyrene and acrylic), or reclaimed or recycled acrylic plastic.

C. All reflector or louver striations deemed unacceptable by the Engineer shall be replaced prior to project closeout.

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D. Align lenses/diffusers/louvers/reflectors for all fixtures in a like manner, unless noted otherwise.

E. Clean luminaire reflector systems, lenses, and enclosures prior to project closeout.

2.5 SUPPORT

A. Furnish and install supplementary blocking and support as required to support fixtures from structural members. This blocking may include multiple members and shall be coordinated with the Structural Engineer prior to rough-in.

B. Suspended fixtures shall be stem-mounted and shall be free to swing 20 degrees in any direction. Ceiling swivels shall be of the ball aligner type.

C. All supports, where not concealed, shall be painted. Coordinate paint requirements with the Architect.

D. Pole assemblies shall be designed by a Structural Engineer with specific Effective Projected Area (EPA) of the fixture(s) on each pole taken into account. This shall include, but not be limited to the pole assembly base design. Provide a base design including anchor bolts, steel cage components, concrete strength, surface finish and overall formed dimensions. Coordinate these requirements with pole assembly detail(s) on the drawings. Coordinate the base design with prevailing local soil conditions. Obtain the project soils report prior to design of the base information. Where a soils report is not available, obtain a soils report for the specific base locations for the project.

E. Provide concrete base height protection from vehicles in parking or driveway areas at a minimum of 36" AFG where curb protection is not available, unless noted otherwise. Where curb protection is available, provide a minimum of 36" AFG at no walkway areas. Provide flush base mounting at pedestrian walkways with bolt cover being the only item above grade. Fully coordinate the top of the base to be flush with the surrounding surface.

2.6 LAMPS

A. LED manufacturer will include, but no be limited to, light source, luminaire, power supply and control interface with added components as needed for complete and functioning system.

1. Comply with ANSI chromaticity standard for classifications of color temperature. Reference luminaire schedule for specified LED lamp color and color temperature. UL or ETL listed and labeled.
2. Luminaire tested per IESNA LM-79 and LM-80 requirements.
3. Lamp life for white LED's: 50,000 plus hours with lamp failure occurring when LED produces 70% of initial rated lumens.
4. Lamp life for color LED's: 30,000 plus hours with lamp failure occurring when LED produces 50% of initial rated lumens.
5. LED light source manufacturers: Nichia, CREE, Osram Sylvania, GE lighting, Philips, or approved equal.

B. LED modules that fail during the initial 12 month warranty period will be replaced and installed at no cost to the Owner. Lamps that fail during the second 12 months will be replaced, but not installed by the manufacturer.

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PART 3 - EXECUTION

3.1 SITE LIGHTING OPTICS

A. Rotate optics as required to obtain proper coverage. In general:

1. The horizontal lamp in IES type 2 or 3 optics should be oriented perpendicular to the long direction being illuminated.
2. The horizontal lamp in IES type 4 optics should be oriented perpendicular to the long direction being illuminated.
3. The horizontal lamp in IES type 5 optics should be oriented parallel or perpendicular to the long direction being illuminated.
4. Submit questionable cases to the Architect for clarification at least two weeks in advance of installation.
5. Vertical lamp optics of any IES type shall be referred to the lighting designer for optic orientation. Submit request to the Architect at least two weeks in advance of installation.

3.2 LIGHTING FIXTURE OPERATION

A. Test for proper operation of all lighting fixtures, including control requirements for each. This may include line voltage or low voltage switching requirements.

END OF SECTION 26 56 00

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SECTION 27 05 13

COMMUNICATION SERVICES

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. Communications equipment coordination and installation.
2. Sleeves for pathways and cables.
3. Raceway Systems.
4. Common communications installation requirements.

B. Related Sections:

1. Division 27 Section 27 05 26 "Grounding & Bonding for Communication Systems".
2. Division 26 Section 26 05 33 "Raceway and Boxes for Electrical Systems".

1.3 QUALITY CONTROL

A. NEC Compliance: Comply with NEC as applicable to Communication System Materials and Installation.

B. NEMA Compliance: Comply with applicable portions of NEMA Standards pertaining to Types of Electrical Equipment Enclosures.

C. EIA/TIA 569A Compliance: Comply with EIA/TIA-569A Standards for Telecommunication Pathways and Spaces for Commercial Buildings.

1.4 SUBMITTALS

A. Product Data: For sleeves, seals, cable ladder and back-boxes.

1.5 COORDINATION

A. Coordinate arrangement, mounting and support of communications equipment.

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.

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4. So connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for communications item that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames".

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 section "Penetration Firestopping".

E. Conduit systems shall be color coded. Conduit shall be factory anodized in color as stated below. As an option, contractor may use natural colored conduit with painted markings every 5'-0". Where conduit system is painted, all junction boxes shall be required to be painted to match system color. On junction boxes that are larger than 16" square, only the cover of the box need be painted.

System	Conduit Color
Power – Normal	Natural
Power – Emergency NEC 700 & Standby NEC 701	Orange
Communications / Data / Voice / Video	Yellow
HVAC Controls	White
Fire Alarm	Red
Public Information Paging System (PIPS)	Blue
Access Control and Monitoring (ACAMS)	Green

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. Comply with NECA1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Installed to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

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3.2 CABLE LADDER

A. Cable ladders shall be installed per manufacturer's instructions, utilizing product series accessories and components.

B. Cable ladders, supports and brackets shall be cleanly cut, deburred, and sharp edges removed.

C. Verify installed loading requirements and install the raceway system per the manufacturer's recommendations. Provide additional load capacity to support a 2X growth factor.

D. Install end caps, mounting spacers, couplings, hangers, brackets, dropouts, connectors, supports, and other manufacturer's accessories as required to provide a complete and functioning installation.

3.3 CONDUIT

A. Conduit shall be sized per Table below, or as noted on the drawings. Where section of conduit runs are longer than 100'-0", or have more than 180 degrees of bends, or have a reverse bend (greater than 90 degrees), pull boxes shall be provided and installed. Bends in conduit larger than 2" shall be long sweep type. Except where specifically noted, the inside radius of bends shall not be less than:

1. Six times the internal diameter of conduits 2" and smaller.
2. Ten times the internal diameter for conduits 2-1/2" and larger.

TABLE 1.

Inside Diameter in mm	Trade Size	Cable Outside Diameter in mm (inches)									
		3.3 (0.13)	4.6 (0.18)	5.6 (0.22)	6.1 (0.24)	7.4 (0.29)	7.9 (0.31)	9.4 (0.37)	13.5 (0.53)	15.8 (0.62)	17.8 (0.70)
16	1/2	1	1	0	0	0	0	0	0	0	0
21	3/4	6	5	4	3	2	2	1	0	0	0
27	1	8	8	7	6	3	3	2	1	0	0
35	1-1/4	16	14	12	10	6	4	3	1	1	1
41	1-1/2	20	18	16	15	7	6	4	2	1	1
53	2	30	26	22	20	14	12	7	4	3	2
63	2-1/2	45	40	36	30	17	14	12	6	3	3
78	3	70	60	50	40	20	20	17	7	6	6
91	3-1/2							22	12	7	6
103	4							30	14	12	7

B. Conduits entering telephone and data closets shall terminate as close as possible to the wall through which the conduits enter, unless otherwise noted. In-floor conduit shall terminate 4" AFF or curb unless noted otherwise. All conduits shall be left clean, dry, and free of debris or other obstructions, with insulated grounding bushings installed.

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C. Pull boxes shall be sized and installed per BICSI Standards.

D. Conduit, sleeves, and stubs through fire rated floors and walls shall be rigid galvanized steel conduit with insulated and/or grounding bushings per specifications. Conduit sleeve shall extend a minimum of 6" beyond each wall surface. Upon completion of the work, install fire stop per specifications and codes.

E. Furnish and install pipe sleeves as shown on the drawings. The sleeves shall extend 4" above the floor and a minimum of 2" below the bottom of the ceiling slab. The inner edges of the sleeve shall be reamed, providing a smooth surface to prevent damage to cable insulation. Sleeves shall be equipped with metal caps to ensure fireproofing between floors and/or insulated bushings when occupied with cable.

F. Feeder conduit should enter from the top or bottom, close to one side; never in the center. Distribution conduit should enter in the center.

G. Conduit for outlets shall turn toward the main pathway and have an insulated bushing installed.

3.4 MISCELLANEOUS

A. Raceway systems shall be bonded to the telecommunication grounding system per NEC Article 250, EIA/TIA 607 Standard, and Division 27, Section 27 05 26.

B. Provide a 1/8" nylon or polypropylene line in all conduits.

C. Where cable tray is specified, or conduits are routed back to MDF or IDF Rooms or extended beyond the stub-out (greater than 3' from wall), install grounding bushing and bond to telecommunication grounding system.

3.5 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeve opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Furnish and install pipe sleeves as shown on the drawings. The sleeves shall extend 4" above the floor and a minimum of 2" below the bottom of the ceiling slab. The inner edges of the sleeve shall be reamed, providing a smooth surface to prevent damage to cable insulation. Sleeves shall be equipped with metal caps to ensure fireproofing between floors and/or insulated bushings when occupied with cable.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

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H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".

I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".

J. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

K. Above ground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

L. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25 mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Furnish and install pipe sleeves as shown on the drawings. The sleeves shall extend 4" above the floor and a minimum of 2" below the bottom of the ceiling slab. The inner edges of the sleeve shall be reamed, providing a smooth surface to prevent damage to cable insulation.

G. Sleeves shall be equipped with metal caps to ensure fireproofing between floors and/or insulated bushings when occupied with cable.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

I. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint.

K. Comply with requirements in Division 07 Section "Joint Sealants".

L. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping".

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M. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

N. Above ground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

O. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25 mm) annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.7 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

1. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway of cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathways or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.8 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistances rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping".

END OF SECTION 27 05 13

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SECTION 27 05 26

GROUNDING & BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This section outlines the requirements of the telecommunication grounding work as indicated on the drawings and in the contract documents.

1.2 RELATED DOCUMENTS

A. Division 26 Sections as applicable shall apply to work of this section.

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in the manufacture of electrical connectors, terminals and fittings, of types and ratings required, and ancillary grounding materials including stranded cable, copper braid and bus, ground rods and plate electrodes, whose products have been in satisfactory use in similar service for not less than three years.

B. NEC Compliance: Comply with NEC requirements as applicable to materials and installation of data/telecommunication grounding systems, associated equipment and wiring. Provide grounding products which are UL listed and labeled.

C. UL Compliance: Comply with applicable requirements of UL Standard Numbers 467 and 869, pertaining to data/telecommunication grounding and bonding.

D. TIA/EIA Compliance: Comply with TIA/EIA-607 Standards and the BICSI Telecommunications Distribution Methods Manual (TDMM) for the installation of data/telecommunication grounding and bonding systems.

PART 2 - PRODUCTS

2.1 TELECOMMUNICATION GROUNDING SYSTEM

A. Provide a low impedance telecommunication grounding system with a stable □0 volt to ground signal reference point for communication system equipment and infrastructures.

B. Telecommunication bonding backbone (TBB) shall be sized per NEC Table 250-66 (based on largest service entrance conductor or equivalent area for parallel conductors), minimum of a #2 AWG copper conductor.

C. All bonding conductors shall be minimum #6 AWG, insulated (green jacket), stranded copper.

D. In multi-story buildings requiring two or more vertical MDF's, IDF's, and /or TBB's, they shall be bonded together at the top and bottom floors, with a minimum of every third floor when the building exceeds four floors.

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E. System connections shall be irreversible compression-type connectors or exothermic welding with bronze bolt, star washer and nut connection hardware.

F. Zinc-clad or nickel-plated steel hardware is not acceptable.

G. Set screw, box lug, and split-bolt connectors are not acceptable.

H. Where required by local code interpretation, the data/telecommunication grounding system backbone cable conductor shall be a bare stranded copper conductor in lieu of an insulated conductor when installed in open cable trays and/or exposed in a return air plenum space or riser rated space. The Contractor shall verify requirements and coordinate with the Engineer.

I. Two-hole compression lugs shall be utilized for backbone cable terminations of #2 AWG and larger. One-hole compression lugs may be utilized for cable terminations of #6 AWG up to #2 AWG.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Bonding and grounding conductors installed in ferrous metallic conduit shall be bonded at each end of conduit, utilizing a minimum #6 AWG copper conductor and bond bushings. Conduits less than 3'-0" in length shall be bonded at one end. Bond bushing lug shall be replaced with a compression-type ground lug, bolted to bushing with bronze machine screw and star washer.

B. Bonding and grounding conductor splices shall be kept to a minimum. All splices shall be located in the telecommunication spaces only and shall be fully accessible.

C. Bonding conductors shall be individually routed to each piece of equipment.

D. Conductors shall terminate onto dedicated grounding lugs, one conductor per termination.

E. All conductors shall be maintained as short and as straight as possible.

F. Conductors shall be free from loops and coils; no bend shall be greater than 90 degrees.

G. The data/telecommunication grounding system shall be extended to and through data/communication raceways such as cable trays, cable channels, ladder systems, metallic surface-mounted raceways, etc., by means of extending a #6 AWG minimum bonding conductor through the length of the raceway system and bonding to each section of raceway, lugging at 10 foot maximum intervals along the length of the raceway, and lugging to any section of raceway greater than 3 feet in length, in lieu of the installation of individual bonding jumpers between each raceway section.

H. Where a bare copper TBB conductor or bonding conductor is routed through a cable tray system, the conductor shall be tied down and anchored to the cable tray, 36" maximum on center, utilizing a UL listed wire fastener as required.

I. The data/telecommunication grounding system shall meet the requirements of NEC Articles 250 and 800. The Contractor shall bond individual electronic components and equipment to the grounding system per the equipment manufacturer's recommendations and instructions.

J. Each telecommunication bonding conductor shall be labeled. Labels shall be located on conductors, as close as practicable to their point of termination. Label shall be non-metallic and include the following

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information: "WARNING - IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATION MANAGER."

K. Items to be bonded to the data/telecommunication grounding system at the ground distribution bus bars shall include, but not be limited to, the following:

1. Telephone equipment (e.g. PBX's, KSU's, ISDN equipment, etc.).
2. CATV equipment.
3. Equipment racks and cabinets.
4. Cable ladders, trays, and channels.
5. Surface-mounted metallic raceways and wireways.
6. Metallic conduit systems.
7. Service entrance protected terminals.
8. Telecommunications and fiber-optic splice enclosures.
9. Inter-building cable sheaths and messengers.
10. Coupled bonding conductors.
11. Paging and access control systems.

3.2 SYSTEM TESTING

A. Upon completion of the installation of the data/telecommunication grounding system and/or servicing of the existing grounding systems, the Contractor shall perform approved standard ground resistance tests with an Engineer-approved ground resistance test unit (i.e., stakeless clamp-on ground resistance tester, three-point fall of potential tester), using approved procedures as noted in this specification.

B. The Contractor shall perform telecommunication grounding system testing as follows:

1. Measure ground current and ground resistance readings on all TBB conductors at each telecommunications main grounding bus bar.
2. Measure ground current and ground resistance readings on all bonding jumpers at each telecommunications main grounding bus bar.
3. Record all readings in a Test Report.
4. Where test results indicate a ground current of 1 amp or greater, the Contractor shall take appropriate action to identify and reduce the ground current to less than 1 amp. The Contractor shall notify the Engineer in writing of the excessive ground current, the source, and the action taken to reduce the current.

C. The Contractor shall demonstrate to the Owner or Owner's representative, by testing, that the data/telecommunication ground system to earth resistance value is 10 ohms or less, utilizing a "clamp-on" or three-point fall of potential tester.

D. The Contractor shall be able to demonstrate to the Owner or Owner's representative, by test, that the data/telecommunication grounding system resistance from any grounded non-current-carrying conductor in the system to the electrical service entrance neutral/ground bonding conductor is less than 0.1 ohms.

E. The Contractor shall record the test results in a Test Report, and provide a description of the testing procedures for submission to the Engineer for approval.

F. The Contractor shall include copies of the completed and approved Test Report in the Instruction Manuals.

END OF SECTION 27 05 26

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SECTION 27 05 44

SLEEVES & SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS & CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire resistance rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
2. Laboratory Tests Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized steel sheet; 0.0239-inch (0.6 mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw fastening the sleeve on the board.

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C. Sleeves for Rectangular Openings:

1. Material: Galvanized steel sheet.
2. Minimum Metal Thickness:

a. For sleeve cross section rectangular perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
b. For sleeve cross section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM Nitrile) Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel.
4. Connecting Bolts and Nuts: stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Pre-sealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume adjusting, dry, hydraulic cement grout.

C. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

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2.5 SILICONE SEALANTS

A. Silicone Sealants: Single component, silicone based, neutral curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall comply with the testing and product requirements of the California Department of health Services "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Silicone Foams: Multicomponent, silicone based liquid elastomers that when mixed, expand and cure in place to produce flexible, non-shrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for conduits penetrating above grade non-fire rated concrete and masonry unit floors and walls:

1. Interior penetrations of non-fire rated walls and floors:

a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch (6.4 mm) annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed.
4. Install sleeves for all penetrations unless core drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved openings.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Above Ground, Exterior Wall Penetrations: Seal penetration using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25 mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

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G. Underground, Exterior Wall and Floor Penetrations: Install cast iron pipe sleeves. Size sleeves to allow for 1 inch (25 mm) annular clear space between pathway or cable and sleeve for installing sleeve seal system.

3.2 SLEEVE SEAL SYSTEM INSTALLATION

A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE SEAL FITTING INSTALLATION

A. Install sleeve seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve seal fittings.

END OF SECTION 27 05 44

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SECTION 27 06 10

SCHEDULES FOR STRUCTURED CABLING & ENCLOSURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Telecommunications:

PRODUCT	MANUFACTURER	PRODUCT NUMBER	DESCRIPTION	APPROVED EQUAL MANUFACTURER
Wire Basket Tray "Accessories"	HUBBELL HUBBELL CABLOFIL HUBBELL HUBBELL CABLOFIL HUBBELL HUBBELL	HPWW0418 HPWWSKT EZT 90 Kit HPWWGSP20 HPWWUST18 HB 2 HPWWCG HPWWRDN##	18"W x 4"H Cable Tray, Underfloor Ceiling Tray Splice 90 Degree and T-Bend Kit Hanger Bracket Under Floor Support Wall Termination Bracket Cable Guides Radius Down 4", 6", 12"	
Horizontal Organizer	HUBBELL	HC219CC3P	2RU DOUBLE-SIDED	
Vertical Organizer	HUBBELL	VS76H	Double Side Organizer with Doors HUBBELL MNGR IS SINGLE-SIDED W/ COVER	
Data Rack 19"	HUBBELL	HPW90RR19 HPW84RR19	Gray Rack, 7'-6" High – MIL FINISH Black Rack, 7' High - BLACK	
Vertical Organizer-23"	Chatsworth	VS76	7' Tall Narrow Vertical Cabling Section	
Data Rack 23"	HUBBELL	HPWW90RR23	Gray Rack, 7'-6" High	
Ladder Rack	HUBBELL	HLS1012B	Black 12" Wide Ladder Tray	
Rack-to-Runway Mounting	HUBBELL	HLMPK19	Steel Mounting Plate	

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PRODUCT	MANUFACTURER	PRODUCT NUMBER	DESCRIPTION	APPROVED EQUAL MANUFACTURER
Ladder Rack Splice Kits	HUBBELL	HLBSK HLTK	Butt-Splice Kit, Gold Junction-Splice Kit, Gold	
Wall Angle Support Kit	HUBBELL	HLX0612	12" Wall Angle Support	
Fire Rated Pathway	STI	Series 44	4" x 4-5/8"	
Grounding Lug	HUBBELL	HGBL06D	Two-Hole Copper Lug, Standard Barrel	
Ground Bus Bar MDF/Equipment Room	HUBBELL	HBBB14420J	20" x 4" x 1/4" Copper Bar with Stand Off Brackets	
Ground Bus Bar IDF	HUBBELL	HBBB14416G	12" x 4" x 1/4" Copper Bar with Stand Off Brackets	
Rack Radius Drop	Chatsworth	12394.701	For use with double sided vertical cabling section	

NOTE: NO DEVIATIONS TO SPECIFICATIONS UNLESS APPROVED BY OWNER.

END OF SECTION 27 06 10

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SECTION 27 06 20

SCHEDULES FOR DATA COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Telecommunications:

PRODUCT	MANUFACTURER	PRODUCT NUMBER	DESCRIPTION	APPROVED EQUAL MANUFACTURER
OSP Backbone Fiber Between Buildings	HUBBELL HUBBELL	HFC3012BKS HFC3006BK3	12 Strand Single Mode Fiber 62.5 Micron 6 Strand Multi Mode Fiber 62.5 Micron	
OSP Backbone Copper Between Buildings	Superior Essex Superior Essex Superior Essex Superior Essex	04-104-21 04-100-21 04-104-21 04-110-21	100 Pair #24 awg, PE-39 with water blocking, inhibits corrosion and water migration 50 & 100 Pair #24 awg, PE-39 with water blocking, inhibits corrosion and water migration 300 Pair #24 awg, PE-39 with water blocking, inhibits corrosion and water migration	General Cable
Backbone Cable Between MDF/IDF	HUBBELL HUBBELL HUBBELL	C6SPW HFCD1012PS HFCD1006P3	25 Pair CAT 6 - Plenum 12 Strand SM Fiber 50 Micron – TB Plenum 6 Strand Multi Mode Fiber 50 Micron – TB Plenum	
Patch Panel	HUBBELL	P6E48U	48 Port Patch Panel, 6 – Port Modules, 19"	

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PRODUCT	MANUFACTURER	PRODUCT NUMBER	DESCRIPTION	APPROVED EQUAL MANUFACTURER
Horizontal Cable	HUBBELL	C6RPEY - Yellow C6RPEB - Blue C6RPEW - White	Cat 6 Copper Cable, 4-Pair Voice - Yellow Jacket Data – Blue Jacket CATV - White Jacket Wireless – Gray Jacket Security – Green Jacket Data Backbone – Purple Jacket	
Fiber Enclosure	HUBBELL	FCR4U15SP FSPLCDM6AQ FSPLCDS6B FCLC900K50GM12 FCLC900KSM12	Closet Connector Housing - 4RU HOLDS 15 PNLS LC Closet Connector Panel - 12 PORT MM AQUA LC Closet Connector Panel – 12 PORT SM BLUE LC Connectors Multimode - PRO CLICK-12/PK LC Connectors Single Mode - PRO CLICK-12/PK	
Fiber Jumper	HUBBELL	DFPCLCLCS3SM	3 Meter LC-LC SM Fiber Jumper (receive fiber must stay on left)	
Fiber Optic Warning Tags	Panduit	PST-FO	Fiber Optic Warning Tag	
Patch Cords	HUBBELL	HC6B05 5FT BLUE HC6B07 7FT BLUE HC6B10 10FT BLUE HC6Y05 5FT YEL HC6Y07 7FT YEL HC6Y10 10FT YEL	Blue Cat 6 1 M-3M, Workstations Yellow Cat 6 1M-3M, Network Printers	
Terminations Blocks	HUBBELL	6110FTK64WL (64 PAIR) 6110FTK192WL (192 PAIR)	C6 64 Pair Termination Block C6 192 Pair Termination Block	110 RM 25 110RM 25
Jumper Trough	HUBBELL	110TRB 110TRA	110 Jumper Trough without Legs 110 Jumper Trough with Legs	

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PRODUCT	MANUFACTURER	PRODUCT NUMBER	DESCRIPTION	APPROVED EQUAL MANUFACTURER
Service Entrance Protection	Porta-System	Series 24	Service Entrance Protection with 710 input/RJ21 output, gas tube type modules (+300 volts) self-resetting current limiter UL497	
Distribution Block	HUBBELL		66M1-50	
Cat 6 Jack	HUBBELL	HXJ6Y HXJ6B HXJ6W	Category 6 – NEXTSPEED – Yellow Category 6 – NEXTSPEED – Blue Category 6 – NEXTSPEED – White	
Faceplate	HUBBELL	IFP12W IFP13W IFP14W ISB2W	2-port single gang faceplate – White 3-port single gang faceplate – White 4-port single gang faceplate - White 2-port surface mounted box - White	
Wireless Access	HUBBELL	C6ASPGY	Category 6a - Gray	

NOTE: NO DEVIATIONS TO SPECIFICATIONS UNLESS APPROVED BY OWNER.

END OF SECTION 27 06 20

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SECTION 27 11 00

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

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. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Telecommunications service entrance pathways.
5. Grounding.

B. Related Sections:

1. Division 27 Section "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
2. Division 27 Section "Communications Horizontal Cabling for voice data and cabling associated with system panels and devices".

1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. Ladder Rack: A fabricated structure consisting of two longitudinal side rails connected by individual cross supports.

D. LAN: Local area network.

E. RCDD: Registered Communications Distribution Designer.

F. Solid-Button or Non-Ventilated Cable Tray: A fabricated structure consisting of a bottom without ventilation openings within integral or separate longitudinal side rails.

G. Owner:

H. NECA: National Electrical Contractor Association.

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1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Floor-mounted cabinets and cable pathways shall withstand the effects of earthquake motions determined according to Structural Engineering Institute/American Society of Civil Engineering SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event".

1.5 SUBMITTALS

A. Product Data: For each type of proud indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

D. Seismic Qualification Certificates: For floor-mounted cabinets, accessories and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
3. Detail description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 QUALITY CONTROL

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed as Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform on-site inspection.

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

C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

D. Grounding: Comply with ANSI-J-STD-607-A.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.8 COORDINATION

A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance with pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.

1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
2. Support brackets with cable tie slots for fastening cable ties to brackets.
3. Lacing bars, spools, J-hooks, and D-rings.
4. Straps and other devices.

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C. Cable Trays:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Cablofil Inc.
   b. Cooper B-Line, Inc.
   c. GS Metal Corp.

2. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch (0.012 mm) thick.

   a. Basket Cable Trays: 12 & 18 inches (305mm) wide and 4 inches (100 mm) deep. Wire mesh spacing shall not exceed 2 by 4 inches (50 by 100 mm).
   b. Ladder Rack: Nominally 12 inches (305 mm) wide, and a rung spacing of 12 inches (305 mm).

D. Conduit and Boxes:

1. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical System". "Flexible metal conduit shall not be used unless approved by Owner".
2. Outlet boxes shall be no smaller than 4-11/16 inches wide, 4-11/16 inches (120 mm) high, and 2-1/2 inches (64 mm) deep.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, painted with two (2) coast of fire retardant paint (stamp) 3/4 by 48 by 96 inches (19 mm by 1220 mm by 2440 mm). Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry".

2.3 EQUIPMENT FRAMES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chatsworth.

B. General Frame Requirements:

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Module Dimension: Width compatible with EIA 310 standard, 19-inch (480 mm) panel mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Provide three rack systems within the MER/MDF & two rack systems within the TR/IDF rooms ready to accept Owner equipment.

C. Modular Freestanding Cabinets:

1. Removable and lockable side panels.
2. Hinged and lockable front and rear doors.
3. Adjustable feet for leveling.

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4. Screen ventilation openings in the roof and rear door.
5. Cable access provisions in the roof and base.
6. Grounding bus bar.
7. Roof-mounted, 550-cfm (260-L/s) fan with filter, (if requested by OWNER).
8. Power strip.
9. Baked-polyester powder coat finish.
10. All cabinets keyed alike.
11. Provide three rack systems within the MER/MDF & two rack systems within TR/IDF rooms ready to accept Owner equipment.

D. Cable Management for Equipment Frames:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.4 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" and Division 27 Section 27 05 26 Grounding and Bonding for Communications Systems" and for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.5 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by printers.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entranced terminals, and a housing when so directed by service provider.

B. Install underground pathways complying with recommendations in TIA/EIA-569-A, "Entrance Facilities" Section and BICSI Chapter 9 Telecommunications Entrance Facilities and Termination.

C. Install underground entrance pathway complying with Division 26 Section "Raceway and Boxes for Electrical System".

3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

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C. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-69-A-7.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radius. Install lacing bars and distribution spools.

3.3 FIRESTOPPING

A. Comply with requirements in Division 07 Section 07 84 13 "Penetration Firestopping". Comply with TIA/EIA-569-A, Annex A, "Firestopping".

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a grounding electrode conductor to match electrical service entrance section up to #3/0 AWG (minimum No. 2 AWG grounding electrode conductor) from grounding bus bar to suitable electrical building ground. (At service entrance switchboard or first building electrical panel).

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

E. Refer to Division 27 Section 27 05 26 Grounding and Bonding for Communications Systems for additional requirements.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirement in Division 26 Section 26 05 53 "Identification for Electrical System." Comply with requirements in Division 09 Section 09 91 23 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

B. See Division 27 Section 27 15 00 "Communications Horizontal Cabling" for additional identification requirements. See evaluations for discussion of TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 4 (multi-site system) level of administration including optional identification requirements of this standard.

C. Labels shall be preprinted or computer-printed type.

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3.6 INSTALLATION OF PATHWAYS

A. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls or room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches (76 mm) above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor or grounding system.

B. Backboards: Install backboards with 06-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joint.

C. Vertical cables shall be supported for a ladder or rings by use of cable ties 24" on center. If messenger strand cable is utilized for cable support, the cable shall be grounded to the telecommunication grounding system at both ends and shall not be used as a grounding conductor.

D. Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors, or as required by local codes.

END OF SECTION 27 11 00

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SECTION 27 13 00

COMMUNICATIONS BACKBONE CABLING

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. Pathways.
2. UTP cable.
3. 50.0/125-micrometer, optical fiber cabling.
4. 62.5/125-micrometer, optical fiber cabling.
5. Coaxial cable.
6. Cable connecting hardware, patch panels, and cross-connects.
7. Cabling identification products.
8. Single Mode Fiber.

1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel.

D. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

E. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

F. EMI: Electromagnetic interference.

G. IDC: Insulation displacement connector.

H. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

I. LAN: Local area network.

J. NECA: National Electrical Contractor Association.

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K. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

L. RCDD: Registered Communications Distribution Designer.

M. Trough or Ventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and bottom having openings for the passage of air.

N. UTP: Unshielded Twisted Pair.

O. Owner:

1.4 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Refer to Division 27, Section 270513 "Communication Services".
2. Include the following installation data for each type used:

    a. Nominal OD.
    b. Minimum bending radius.
    c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. Cabling administration drawings and printouts.
3. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

C. Source quality-control reports.

D. Field quality-control reports.

E. Maintenance Data: For splices and connectors to include in maintenance manuals.

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F. Testing Documentation:

1. Provide three hard copies and one electronic copy (CD-rom) of test reports for horizontal UTP cables, coaxial cables, and fiber-optic cables. Test reports provided in electronic format shall include a shareware copy of the appropriate software for managing the reports of CSV format.
2. Documentation (printed form) shall be submitted to the Architect within five working days of the completion of each testing phase (e.g., subsystem, cable type, area, floor, etc.).

1.7 QUALITY CONTROL

A. Installer Qualifications: Cabling Installer must have personnel certified BICSI on staff.

1. Installation Supervision: Installation shall be under the direct supervision of Registered Technician who shall be present at all times when Work of this Section is performed at project site.
2. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

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

D. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

E. Grounding: Comply with ANSI-J-STD-607-A.

1.8 DELIVERY, STORAGE AND HANDLING

A. Test cables upon receipt at Project Site.

1. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
2. Test each pair of UTP cable for open and short circuits.
3. Cable shall be stored according to manufacturer's recommendations as a minimum. In addition, cable must be stored in location protected from vandalism and weather. Air temperature at cable storage location shall not exceed 50°F minimum, 130°F maximum. Storage location shall be well ventilated to prevent condensation. If necessary, cable shall be stored offsite at the Contractor's expense.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Cable shall be stored according to manufacturer's recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. Air temperature at cable storage

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location shall not exceed 50°F minimum, 130°F maximum. Storage location shall be well ventilated to prevent condensation. If necessary, cable shall be stored offsite at the Contractor's expense.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate layout and install of telecommunication pathway and cabling with other trades (Electrical, Mechanical, Plumbing, Etc.).

PART 2 - PRODUCTS

2.1 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by:

1. Hubbell Incorporated.

B. Description: 100-ohm, 200 pair UTP, formed into 25-pair binder groups covered with gray thermoplastic jacket and overall metallic shield.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 5e.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as comply with UL 444 and NFPA 70 for the following types:

a. Communications, General Purpose: Type CM or CMG.
b. Communications, Plenum Rated: Type CMP complying with NFPA 262.
c. Communications, Riser Rated: Type CMR complying with UL 1666.
d. Communications, Limited Purpose: Type CMX.
e. Multipurpose: Type MP or MPG.
f. Multipurpose, Plenum Rated: Type MPP complying with NFPA 262.
g. Multipurpose, Riser Rated: Type MPR complying with UL 1666.

2.2 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by:

1. Hubbell Incorporated.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 5e or Category 6 New Construction. 66-style IDC for renovations when 66 blocks are existing. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

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D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated.

F. Jack and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

G. Patch Cords: Factory-made, 4-pair cables in 36-inch (900-mm) and 48-inch (1200-mm) lengths; terminated with 8-position modular plug at each end or as directed by Owner. (Owner to modify)

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

2.3 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Corning Cable Systems.

B. Description: Multimode, 62.5/125-micrometer, tight buffer and optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-B.3 for performance specifications.
3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

    a. General Purpose, Nonconductive: Type OFN or OFNG.
    b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
    c. Riser Rated, Nonconductive: Type OFNR complying with UL 1666.
    d. General Purpose, Conductive: Type OFC or OFCG.
    e. Plenum Rated, Conductive: Type OFCP complying with NFPA 262.
    f. Riser Rated, Conductive: Type OFCR complying with UL 1666.

4. Conductive cable shall be aluminum armored type.
5. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
6. Minimum Model Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300nm.

2.4 BUILDING OPTICAL FIBER CABLE BACKBONE

A. Single-Mode and 50 Micron Laser optimized Multi-mode fiber optic backbone required between BDF and all IDF locations. All cable to be homerun with no splices and installed in MaxCell sleeves or 1" plenum rated innerduct. Strand count to be determined by NAU/ITS on a per project basis.

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2.5 ISP CABLE - MIC 2-24 FIBERS PLENUM

A. Cable shall be plenum-rated, all-dielectric, with two to twenty-four 900 ± 50 µm tight-buffered fibers. TBII® Tight-Buffered Fiber shall be made of a PVC material and shall have a UV-cured acrylate coating (low-friction slip layer) between the acrylate coating of the optical fiber and the PVC buffer. The fiber coating, low-friction slip layer and PVC buffer shall be removable with commercially available stripping tools in a single pass for termination or splicing. The individual fibers shall be color-coded for identification. The optical fiber color coding shall be in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding." Fibers shall be stranded together around jacketed or non-jacketed dielectric strength members via reverse oscillation and surrounded with dielectric strength members and a ripcord. Cables containing 12 to 24 fibers shall have a dual-layer stranded design. The cable jacket color shall be orange for cables containing all multimode fiber, except for cables containing 50/125 µm, 850 nm laser optimized fiber, which shall have an aqua colored outer jacket. The cable jacket color shall be yellow for cables containing all single mode fiber. Hybrid cables (containing more than one type of fiber) shall have an outer jacket with the color corresponding to the greatest percentage of total fibers within the cable, except for hybrid cables containing 50/125 µm, 850 nm laser optimized fiber, which shall have an aqua colored outer jacket. Unique color identification of all fibers within the hybrid cable shall correspond to fiber core diameter (or mode field diameter) from smallest to largest in accordance with TIA/EIA-598-B. Cable shall be listed OFNP/FT-6 and be fully compliant with ICEA S 83-596. The outer jacket shall be marked with the manufacturer's name or ETL file number, date of manufacture, fiber count, fiber type, flame rating, listing symbol, and sequential length markings every two feet (e.g., "CORNING OPTICAL CABLE - 01/00 – 12 SM – TB2 - OFNP (ETL) OFN FT6 (CSA) 0001 marking shall be in contrasting color to the cable jacket. FEET"). The Cable shall have a storage temperature range of -40° to 70°C on the original shipping reel, installation temperature range of 0° to 60°C, and an operating temperature range of 0° to 70°C. Cable manufacturer shall be ISO 9001 registered.

2.6 ISP CABLE - UMIC 24-144 FIBERS PLENUM

A. Cable shall be all-dielectric and contain 36 to 144 900 ± 50 µm tight-buffered fibers. TBII® Tight-Buffered Fiber shall be made of a PVC material and shall have a UV-cured acrylate coating (low friction slip layer) between the acrylate coating of the optical fiber and the PVC buffer. The fiber coating, low friction slip layer and PVC buffer shall be removable with commercially available stripping tools in a single pass for termination or splicing. The individual fibers shall be color-coded for identification. The optical fiber color coding shall be in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding." Fibers shall be stranded via reverse oscillation with dielectric strength members and a ripcord in either 6-fiber or 12 fiber subunits. Cable with < 60 fibers shall contain 6-fiber subunits, otherwise cable shall contain 12-fiber subunits. Subunits shall be stranded together in a planetary configuration around a jacketed or bare glass reinforced plastic (GRP) dielectric central member. Cable shall contain a ripcord underneath outer cable jacket to facilitate jacket removal. Each subunit jacket shall be made of a PVC material and shall be identified with a unique number at periodic intervals. Subunit color containing multimode fiber shall be orange. Subunit color containing 50/125 µm, 850 nm laser optimized fiber shall be aqua. Subunit color containing single-mode fiber shall be yellow. A dual-layer subunit design shall be used for cables containing 108 to 144 fibers. The cable jacket color shall be orange for cables containing all multimode fiber, except for cables containing 50/125 µm, 850 nm laser optimized fiber, which shall have an aqua colored outer jacket. The cable jacket color shall be yellow for cables containing all single mode fiber. Hybrid cables (containing more than one type of fiber) shall have an outer jacket with the color corresponding to the greatest percentage of total fibers within the cable, except for hybrid cables containing 50/125 µm, 850 nm laser optimized fiber, which shall have an aqua colored outer jacket. Cable shall be listed OFNP/FT-6 and be fully compliant with ICEA S-83-596. Cable outer jacket shall be marked with the manufacturer's name or ETL file number, date of manufacture, fiber count, fiber type, flame rating, listing symbol, and sequential length markings every two feet (e.g., "CORNING OPTICAL CABLE - 01/00 – 72 SM– TB2 - OFNP (ETL) OFN FT6 (CSA) 0001 FEET"). The marking shall be in contrasting color to the cable jacket.

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B. Cable shall have a storage temperature range of -40°C to +70°C, installation temperature range of 0°C to +60°C, and an operating temperature range of 0°C to +70°C. Cable manufacturer shall be ISO 9001 registered.

2.7 INTER BUILDING OPTICAL FIBER CABLE

A. Fiber optic cable shall meet following requirements:

1. Cable shall be all-dielectric, stranded loose-tube design with dry water blocking for outdoor duct and aerial installations in fiber counts from two to 288. Each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding." The fibers shall be colored with ultraviolet (UV) curable inks. Buffer tubes shall be made from polypropylene. Each buffer tube shall contain a water swellable yarn for water blocking protection. The water-swellable yarn shall be non-nutritive to fungus, electrically non-conductive, and homogeneous. It shall also be free from dirt or foreign matter. This yarn will preclude the need for other water blocking material; the buffer tube shall be gel free. The optical fibers shall not require cleaning before placement into a splice tray or fan out kit. The buffer tube shall be manufactured to a standard 3.0 mm in size, regardless of fiber count, to reduce the number of required installation and termination tools. Buffer tubes containing fibers shall be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-B. Buffer tube colored stripes shall be inlaid in the tube by means of co extrusion when required. The nominal stripe width shall be 1 mm. Buffer tubes in a hybrid cable (cable containing more than one type of fiber) shall contain only one fiber type. Identification of fiber types in a hybrid cable shall correspond to fiber core diameter (or mode field diameter) from smallest to largest in accordance with TIA/EIA-598-B. Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation stranding process. Two polyester yarn binders shall be applied contra helically with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking, and dielectric with low shrinkage. Water swellable yarn(s) shall be applied longitudinally along the central member during stranding. For dual-layer cables, a second (outer) layer of buffer tubes shall be stranded over the original core to form a two-layer core. A water swellable tape shall be applied longitudinally over both the inner and outer layer. The water-swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter. Cable shall be comprised of water-swellable yarns and/or tapes, dielectric strength members (as required), ripcord(s) and an MDPE jacket containing carbon black to provide ultraviolet light protection while inhibiting the growth of fungus. Cable jacket shall be marked with the manufacturer's name, month and year of manufacture, sequential meter or foot markings, a telecommunication handset symbol as required by Section 350G of the National Electrical Safety Code® (NESC®), fiber count, and fiber type. The actual length of the cable shall be within -0/+1% of the length markings. The print color shall be white, with the exception that cable jackets containing one or more coextruded white stripes, which shall be printed in light blue. The height of the marking shall be approximately 2.5 mm. Cable shall contain reverse oscillation lay (ROL) markings as needed. Cable shall have a storage temperature range of -40° to 70°C, an installation temperature range of -30°C to 70°C, and an operating temperature range of -40° to 70°C. Cable shall have a short-term tensile rating of 2700 N. No fiber strain shall occur over the service life of the cable when subjected to a maximum, long-term tensile rating of 890 N. Cable shall meet the functional requirements of Rural Utilities Service (RUS) 7 CFR 1755.900 and be fully compliant with ICEA S-87-640. Manufacturer shall be ISO 9001 and TL 9000 registered.

B. Jacket:

1. Jacket Color: Orange for 62.5/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.

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3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

C. Description: Single mode, 8/125-micrometer, tight buffer and optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-B.3 for performance specifications.
3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

   a. General Purpose, Nonconductive: Type OFN or OFNG.
   b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
   c. Riser Rated, Nonconductive: Type OFNR complying with UL 1666.
   d. General Purpose, Conductive: Type OFC or OFCG.
   e. Plenum Rated, Conductive: Type OFCP complying with NFPA 262.
   f. Riser Rated, Conductive: Type OFCR complying with UL 1666.

4. Conductive cable shall be aluminum armored type.
5. Maximum Attenuation: 3.50 dB/km at 1310 nm; .2 dB/km at 1550 nm.
6. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
7. Jacket Color: Yellow for single mode cable.
8. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
9. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

2.8 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Corning Cable Systems.
2. Dynacom Corporation.

B. Rack Mount Housings: Housing shall be Hubbell brand. Housings shall be mountable in an EIA-310 compatible 465- or 592 mm rack. Housings shall be available in both 1U, 2U and 4U sizes. One EIA rack space or panel height (denoted as 1U) is defined as being 44.45 mm in height. The unit shall meet all applicable design requirements listed in ANSI/TIA/EIA-568, ANSI/TIA/EIA-942, and the polymer compounds flammability requirements of UL 94 V-0. Manufacturer shall be ISO 9001 and TL 9000 registered. Housings shall be manufactured using 16-gauge aluminum or equivalent for structural integrity and shall be finished with a black powder coat for durability. All joints shall be welded and finished in a workman-like manner. Installation fasteners shall be included and shall match the housing color. The unit shall include a cable clamping mechanism to provide cable strain-relief. The front and rear doors shall be lockable when used with an optional key lock kit. The Connector Housings shall have a labeling scheme that complies with ANSI/TIA/EIA-606. The housings shall be available with factory-installed connectorized cable stubs in multiple cable and connector types. The housing shall have the ability to accommodate fusion splicing with additional hardware. The housing shall be 16 inches deep for extra cable routing.

C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

D. Patch Cords: Factory-made, dual-fiber cables in 36-inch (900-mm) lengths or lengths as directed by Owner.

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E. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
2. Quick-connect, simplex and duplex, UNICAM connectors. Insertion loss not more than 0.75 dB.

2.9 COAXIAL CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden CDT Inc., Electronics Division.
2. CommScope, Inc.

B. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.

C. RG-11/U: NFPA 70, Type CATV.

1. No. 14 AWG, solid, copper-covered steel conductor.
2. Gas-injected, foam-PE insulation.
3. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
4. Jacketed with sunlight-resistant, black PVC or PE.
5. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85°C.

D. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Type as follows:

1. CATV Cable: Type CATV, or CATVP or CATVR.
2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
3. CATV Riser Rated: Type CATVR or CATVP, CATVR, or CATV, complying with UL 1666.
4. CATV Limited Rating: Type CATVX.

2.10 COAXIAL CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Blonder – Tongue.

B. Coaxial-Cable Connectors: Type BNC, 75 ohms.

2.11 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.12 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

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B. Factory test cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode and single mode optical fiber cables according to TIA/EIA-526-14.A and TIA/EIA-568-B.3.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems".

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring with Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radius. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices".
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Cabling shall be installed in continuous runs from cross-connect fields to cross-connect fields, to patch panels, workstation outlets, etc. Cabling shall be free from splices, taps, splitters, baluns and any other in-line connections.
6. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Unsupported spans between cable trays and conduit sleeve shall not exceed 12" horizontally, 24" vertically.
8. All cables shall be new and as specified on the drawings. Cables shall be shipped on 1,000 ft. reels or boxed. Coiled cables are not acceptable. Factory shorts and/or factory seconds, salvaged, leftover and reused cables are not acceptable. Cables of a given type shall be of a single manufacturer and part number. All unapproved or unacceptable cable shall be removed and replaced at the Contractor's expense.

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9. Cables routed above a suspended ceiling in exposed space, and not installed in a conduit system, shall be supported by a cable tray, channel or hangers.
10. Cables shall not be supported from ceiling support wires, lighting fixture support wires, ductwork, plumbing line, fire suppression systems, mechanical systems or electrical conduits. Cable shall not come in contact with ductwork or piping, or lay on top of ceiling systems and lighting fixtures.
11. Where cables are routed through inaccessible ceilings, the Contractor shall install conduit sleeves extending 1 foot beyond the inaccessible area, sized in accordance with ANSI/TIA/EIA-569-A Guidelines, as outlined in Table 1. Install insulated conduit bushing on both ends of sleeve and ground conduit per Division 27 Specification Section 27 05 26 "Grounding & Bonding for Communications Systems".
12. Install conduit sleeves where cables pass through walls. Conduits shall be sized in accordance with ANSI/TIA/EIA-569-A Guidelines, as outlined in Division 27 Specification Section 27 05 28 "Pathways for Communications Systems" Table 1. Install insulated conduit bushing on both ends of sleeve and ground conduit per Division 27 Specification Section 27 05 26 "Grounding & Bonding for Communications Systems.
13. Cables supported by hangers shall utilize Caddy Cable-Cat hangers or approved equal communication cable hangers. Hangers shall be supported from the building structure. Hangers shall not utilize other systems support wires or rods.
14. A maximum of 36 (three groups of 12) cables shall be supported in a single hanger with a spacing of 48" on center. Cables shall be loosely bundled.
15. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radius than minimums recommended by manufacturer.
16. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radius, but not than radius specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
17. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
18. Cold-Weather Installation: Bring cable to room temperatures before dereeling. Heat lamps shall not be used for heating.
19. In the communications equipment room, install a 10-foot – (3-m-) long service loop on each end of cable.
20. Pulling Cable: Comply with BICSI ITSIM Ch. 4, "Pulling Cable." Monitor cable pull tensions.
21. Cables requiring additional length shall be stored in an extended loop or in a "Future 8" configuration. Do not store additional length in bundled loops. Each individual loose shall be tagged with cable number.
22. The Contractor shall make certain that during the installation and upon completion, all cables have been installed in good condition, free from jacket cuts, or tears, kinks, twist, knots, sharp bends, etc., or any other physical damage. During the installation, the Contractor shall not allow the cables to be exposed to foot, vehicle or equipment traffic, or be exposed to any other form of abuse which shall cause damage to cables, altering the electrical characteristics. Cable exhibiting such damage or an attempt by the Contractor to correct, hide or otherwise conceal such damage, shall result in cables being replaced at the Contractor's expense.
23. Cable pulls shall not exceed 100 feet in length. Cables shall be neatly coiled in a figure "8" pattern at the completion of a pull in preparation of the next pull.
24. Data/telecommunication and fiber-optic cables shall not be stored or installed in an unheated building where the temperature is less than 40°F. The structure and the cable must be brought to a minimum 50°F ambient for a minimum of 48 hours prior to installation of the cables. Failure to observe this precaution may result in damage to the cable and shall result in the cable being replaced at the Contractor's expense.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.

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2. Do no untwist UTP cables more than 1/2 inch (12mm) from the point of termination to maintain cable geometry.
3. Maximum of 12" and minimum of 6" of cable shall be stored in back box or raceway. Slack shall be coiled in the box without exceeding the bend radius.
4. Bend radiuses of the horizontal cable shall not be less than four times the outside diameter of the cable.
5. Cable jacket shall be maintained to within 1" of termination points.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 48 inches (1524 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet (1800 mm) long in Figure 8 configuration not less than 12 inches (300 mm) in diameter below each feed point.

G. Group connecting hardware for cables into separate logical fields.

H. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
    c. Electrical Equipment Rating More than 5 kVA: A minimum of 24 inches (610 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
    c. Electrical equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.

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b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.3 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping." Comply with TIA/EIA-569-A, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Administration Class 4.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion about TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 4 level of administration, including optional identification requirements of this standard.

C. Comply with requirements in Division 27 Section "Communications Horizontal Cabling" for cable and asset management software.

D. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

E. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
3. Label each terminal strip and screw terminal in each cabinet, rack or panel.

a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
b. Label each unit and field within distribution racks and frames.

4. Identification within Connector Field in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

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F. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1 and Addenda.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform test with a testing that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

4. Optical Fiber Cable Tests:

    a. Multi-Mode (62.5 / 125 UM) and Single-Mode (8.7 / 125 UM) Fiber-Optic Cable:

        1) All fiber-optic cables shall be fully tested for continuity and attenuation, utilizing fiber-optic power motor and fiber-optic LED/laser light source. The fiber-optic test equipment shall be capable of testing multi-mode and/or single-mode fiber cable.
        2) The fiber-optic test equipment shall be an electronic micro-controller with automatic self-testing and data storage. The Contractor shall provide shop drawings, catalog cut sheets and operational procedures describing the test equipment proposed to be utilized, for the Architect's review and approval.
        3) Fiber conductor shall be tested with the cable completely installed and in final placement, with connector installed and polished out. The "ST" and/or "SC" connectors shall be inspected for proper termination techniques, workmanship, labeling, etc., and verified by the Contractor to be free from any visual defects, such as scratches and chips. All connector installations exhibiting any defected and/or improper assembly procedures shall be replaced at the Contractor's expense.

    b. Each fiber shall be tested in both directions, with both readings recorded. The worst-case reading shall be utilized to determine acceptability of the fiber.
    c. Attenuation shall be recorded for each fiber at 850 and 1,300 nm for multi-mode fiber-optic cable, and at 1,310 nm and 1,550 nm for single-mode fiber-optic cable. Fiber-optic cable link test procedures shall be based upon EAI/TIA-568A Annex "H" Standard procedures. The technician performing the fiber-optic verification test should periodically check and verify the reference dB loss. All fiber-optic "ST" and/or "SC"

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connectors and couplers shall be thoroughly cleaned before and after testing, and dust caps installed after the test procedures have been completed.

d. The fiber-optic cable test report shall provide the following information:

1) Contractor's name.
2) Test Equipment Identification: Manufacturer, model number, and serial number.
3) Client/Owner identification.
4) Data test performed.
5) Cable manufacturer and part number.
6) Cable identification number.
7) Cable location (i.e., building – from/to).
8) Cable description (i.e., number of fibers, S/M, M/M).
9) Name, signature and date of signature of the technician performing the tests.
10) Cable length.
11) Proper conductor termination verification, both ends.
12) Link attenuation (loss) measurement in dB per fiber.
13) Reference dB.
14) Visual connector (both ends) inspection verification.
15) Calculated fiber loss based on fiber length and factory OTDR readings.
16) Calculated optical attenuation per connector pair (fiber link attenuation loss measurement), less the calculated fiber loss, less the reference dB, equals optical attenuation per connector pair.
17) Test results (i.e., pass/fail).

e. Maximum optical attenuation per connector pair for multi-mode fiber connectors shall be 0.5 dB or less when measured at 850/1,300 nm in accordance with ANSI/EIA/TIA-526-14A, Method A.1. Maximum optical attenuation per connector pair for single-mode fiber connectors shall be 0.5 dB or less when measured at 1,310/1,550 nm in accordance with ANSI/EIA/TIA-526-7, Method B. (NOTE: It is recognized by the Engineers that this specification is much more stringent than the EIA/TIA-568A Annex "H" Standard.) Reflection shall be > 45 dB.

C. Coaxial Cables: All coaxial cables shall be tested for "opens", "shorts", continuity, capacitance, impedance, loop resistance and length. Coaxial cables shall be tested utilizing a programmable micro-computer based automatic scanner/tester capable of generating complete printed test reports as noted above.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION 27 13 00

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SECTION 27 15 00

COMMUNICATIONS HORIZONTAL CABLING

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. Pathways.
2. UTP cabling.
3. Coaxial cable.
4. Cable connecting hardware, patch panels, and cross-connects.
5. Telecommunications outlet/connectors.
6. Cabling system identification products.
7. Cable management system.

B. Related Sections:

1. Division 27 Section 27 13 00 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
2. Divisions 27 05 26 "Grounding & Bonding for Communications Systems", 27 05 28 "Pathways for Communications Systems", 27 06 10 "Schedules for Structured Cabling & Enclosures", 27 06 20 "Schedules for Data Communications" & 27 11 00 "Communications Equipment Room Fittings".

1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel.

D. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

E. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

F. EMI: Electromagnetic interference.

G. IDC: Insulation displacement connector.

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H. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

I. LAN: Local area network.

J. NECA: National Electrical Contractors Association.

K. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

L. RCDD: Registered Communications Distribution Designer.

M. UTP: Unshielded twisted pair.

N. Owner:

1.4 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunication outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.

1. Minimum of three communications outlet/connectors be installed for each work area (one voice / two data).
2. Horizontal cabling shall contain no transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridge taps and splices shall not be installed in the horizontal cabling.
4. Splitters shall not be installed as part of the optical fiber cabling.

B. A work area includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is 275 feet. This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) in the horizontal cross-connect.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Refer to Division 27 Section 27 05 13 "Communication Services".
2. Include the following installation data for each type used:

   a. Nominal OD.
   b. Minimum bending radius.

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c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector including BICSI Certification.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For splices and connectors to include in maintenance manuals.

G. Testing Documentation:

1. Provide three hard copies and one electronic copy (CD-rom) of test reports for horizontal UTP cables, coaxial cables, and fiber-optic cables. Test reports provided in electronic format shall include a shareware copy of the appropriate software for managing the reports in CSV format.
2. Documentation (printed form) shall be submitted to the Architect within five working days of the completion of each testing phase (e.g., subsystem, cable type, area, floor, etc.).

1.7 QUALITY CONTROL

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project Site.
2. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

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

D. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

E. Grounding: Comply with ANSI-J-STD-607-A.

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1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of UTP cables for open and short circuits.
2. Delivery and receipt of products shall be at the site described in the Scope section.
3. Cable shall be stored according to manufacturer's recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. Air temperature at cable Storage location shall be well ventilated to prevent condensation. If necessary, cable shall be stored offsite at the Contractor's expense.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Cable shall be stored according to manufacturer's recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. Air temperature at cable storage location shall not exceed 50°F minimum, 130°F maximum. Storage location shall be well ventilated to prevent condensation. If necessary, cable shall be stored offsite at the Contractor's expense.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

C. Refer to Division 27 Section 27 05 13 "Communication Services".

PART 2 - PRODUCTS

2.1 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by:

1. Hubbell Incorporated.

B. Description: 100-ohm, 4-pair UTP, covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6 for new construction.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as comply with UL 444 and NFPA 70 for the following types:

a. Communications, Plenum Rated: Type CMP complying with NFPA 262.

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b. Communications, Riser Rated: Type CMR complying with UL 1666.
c. Communications, Limited Purpose: Type CMX.
d. Multipurpose: Type MP or MPG.
e. Multipurpose, Plenum Rated: Type MPP complying with NFPA 262.
f. Multipurpose, Riser Rated: Type MPR complying with UL 1666.

2.2 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by:

1. Hubbell Incorporated.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated.

D. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

E. Patch Cords: Factory-made, four-pair cables in 36-inch (900 mm) and 48-inch (1200 mm) Length as directed by Owner; terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

2.3 COAXIAL CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Incorporated.

B. Cable Characteristics: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.

C. RG-6/U: NFPA 70, Type CATVP.

1. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
3. Jacketed with Copolymer jacket.
4. Suitable for indoor installations.

D. RG59/U (Plenum Rated): NFPA 70, Type CMP.

1. No. 20 AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.
2. Double shielded with 100 percent aluminum-foil shield and 65 percent aluminum braid.

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3. Copolymer jacket.

E. NFPA and UL compliance listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and the NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Type are as follows:

1. CATV Plenum Rated: Type CATVP, complying with NFPA 262.

2.4 COAXIAL CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Incorporated.

B. Coaxial-Cable Connectors: Type BNC, 75 ohms.

2.5 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.

B. Workstation Outlets: Four port-connector assemblies mounted in single faceplate.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Division 26 Section 26 27 26 "Wiring Devices."
2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work areas cords.

a. Flush mounting jacks, positioning the cord at a 90-degree angle.

3. Legend: Machine printed, in the field, using adhesive-tape label for cable.
4. Legend: Snap-in, clear-label covers and machine-printed paper inserts for faceplate.

2.6 VOICE COMMUNICATIONS HORIZONTAL CABLING

A. All workstations shall be fed by one (1) 4-pair 100 ohm balanced Category 6 plenum rated with yellow jacket cable with matching color jacks. Manufacturer of cable must be accepted by the proposed warranty. No Horizontal permanent link cable run shall exceed 90 meters. Cable shall be terminated at the work station on one (1) Category 6 yellow jack capable of Gigabit Ethernet (GbE). All Voice jacks should have Gigabit Ethernet (GbE) capability.

B. All Terminations shall be 568-A.

C. All work Stations shall consist of one (1) yellow Cat 6 and two (2) blue Cat 6 cables with matching color jacks. All cable colors to be bundled separately in the ceiling and all closets. When cables enter the closets they will be packed neatly (i.e., cigarette packing).

2.7 DATA COMMUNICATIONS HORIZONTAL CABLING

A. All workstations shall be fed by two (2) 4-pair 100 ohm balanced Category 6 plenum rated with blue jacket cables with matching color jacks. Manufacturer of cable must be accepted by the proposed

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warranty. No Horizontal cable run shall exceed 90 meters. Cable be terminated at workstation on Hubbell Category 6 jack and terminated at the BDF/IDF on Hubbell Category 6 patch panel. All cables tested and certified to Category 6 standard. All Data jacks should have a Gigabit Ethernet (GbE) capability. Computer labs, classrooms, and all other special applications require the input of NAU/ITS on number and location of drops. Only Velcro type cable ties shall be used with Category 6 and 6a cabling.

B. All Terminations shall be 568-A.

C. All work Stations shall consist of one (1) yellow Cat 6 and two (2) blue Cat 6 cables with matching color jacks. All cable colors to be bundled separately in the ceiling and all closets. When cables enter the closets they will be packed neatly (i.e., cigarette packing).

2.8 WIRELESS DATA COMMUNICATION HORIZONTAL CABLING

A. Wireless solution is Cisco 3602I or 3602E w/ external antennae (Cisco Aironet 2.4-GHz/5-GHz MIMO 4-Element Patch Antenna (AIR-ANT2566P4W-R)) 802.11n access points utilizing WISM 2 Controllers. Horizontal cabling shall be designed to meet minimum -61db signal strength in all areas. This is generally achieved with AP locations placement at a 35' radius. NAU/ITS shall use the planning mode of the Cisco Prime Infrastructure (PI) or other comparable software to generate the locations that meet these parameters as well as any user requirements such as increased client density loads found in classroom and large capacity spaces. WAP locations should be located so that horizontal mounting will be allowed. All WAP locations shall consist of (2) Cat 6a gray cables with matching color jacks. Wireless Cables shall be terminated 568-A on Hubbell Cat 6a Patch Panels separate from the station cable Patch Panels. All wireless cabling shall terminate in the BDF unless distance is an issue.

2.9 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by printers.

B. Comply with requirements in Division 26 Section "Identification for Electrical Systems".

C. Cable identification shall be by means of permanently applied, pre-printed, wraparound wire markers (i.e., "Brady-Wrap" B-292, LAT-18, or LAT-19 self-laminating markers). These labels must withstand the requirements of UL 969 as outlined in the EIA/TIA-606 Standard.

D. Patch panel labels shall be pre-printed and enclosed in self-adhesive clear strips Hubbell Incorporated or as accepted by the Engineer.

E. Data/Telecommunications Outlet Face Plates: Permanent, clear, pre-printed laminated label with black lettering (Brade Label #CL-311-621 or LAT-7-722-10, or as accepted by the Engineer).

2.10 SOURCE QUALITY CONTROL

A. Factory test UTP on reels according to TIA/EIA-568-B.1.

B. Factory test UTP cables according to TIA/EIA-568-B.2.

C. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, or a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

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D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports. Provide software to read original test results on disc provided by Owner.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems".

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring with Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radius. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices".
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Cabling shall be installed in continuous runs from cross-connect fields to cross-connect fields, to patch panels, workstation outlets, etc. Cabling shall be free from splices, taps, splitters, baluns and any other in-line connections.
6. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Unsupported spans between cable trays and conduit sleeve shall not exceed 12" horizontally, 24" vertically.
8. All cables shall be new and as specified on the drawings. Cables shall be shipped on 1,000 ft. reels or boxed. Coiled cables are not acceptable. Factory shorts and/or factory seconds, salvaged, leftover and reused cables are not acceptable. Cables of a given type shall be of a single manufacturer and part number. All unapproved or unacceptable cable shall be removed and replaced at the Contractor's expense.
9. Cables routed above a suspended ceiling in exposed space, and not installed in a conduit system, shall be supported by a cable tray, channel or hangers.
10. Cables shall not be supported from ceiling support wires, lighting fixture support wires, ductwork, plumbing line, fire suppression systems, mechanical systems or electrical conduits. Cable shall not come in contact with ductwork or piping, or lay on top of ceiling systems and lighting fixtures.

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11. Where cables are routed through inaccessible ceilings, the Contractor shall install conduit sleeves extending 1 foot beyond the inaccessible area, sized in accordance with ANSI/TIA/EIA-569-A Guidelines, as outlined in Table 1. Install insulated conduit bushing on both ends of sleeve and ground conduit per Division 27 Specification Section 27 05 26 "Grounding & Bonding for Communications Systems".
12. Install conduit sleeves where cables pass through walls. Conduits shall be sized in accordance with ANSI/TIA/EIA-569-A Guidelines, as outlined in Division 27 Specification Section 27 05 28 "Pathways for Communications Systems" Table 1. Install insulated conduit bushing on both ends of sleeve and ground conduit per Division 27 Specification Section 27 05 26 "Grounding & Bonding for Communications Systems.
13. Cables supported by hangers shall utilize Caddy Cable-Cat hangers or approved equal communication cable hangers. Hangers shall be supported from the building structure. Hangers shall not utilize other systems support wires or rods.
14. A maximum of 36 (three groups of 12) cables shall be supported in a single hanger with a spacing of 48" on center. Cables shall be loosely bundled.
15. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radius than minimums recommended by manufacturer.
16. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radius, but not than radius specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
17. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
18. Cold-Weather Installation: Bring cable to room temperatures before de-reeling. Heat lamps shall not be used for heating.
19. In the communications equipment room, install a 10-foot – (3-m-) long service loop on each end of cable.
20. Pulling Cable: Comply with BICSI ITSIM Ch. 4, "Pulling Cable." Monitor cable pull tensions.
21. Cables requiring additional length shall be stored in an extended loop or in a "Future 8" configuration. Do not store additional length in bundled loops. Each individual loose shall be tagged with cable number.
22. The Contractor shall make certain that during the installation and upon completion, all cables have been installed in good condition, free from jacket cuts, or tears, kinks, twist, knots, sharp bends, etc., or any other physical damage. During the installation, the Contractor shall not allow the cables to be exposed to foot, vehicle or equipment traffic, or be exposed to any other form of abuse which shall cause damage to cables, altering the electrical characteristics. Cable exhibiting such damage or an attempt by the Contractor to correct, hide or otherwise conceal such damage, shall result in cables being replaced at the Contractor's expense.
23. Cable pulls shall not exceed 100 feet in length. Cables shall be neatly coiled in a figure "8" pattern at the completion of a pull in preparation of the next pull.
24. Data/telecommunication and fiber-optic cables shall not be stored or installed in an unheated building where the temperature is less than 40°F. The structure and the cable must be brought to a minimum 50°F ambient for a minimum of 48 hours prior to installation of the cables. Failure to observe this precaution may result in damage to the cable and shall result in the cable being replaced at the Contractor's expense.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do no untwist UTP cables more than 1/2 inch (12mm) from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

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2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 48 inches (1524 mm) apart. Refer to Part B Item 10 for support requirements.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Installation of Cable Routed Exposed Under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet (1800 mm) long in Figure 8 configuration not less than 12 inches (300 mm) in diameter below each feed point.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   c. Electrical Equipment Rating More than 5 kVA: A minimum of 24 inches (610 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   c. Electrical equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.3 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, Chapter 11 "Firestopping Systems" Article.

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3.4 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Administration Class 4.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Comply with requirements in Division 09 Section 09 91 23 "Interior Painting" for painting backgrounds. For fire-resistant plywood, do not paint over manufacturer's label.

D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 4 level of administration.

E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cable administration-point labeling. Identify labeling convention and show labels for telecommunications closet, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

G. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) of each termination point.
2. Exposed Backbone Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
3. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.
4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables are flexible vinyl or polyester that flex as cables are bent.

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3.5 FIELD QUALITY CONTROL

A. Testing Agency: Installing Contractor to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
2. Visually confirm Category 5e or Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords and labeling of all components.
4. Test UTP backbone copper cabling for DC loop resistances, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shoring bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. UTP Performance Tests:

    a. Test for each outlet. Perform the following test according to TIA/EIA-568-B-1 and TIA/EIA-568-B.2:

        1) Wire map.
        2) Length (physical vs. electrical, and length requirements).
        3) Insertion loss.
        4) Near-end crosstalk (NEXT) loss.
        5) Power sum near-end crosstalk (PSNEXT) loss.
        6) Equal-level far-end crosstalk (ELFEXT).
        7) Power sum equal-level far-end crosstalk (PSELFEXT).
        8) Return loss.
        9) Propagation delay.
        10) Delay skew.

6. Coaxial Cable Tests: Conduct tests according to Division 27 Section "Master Antenna Television System."

D. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. End-to-end cabling will be considered defective if it does not pass test and inspections. Minimum acceptable level above testing standard is 4 dBA. Although test equipment may "pass" a cable based on standard valves, Owner reserves the right to reject any cable test report indicating 4.0 dBA or less. Contractor shall repair or replace unaccepted cable at their expense.

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F. Prepare test and inspection reports.

END OF SECTION 27 15 00

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SECTION 27 41 33

MASTER ANTENNA TELEVISION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. MATV equipment using cable television an off-air antenna system, CCTV cameras and video recorders as the signal source.
2. Off-air antennas.
3. MATV head-end components.
4. Distribution components.

B. Related Sections:

1. Division 27 "Communications Backbone Cabling" for coaxial, UTP, and fiber-optic cables and connectors.
2. Division 27 "Communications Horizontal Cabling" for coaxial, UTP, and fiber-optic cables and connectors.
3. Division 28 Section "Video Surveillance" for cameras, monitors, computers, and cabling for video surveillance systems.

1.2 DEFINITIONS

A. dBmV: Decibels relative to 1 mV across 75 ohms. Zero dBmV is defined as 1 mV across 75 ohms. dBmV = 20 log 10(V1/V2) where V1 is the measurement of voltage at a point having identical impedance to V2 (0001 V across 75 ohms).

B. User Interface: End point of Contractor's responsibility for Work of this Section. User interfaces are the 75-ohm terminals on device plates.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum acceptable performance of distribution system at all user-interface points shall be as follows:

1. RF Video-Carrier Level: Between 3 and 12 dBmV.
2. Relative Video-Carrier Level: Within 3 dB to adjacent channel.
3. Carrier Level Stability, Short Term: Level shall not change more than 0.5 dB during a 60-minutes period.
4. Carrier Level Stability, Long Term: Level shall not change more than 2 dB during a 24-hour period.
5. Channel Frequency Response: Across any 6-MHz channel in the 54- to 220-MHz frequency range, referenced to video; signal amplitude shall be plus or minus 1 dB, maximum.
6. Carrier-to-Noise Ratio: 45 dB or more.
7. RF Visual Signal-to-Noise Ratio: 43 dB or more.
8. Antenna Combiner Insertion Loss: 40 dB maximum.
9. Signal Power Splitter and Isolation Tap Return Loss: 17 dB maximum.
10. Cable Connectors Attenuation: Less than 0.1 dB.

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11. RF FM Carrier Level: 13 to 17 dB below video-carrier level.
12. FM Frequency Response: More than in the 88- to 108-MHz frequency range; signal amplitude is plus or minus 0.75 dB, maximum.
13. FM Carrier-to-Noise Ratio: More than 24 dB.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For headend and distribution system. Include plans, elevations, sections, details, and attachments to other work.

1. Show fabrication and installation details for television equipment.
2. Wiring Diagrams: For power, signal, and control wiring. For UTP or fiber-optic cable, include cross connects, patch panels, and patch cords.

C. Design Calculations: Calculate signal attenuation budget and show calculated line and equipment losses for the system based on the functional block diagram, to show that proposed system layout can be expected to perform up to specification. Calculate signal strength from sources to headend input points for each antenna, satellite dish, and CATV grouping. Allowable losses between components and user interface shall be used to determine size and type of coaxial cable.

D. Field quality-control reports.

E. Operation and maintenance data.

1.5 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 SYSTEMS REQUIREMENTS

A. Components: Plug-in, modular, heavy-duty, industrial or commercial grade units.

B. Equipment: Silicon based, solid state, integrated circuit devices.

C. Power Supply Characteristics: Devices shall be within specified parameters for ac supply voltages within the range of 105 to 130V.

D. Protect signal cables and connected components against transient-voltage surges by suppressors and absorbers designed specifically for that purpose. Comply with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."

E. Provide ac-powered equipment with integral surge suppressors complying with UL 1449.

F. RF and Video Impedance Matching: Signal handling components, including connecting cable, shall have end-to-end impedance-matched signal paths. Match and balance devices used at connections where it is impossible to avoid impedance mismatch or mismatch of balanced circuits to unbalanced circuits.

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2.2 MATV EQUIPMENT

A. Description: Signal-source components, signal-processing and amplifying equipment, distribution components, and interconnecting wiring. System shall receive, amplify, process, and distribute signals to outlets for receiving sets. Equipment shall translate UHF channels to VHF channels before distribution to outlets.

B. Identification of Signal Sources Distributed:

1. Owner defined. Coordinate directly with NAU Television services.

C. MATV System Qualitative and Quantitative Performance Requirements: Reception quality of color-television program transmissions at each system outlet from each service and source shall be equal to or superior than that obtained with performance checks specified in "Field Quality Control" Article, using standard, commercial, cable-ready, multiple A/V input color-television receivers.

2.3 OFF-AIR ANTENNAS

A. Antennas shall be tested, marked, and packaged, according to CEA-774-A, CEA-2028, and CEA-2032. Antennas shall be labeled according to CEA antenna mapping program.

B. Off-Air, Mast-Mounted Antennas: Weatherproof single-channel or broadband type, constructed of high-strength anodized aluminum and rated to survive in a 100-mph (160-km/h) speed wind, minimum.

1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

a. Channel Master; Part of Andrew Corporation.
b. Radio Shack Corporation.
c. TERK by Audiovox; a subsidiary of Audiovox Corporation.
d. Winegard Company.

2. Elements: Internally dampened against mechanical vibration that may occur in service.
3. Ends of Crossarms and Elements: Sealed.
4. Mounting and Connecting Hardware: Corrosion proof.
5. Frequency Range: Matched to source frequencies.
6. CEA Reception Patterns:
7. FM Antenna: Separate from the broadband antenna and the omnidirectional antenna, with 2-dB minimum gain.

C. Antenna-Supporting Structures: Prefabricated, hot-dip galvanized-steel units.

1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

a. Channel Master; Part of Andrew Corporation.
b. Radio Shack Corporation.
c. TERK by Audiovox; a subsidiary of Audiovox Corporation.
d. Winegard Company.

2. Strength of Structure and Attachments: Adequate to withstand 100-mph (160-km/h) wind speed while supporting installed antennas.
3. Comply with 47 CFR 17 and TIA 222-G.
4. Comply with FAA AC 70/7460-1K.

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2.4 MATV HEADEND COMPONENTS

A. Headend Equipment: Channel mixers, Processors, Broadband amplifier, Single-channel amplifiers, and FM module, for receiving off-air television and FM signals and outputting the signals to cable distribution system. Equip coaxial down-leads of the off-air antennas with preamplifiers to send signals at strength required by headend. Headend component performance specified in this article is minimum acceptable; better performance may be required to comply with minimum acceptable system performance standard in "Performance Requirements" Article.

1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

    a. Blonder Tongue Laboratories, Inc.
    b. Canare Corp.
    c. Channel Master; Part of Andrew Corporation.
    d. Leviton Manufacturing Co., Inc.; Leviton Voice & Data Division.
    e. Motorola, Inc.; Connected Home Solutions.
    f. Quality RF Services, Inc.; a member company of ATX Networks.
    g. Scientific-Atlanta, Inc.; a subsidiary of Cisco Systems, Inc.

2. House units in standard 19-inch (483-mm) electronic equipment cabinet complying with EIA 310.

B. Antenna Combiner: Directional coupler design network, combining up to eight antenna signals into a single output. Frequency response of the device shall be 5 to 400 MHz, and the insertion loss between input ports shall be not less than 40 dB.

C. Down-Lead Preamplifiers: Antenna mast-mounted preamplifier, designed to boost antenna signal and contained in weatherproof housing; single-channel or broadband type. Install power supplies indoors at headend equipment, connected through power inserters to provide power to preamplifiers through the coaxial down-lead cable.

1. Frequency Response: Plus or minus 0.75 dB.
2. Minimum Input: Minus 20 dBmV.
3. Return Loss: 14 dB.
4. I/O Impedance: 75 ohms.

D. Channel Mixers: Use for nonadjacent channels only.

1. Insertion Loss (Maximum 54 to 216 MHz): 2.5 dB.
2. Return Loss: 14 dB.
3. Out-of-Band Rejection: 12 dB.
4. I/O Impedance: 75 ohms.

E. Processors: One of each channel to be translated.

1. Bandwidth: 6 MHz.
2. Return Loss: 16 dB, within the 6-MHz bandwidth.
3. Noise: Not more than 10 dB at maximum gain.
4. Input Level Range, VHF: Minus 20 to plus 30 dBmV.
5. Input Level Range, UHF: Minus 20 to plus 25 dBmV.
6. Output Level Range: 50 to 60 dBmV.
7. Carrier-to-Noise Ratio: Minus 57 dB at plus 10-dBmV input.
8. Automatic Gain Control: Plus or minus 1-dB output variation of rated input level range variation.

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9. Frequency Stability: Plus or minus 10 kHz over the operational temperature range.
10. Spurious Output: 60 dB below the video carrier with video-carrier output level at plus 60 dBmV and audio-carrier level at plus 45 dBmV.
11. Adjacent Channel Rejection: Not less than 60 dB.
12. I/O Impedance: 75 ohms.

F. Broadband Amplifier:

1. Frequency Range: 54 to 220 MHz.
2. Frequency Response: Plus or minus 1.0 dB across passband.
3. Maximum Noise: 10 dB.
4. Minimum Return Loss: 16 dB.
5. I/O Impedance: 75 ohms.

G. Single-Channel Amplifiers:

1. Frequency: 6 MHz for specified channel.
2. Frequency Response: Plus or minus 0.5 dB.
3. Maximum Noise: 10 dB.
4. Minimum Return Loss: 14 dB.
5. Automatic Gain Control: Plus or minus 1-dB output variation for rated input level range variation.
6. Skirt Rejection: Minus 26b dB at plus or minus 5 MHz from channel center.
7. Sound Trap: Adjustable to 10 VdB of attenuation of the sound carrier.
8. I/O Impedance: 75 ohms.

H. FM Module: One RF processor module for each station listed.

1. Frequency Range: Between 88 and 108 MHz.
2. Output Level: 52 dBmV.
3. Output Level Control: Plus or minus 10 dB.
4. Stability: 14 dB.
5. Automatic Gain Control: Plus or minus 1-dB output variation for rated input level range variation.
6. Skirt Rejection: Minus 26b dB at plus or minus 5 MHz from channel center.
7. Sound Trap: Adjustable to 10 VdB of attenuation of the sound carrier.
8. I/O Impedance: 75 ohms.

I. Combining Network (Mixer): Combines the off-air television FM, CCTV, and CATV signals into a single-broadband output. An output test point, a 75 ohm television jack, a mixer output step attenuator dual-pilot insertion network, and a removable mixer-to-trunk jumper are included.

1. Passband: As required by system performance.
2. Distortion: Not more than plus or minus 0.1 dB over any 6-MHz segment.
3. Distortion: Not more than plus or minus 0.5 dB over the 54- to 216-MHz frequency range.
4. Nominal Insertion Loss:

    a. 15 dB maximum, channel input to single-system output.
    b. 13 dB maximum, channel input to mixer output.
    c. 20 dB maximum at test point, e.g., loss from trunk output.

5. Isolation between any Two Inputs: 30 dB.
6. I/O Impedance: 70 ohms.

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2.5 DISTRIBUTION COMPONENTS

A. Signal Power Splitters and Isolation Taps: Metal-enclosed directional couplers with brass connector parts. Where installed in signal circuits used to supply cable-powered amplifiers, power throughout capacity shall exceed load by at least 25 percent.

1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

   a. Canare Corp.
   b. Leviton Manufacturing Co., Inc.; Leviton Voice & Data Division.
   c. Motorola, Inc.; Connected Home Solutions.
   d. Quality RF Services, Inc.; a member company of ATX Networks.
   e. Scientific-Atlanta, Inc.; a subsidiary of Cisco Systems, Inc.

2. Return Loss: 17 dB.
3. RFI Shielding: 100 dB.
4. Isolation: 25 dB.
5. I/O Impedance: 75 ohms.

B. Distribution System Amplifiers: Powered by coaxial cable system and equipped with surge protection device and external test points to allow convenient signal monitoring.

1. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

   a. Canare Corp.
   b. Leviton Manufacturing Co., Inc.; Leviton Voice & Data Division.
   c. Motorola, Inc.; Connected Home Solutions.
   d. Quality RF Services, Inc.; a member company of ATX Networks.
   e. Scientific-Atlanta, Inc.; a subsidiary of Cisco Systems, Inc.

C. Cable System Power Supplies: Plug-in, modular construction, with surge, short-circuit, and overload protection.

D. Signal Traps: Packaged filters tuned to interference frequencies encountered in Project.

E. Attenuators: Passive, of fixed value, and used to balance signal levels.

F. Terminating Resistors: Enclosed units rated 0.5 W and matched for coaxial impedance.

G. User-Interface Device: Flush, female-type outlets, designed to mimic power duplex outlet; for mounting in standard outlet box; with metallic parts of anodized brass, beryllium copper, or phosphor bronze. Cable connector mounting shall be semi-recessed so its protrusion is flush with the plane of device plate. Feed-through-type cable connection shall not be used.

1. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

   a. Canare Corp.
   b. Leviton Manufacturing Co., Inc.; Leviton Voice & Data Division.
   c. Motorola, Inc.; Connected Home Solutions.
   d. Quality RF Services, Inc.; a member company of ATX Networks.
   e. Scientific-Atlanta, Inc.; a subsidiary of Cisco Systems, Inc.

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2. Cable Connector: Female, Type F.
3. Wall Plates: Match materials and finish of power outlets in same space.
4. Attenuation: Less than 0.1 dB.
5. Voltage Standing – Wave Ratio: Less than 1.15 to 1.

2.6 ENCLOSURES

A. Enclosures for Interior, Controlled Environments: NEMA 250, Type 1.

B. Enclosures for Interior, Uncontrolled Environments: NEMA 250, Type 3R.

C. Enclosures for Exterior Environments: NEMA 250 Type 4X.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install single line surge suppressors on coaxial cables entering headend equipment space and at antenna-mounted amplifiers. Comply with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."

B. Install antenna towers, masts, and mountings on concrete bases. Comply with requirements for concrete bases specified in Division 03 Section "Cast-in-Place Concrete."

1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to support equipment.

3.2 ANTENNA AND HEADEND INSTALLATION

A. Mount headend equipment in electronic-equipment cabinets recommended by manufacturer. Group related items in methodical sequence.

B. Arrange equipment to facilitate access for maintenance and to preserve headroom and passage space. Parts that require periodic service or maintenance shall be readily accessible. Headend components that require tuning adjustments shall be accessible from the front of equipment cabinets.

C. Align antenna elements to achieve maximum signal level and quality.

D. Antenna-Supporting Structure: Increase antenna height as required to obtain signal strength needed for specified system performance.

1. Attachment to Building: Use 0.375-inch- (10-mm-) minimum expansion anchors for masonry, and place anchors clear of grout or mortar joints.
2. Attachment to Building: Use 0.375-inch- (10-mm-) minimum lag bolts for attachment to wood.
3. Lightning Protection: Comply with requirements in Division 26 Section "Lightning Protection for Structures."

E. Antenna Cable Entrance: Use weatherproof entrance fittings, and seal at penetrations of the building envelope.

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3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform test and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.

C. Test and Inspections:

1. Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements.
2. Replace malfunctioning or damage items.
3. Retest until satisfactory performance and conditions are achieved.
4. Prepare television equipment for acceptance and operational testing.
5. Use an agile receiver and signal strength meter or spectrum analyzer for testing.
6. Off-air, Mast-Mounted Antenna Sources: Connect receiver to the down-lead of a 10-element, single-channel antenna, tuned and oriented to optimize reception for the channel and placed at system antenna's location. Alternatively, connect receiver to a single channel video amplifier connected to the down-lead of the above single channel antenna.
7. CATV Sources: Connect receiver to an agile demodulator or CATV set-top converter at CATV service entrance to the facility.
8. Satellite Earth-Station System Sources: Adapt receiver to the output of satellite television receiver.
9. CCTV Sources: Connect receiver to the output of each CCTV signal sources or the distribution amplifier associated with it.
10. Test Schedule: Schedule tests after pretesting has successfully been completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
11. Operational Tests: Perform tests of operational system to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
12. Distribution System Acceptance Tests:

    a. Field-Strength Instrument: Rated for minus 40-dBmV measuring sensitivity and a frequency range of 54 to 812 MHz, minimum. Provide documentation of recent calibration against recognized standards.
    b. Signal Level and Picture Quality: Use a field-strength meter or spectrum analyzer, and a standard television receiver to measure signal levels and check picture quality at all user-interface outlets.

        1) Test the signal strength in dBmV at 55 151, 547, and 750 MHz.
        2) Minimum acceptable signal is 0 dBmV (1000mV).
        3) Maximum acceptable signal level over the entire bandwidth is 15 dBmV.
        4) Television receiver shall show no evidence of cross-channel intermodulation, ghost images, or beat interference.

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13. Signal-to-Noise-Ratio Test: Use a field-strength meter to make a sequence of measurements at the output of the last distribution amplifier or of another agreed on location in system. With system operating at normal levels, tune meter to the picture carrier frequency of each of the designated channels in turn and record the level. With signal removed and input to corresponding headend amplifier terminated at 75 ohms, measure the level of noise at same tuning settings. With meter correction factor added to last readings, differences from first set must not be less than 45 dB.
14. Qualitative and Quantitative Performance Tests: Demonstrate reception quality of color television program transmissions at each user interface from each designated channel and source. Quality shall be equal to or superior than that obtained with performance checks specified below, using a standard, commercial, cable-ready, color television receiver. Level and quality of signal at each outlet and from each service and source shall comply with the following Specifications when tested according to 47 CFR 76:

    a. RF video carrier level.
    b. Relative video carrier.
    c. Carrier level stability, during 60-minute and 24-hour periods.
    d. Broadband frequency response.
    e. Channel frequency response.
    f. Carrier-to-noise ratio.
    g. RF visual signal-to-noise ratio.
    h. Antenna combiner insertion loss.
    i. Signal power splitter loss.
    j. Cable connector attenuation.
    k. RF FM carrier level.
    l. FM frequency response.
    m. FM carrier-to-noise ratio.

D. Headend and distribution system will be considered defective if they do no pass tests and inspections.

E. Prepare test and inspection reports.

F. For fiber optic and UTP cable performance test, see Division 27 Section "Communications Horizontal Cabling."

G. Cap all unused connectors and seal weathertight.

3.5 DEMONSTRATION

A. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain MATV equipment.

1. Train Owner's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.
2. Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.
3. Demonstrate programming and tuning of satellite receivers.

END OF SECTION 27 41 33

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SECTION 28 05 00

GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE

A. Provisions of this section apply to all work specified in all sections under Division 28.

B. In addition, work in Division 28 is governed by the provisions of the Bidding Requirements, Contract Forms, General Conditions, and all sections under Division 01.

C. Fire Alarm equipment coordination and installation.

1.2 DEFINITIONS

A. Exposed, not concealed.

B. Finished Spaces: Spaces other than mechanical, electrical, and communication equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and utility tunnels.

C. Exposed, Interior Installations: Exposed to view indoors. Examples include un-finished spaces, mechanical, electrical, and communication equipment rooms.

D. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations and equipment yards.

E. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

F. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

G. Unfinished Space: A room or space that is ordinarily accessible only to building maintenance personnel, a room noted on the "Finish Schedule" with exposed and unpainted construction for walls, floor or ceilings, or specifically mentioned as "unfinished."

1.3 EXAMINATION OF PREMISES

A. Visit the site, verify all measurements and job conditions, and pay all costs necessary to perform the work.

1.4 FIRE ALARM CONTRACTOR

A. The Fire Alarm Contractor shall be licensed and hold a current contracting license that has been valid for a minimum of two years in the State of Arizona as a Fire Alarm Contractor.

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1.5 REGULATIONS, PERMITS, FEES, CHARGES, INSPECTIONS

A. Regulations: Comply with all applicable codes, rules and regulations.

B. Fees and Permits: Pay all connection, installation, use, development, etc., fees and/or charges. Obtain and pay for all required permits and licenses. Refer to Division 01.

C. Inspections: All work must be inspected and approved by local authorities. Prior to final approval, furnish the Engineer with certificates of inspections and approvals by the local authorities in accordance with Division 01.

1.6 DRAWINGS AND SPECIFICATIONS

A. If a conflict exists on the drawings or between the drawings and specifications, promptly notify the Engineer.

1.7 SUBMITTALS

A. Submittals are for information and coordination only. The Engineer will diligently review the submittals and attempt to verify compliance with the project requirements. Such review, however, does not constitute approval or disapproval of obligation to comply with all project requirements. The submittals are not to be construed to be contract documents. Any failure by the Engineer to note a point of non-compliance shall not be construed to be acceptance or approval of the discrepancy.

B. Product Information Sheets: Provide manufacturer's literature which includes the information required by the Product Data paragraph of the applicable Specification Section. Where Product Information Sheets show multiple models or options, clearly mark the model and options to be provided.

C. Assembly: Assemble all required submittal information for each specification section and submit in PDF formats.

1. Assemble PDF submittals in one PDF file for each Division. Separate and order sections within each file by corresponding specification number. Provide bookmarks at the first page of each section and label each bookmark with the specification number and name to allow for easy navigation of the submittal.
2. Partial submittals will be returned without review. Floor Plans with calculations may be submitted for the Fire Alarm System separately.

D. Identification and Information:

1. Name the PDF file with the Project name, Division number and sequential submittal number. (I.E. The first submittal shall be No. 1, the second submittal shall be No. 2.)
2. Provide a cover sheet at the front of each submittal with the following information:

    a. Project name.
    b. Date.
    c. Name of Engineer.
    d. Name of Contractor.
    e. Name of subcontractor.

3. Provide a cover sheet at the front of each submittal section with the following information:

    a. Name of supplier.

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b. Name of manufacturer.
c. Number and title of appropriate Specification Section.
d. Drawing number and detail references, as appropriate.
e. Other necessary identification.

E. Options:

1. Identify options requiring selection by the Engineer.
2. Identify options included with submittal item.

F. Deviations: Identify deviations from the Contract Documents on submittals

1.8 MATERIAL SAFETY DATA SHEETS

A. Provide current, Material Safety Data Sheets (MSDS), for all hazardous chemicals that are proposed for use at the project site.

1. Provide one complete set to the Owner for review and approval a minimum of one week prior to the delivery of any hazardous chemicals to the site.
2. Maintain a second complete set at the project location, readily accessible by both the Owner's personnel and the contractor's personnel.

1.9 REQUEST FOR INFORMATION

A. Request for Information:

1. A document submitted by the Contractor requesting clarification of a portion of the Contract Documents, hereinafter referred to as RFI.
2. A properly prepared request for information shall include a detailed written statement of the clarification, apparent conflict, or information requested that indicates the specific drawings or specification in need of clarification and the nature of the clarification requested.

a. Drawings shall be identified by drawing number and location on the drawing sheet.
b. Specifications shall be identified by section number, page, and paragraph.

3. Include a proposed solution, where appropriate, based upon the field conditions and best knowledge of the Contractor.

B. Improper or Frivolous RFIs: RFIs which are not properly prepared or that request information which is clearly shown in the contract documents will be returned unanswered. Processing time for multiple submissions of improper or frivolous RFIs will be billed at the Engineer's standard hourly rate to the Owner who may deduct an equal amount from the monies due the Contractor.

1.10 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings, Submittals and Shop Drawings.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Include underground and overhead piping. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

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a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
b. Include dimensions both horizontally and vertically to permanent points of reference accurate within 6 inches. Include descriptors such as "below slab", "above ceiling", etc.
c. Record data daily or as soon as possible after obtaining it.
d. Record and check the markup before enclosing concealed installations.

2. Mark the Contract Drawings, Submittals and Shop Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of marked-up record prints.
3. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
4. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Identification: As follows:

a. Project name.
b. Date.
c. Designation "PROJECT RECORD DRAWINGS."
d. Name of Engineer.
e. Name of Contractor.

3. Remove or obscure Engineer's seal from Record Drawings.

C. Building Information Model: Prepare and maintain an up to date building information model throughout the project.

1. Prepare a Building Information Model at the beginning of construction using the latest version of Autodesk REVIT software.
2. Use manufacturer prepared families wherever they are available for the actual equipment used on the project. Include manufacturer's name, model number, serial number, and include links to Operation and Maintenance Information.
3. Update the information contained in the model as the project progresses.
4. Deliver the updated model and all support files to the Owner at the completion of the project.]

1.11 OPERATION AND MAINTENANCE MANUAL

A. Prior to completion of the project, compile a complete equipment, operation and maintenance manual for all equipment supplied under Division 28.

B. Schedule:

1. Submit a preliminary copy of the manual not less than 30 days prior to substantial completion for review and comment.
2. Submit the final version the manual not more than four weeks after substantial completion of the project.

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C. Format: Submit manuals in both of the following formats:

1. PDF electronic file. Assemble each manual into a composite electronically-indexed file. Submit on digital media acceptable to Engineer.

   a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically-linked operation and maintenance directory.
   b. Enable inserted reviewer comments on draft submittals.
   c. Provide one final copy to Engineer and two copies to Owner.

2. Three paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves. Engineer will return three copies.

D. Provide operating and maintenance manuals for all systems, subsystems, and equipment that requires operation and regular maintenance, or has replaceable parts.

E. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, product data, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below. In addition to requirements in this Section, include operation and maintenance data required in individual Specification Sections.

F. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

G. Product Data: Include the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Approved submittals.
3. Include the following if not shown on approved submittals:

   a. Product name and model number. Use designations for products indicated on Contract Documents.
   b. Manufacturer's name.
   c. Equipment identification with serial number of each component.
   d. Equipment function.
   e. Operating characteristics.
   f. Limiting conditions.
   g. Performance curves.
   h. Engineering data and tests.

H. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures. Including precautions against improper use.

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10. Operating logs.

I. Wiring Diagrams: Diagram of factory installed wiring including any options as well as any field modifications.

J. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

K. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

L. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

M. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

N. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

O. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

P. Licenses: Include copies of any licenses with requirements including inspection and renewal dates.

Q. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

R. Test and Balance Report: Include a final, approved copy of the Test and Balance Report.

1.12 WORK AND MATERIALS

A. Unless otherwise specified, all materials must be new and of the quality specified. The workmanship shall be of a quality that is acceptable to the Architect, Engineer, and Owner, and is equal to the standards of the trades. Contractor must staff the project with sufficient skilled workmen, including a fully qualified construction superintendent, to complete the work in the time allotted. The superintendent must be qualified to supervise all of the work in his work category.

B. Uniformity: Unless otherwise specified, provide all equipment and products of same type or classification by the same manufacturer.

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1.13 APPROVALS OF MATERIALS AND EQUIPMENT

A. Refer to Division 01 for description of material and equipment for prior approvals and substitutions.

1.14 COOPERATIVE WORK

A. Correct without charge any work requiring alteration due to lack of proper supervision or failure to make proper provision in time. Correct without charge any damage to adjacent work caused by the alteration. See Division 01 for additional requirements.

B. Cooperative Work Includes:

1. General supervision and responsibility for proper location, rough-in, and size of work related to Division 28 but provided under other divisions of these specifications.
2. Installation of sleeves, inserts and anchors bolts for work under sections in Division 28.

1.15 CONSTRUCTION FACILITIES

A. General: Under this division of the specifications, execute all work in a manner to provide safe and lawful ingress and egress to the Owner's establishment and such facilities shall be kept clear of materials or equipment. Refer to Division 01 for additional requirements.

B. Furnish and maintain from the beginning to the completion of all work all lawful and necessary guards, railings, fences, canopies, lights, and warning signs. Take all necessary precautions required by city and state laws to avoid injury or damage to any and all persons and property.

1.16 GUARANTEE

A. Guarantee all material, equipment, installation and workmanship for all sections under Division 28 in writing to be free from defects of material and workmanship for one year from date of final acceptance as outlined in Division 01. Equipment warranties shall be a minimum of two year from date of substantial completion or as specified elsewhere. Replace without charge any material or equipment proving defective during this period. The guarantee shall include performance of the equipment under all conditions of load, installing any additional items of control and/or protective devices as required and the replacing of any refrigerant lost.

1.17 CONSTRUCTION FACILITIES

A. General: Under this section of the specifications, execute all work in a manner to provide safe and lawful ingress and egress to the Owner's establishment. Construction facilities shall be kept clear of materials or equipment as directed by the Architect.

B. From the beginning to completion, furnish and maintain all lawful and necessary guards, railings, fences, canopies, lights, warning signs, etc. Take all necessary precautions required by city and state laws and OSHA to avoid injury or damage to any persons and property.

C. Temporary toilet facilities are specified and furnished under another section.

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PART 2 - PRODUCTS

2.1 CONCRETE

A. Where used for structures to be provided under the contract such as bases, etc., concrete work and associated reinforcing shall be as specified under that Division.

B. See other sections for additional requirements for underground vaults, cable ducts, etc.

2.2 FRAMING CHANNEL

A. The framing channel shall be a cold-rolled, high-quality, carbon steel channel with factory-applied, hot-dipped-after-fabrication finish. Utilize factory-built interconnecting components, mounting straps, connectors, etc., designed for use with the framing channel supplied. Channel nuts shall be spring type and shall utilize standard US threads. Provide heavy zinc paint for field touch-up. B-Line "B" series, Unistrut "P" series, or as accepted by the Architect.

2.3 ANCHORS

A. Anchors shall be expandable lead type, as manufactured by Ackerman-Johnson, Pierce, Diamond, Hilti, or as accepted by the Architect.

B. Adjustable concrete hanger inserts shall be as manufactured by Grinnell or as accepted by the Architect.

PART 3 - EXECUTION

3.1 SUBMITTALS

A. Prepare submittals as directed for review by the Contractor, Owner, Architect, and Engineer.

B. Submit one copy of PDF submittals via email, project website or other electronic media.

3.2 RECORD DRAWINGS

A. Recording: Post changes and modifications to project record documents as they occur; do not wait until the end of Project.

B. Maintenance of Record Documents and Samples: Store record documents in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Engineer's reference during normal working hours.

3.3 OPERATION AND MAINTENANCE MANUALS

A. Prepare Operation and Maintenance Manuals as directed for review by the Contractor, Owner, Architect, and Engineer.

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B. Make corrections and resubmit as required.

3.4 VERIFICATION OF DIMENSIONS

A. Scaled and figured dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions at site, and be responsible for properly fitting equipment and materials together and to the structure in spaces provided.

B. Drawings are diagrammatic and many offsets, bends, special fittings and exact locations are not indicated. Carefully study drawings and premises in order to determine best methods, exact locations, routes, building obstructions, and install apparatus and equipment in available locations. Install apparatus and equipment in manner and in locations to avoid obstructions, preserve headroom, and keep openings and passageways clear.

3.5 CUTTING AND PATCHING

A. Cut work and patch per Division 01 as necessary to properly install the new work. As the work progresses, coordinate necessary openings, holes, chases, etc., in their correct location. If the required openings, holes and chases are not in their correct locations, make the necessary corrections at no cost to the Owner. Avoid excessive cutting and do not cut structural members without the consent of the Engineer. Include as a part of the work all structural framing required by penetrations through the roof and necessary steel to support ducts and pipes between structural steel unless shown on the structural drawings.

3.6 CLOSING-IN OF UNFINISHED WORK

A. Cover no work until inspected, tested and approved. Where work is covered before inspection and test, uncover it, and when inspected, tested and approved, restore all work to original proper condition.

3.7 EXCAVATION AND BACKFILL

A. Perform all necessary excavation, shoring and backfilling required for the proper laying of all raceways, ducts, and conduits inside the building and premises, and outside as may be necessary. Remove all excess excavated materials from the site or dispose of on site as directed by General Contractor.

B. Excavate all trenches open cut, keep trench banks as nearly vertical as practicable, and sheet and brace trenches where required for stability and safety. Excavate trenches true to line and make bottoms not less than 18" wide but no wider than necessary to provide ample work room. Grade trench bottoms accurately to provide uniform bearing and support for each section of pipe on undisturbed soil along its entire length. Dig "bell" holes after the trench bottom has been graded. Machine grade only to the top line of the raceways, doing the balance by hand. Do not cut any trench near or under footings without first consulting the Engineer. Comply with OSHA requirements.

C. Provide not less than 4 inches of granular material as pipe bedding prior to laying pipe in trench to continuously support pipe and maintain required slope. Granular material shall be pea gravel or sand.

D. Provide backfilling and compaction in accordance with provisions of these specifications and under the direction of the Engineer to the required density.

E. Provide not less than 4 inches of granular material, same as piping bedding, all around pipe. Make the first 2 feet of fill in 6 inch layers, each thoroughly compacted as directed, and free from rocks, large clods

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of earth, leaves, branches, and debris. Compact the rest of the backfill as directed, using in the backfill no rocks larger than 4 inches in diameter, and using no rock in the top 12 inches.

3.8 ACCESSIBILITY

A. Install all control devices or other specialties requiring reading, adjustment, inspection, repairs, removal or replacement conveniently and accessibly throughout the finished building. Where any of these devices are shown on the contract drawings to be installed above any inaccessible ceiling or behind any inaccessible wall, the Fire Alarm Contractor shall furnish access doors or panels as required.

B. All access doors or panels in walls and ceilings required for access to control devices, traps, valves and similar devices are to be furnished and installed as part of the work under this section. Provide type as specified under Division 08.

C. Refer to architectural drawings for type of wall and ceiling in each area and for rated construction.

D. Coordinate work of various sections to locate valves, traps, and dampers with others to avoid unnecessary duplication of access doors.

E. The Contractor, along with the Owner's representative, shall complete the Fire Alarm Accessibility/Clearance Checklist at the end of this section for all fire alarm equipment. The chart shall be submitted to the Engineer for approval prior to substantial completion. All conflicts shall be resolved to the Engineer's and Owner's satisfaction prior to submission.

F. Provide doors that pierce a fire separation with the same fire rating as the separation.

3.9 ROOF FLASHINGS

A. Flash and counterflash all piping, conduits and ductwork penetrating roofing membrane with flashing per roofing manufacturer's recommendations. Refer to architectural drawings for detailing of duct and pipe penetrations through roof.

3.10 PRODUCT AND EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. All equipment, valves, sensors, dampers, detectors, etc., shall be installed in strict conformance with the manufacturer's recommendations and all codes.

B. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install Fire Alarm equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.

E. Do not install any equipment in an application not recommended by the manufacturer.

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3.11 EQUIPMENT ROUGH-IN

A. Rough in all equipment and fixtures as designated on the drawings and in the specifications. The drawings indicate only the approximate location of rough-ins. The exact rough-in locations must be determined from large-scale certified drawings. The Contractor shall obtain all certified rough-in information before progressing with any work for rough-in final connections.

B. Be responsible for providing all outlets and services of proper size at the required locations.

C. Minor changes in the contract drawings shall be anticipated and provided for under this Division.

1. Rough-in only (unless otherwise designated on the drawings) shall include providing all services as indicated and required, including all conduit and conductors. Cap all conduit stub-outs. Cap all conduits stub-outs in a manner suitable for future extension.

3.12 EQUIPMENT FINAL CONNECTIONS

A. Provide all final connections for the following:

1. All equipment furnished under this Division.
2. Fire Alarm equipment furnished under other sections of the specifications (except as otherwise designated).
3. Owner-furnished equipment as shown on the drawings.

3.13 OWNER-FURNISHED AND OTHER EQUIPMENT

A. Rough-in only for all Owner-furnished equipment reference Division 01 and all equipment furnished under other sections of the specifications, except as otherwise specified and/or noted on the drawings.

3.14 EQUIPMENT SUPPORTS

A. Erection of Metal Supports and Anchorages:

1. Refer to Division 05 for structural steel.
2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire alarm materials and equipment. Neatly fabricate and erect steel work with burrs and welding spatter ground off. Paint after fabrication with a rust-inhibitive primer.
3. Field Welding: Comply with AWS D1.1.

B. Erection of Wood Supports and Anchorages:

1. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support and anchor fire alarm materials and equipment.
2. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
3. Attach to substrates as required to support applied loads.

C. Concrete Inserts: Furnish and install all concrete inserts required for all materials and equipment specified and/or shown on the drawings for Division 28.

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3.15 CLEANUP

A. In addition to cleanup specified under Division 01, thoroughly clean all parts of the equipment. Where exposed parts are to be painted, thoroughly clean off any splattered construction materials and remove all oil and grease spots. Wipe the surface carefully and scrape out all cracks and corners.

B. During the progress of the work, keep the premises clean and free of debris.

3.16 PAINTING

A. Except as otherwise specified or indicated in the architectural drawings and/or specifications, paint all exposed unfinished metal with one coat of rust-inhibiting primer. Galvanized ductwork and factory painted equipment shall be considered as having primed surface.

B. Damage and Touch-Up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

C. Finished painting is specified under Division 09.

3.17 OBJECTIONABLE NOISE AND VIBRATION

A. Construct and brace the metal partitions, ducts and sheet metal housings to prevent vibration or rattling when systems are in operation. Install connections to equipment so noise and vibration will not reach the conditioned area through ducts, piping, conduit, sheet metal work, or the building structure.

3.18 TESTING

A. Upon completion of the fire alarm work, the entire installation shall be tested and demonstrated to be operating satisfactorily. Tests and documentation shall be in accordance with NFPA 72 Acceptance Testing Specifications for Fire Alarm Equipment and Systems.

B. Additional equipment-specific testing is described in the equipment's respective section of this Division.

C. Furnish a written report of testing to the Architect. At a minimum, the report shall include:

1. Testing Contractor's letterhead
2. Testing technician's name and signature.
3. Date and time that test was performed.
4. Ambient temperature and weather conditions.
5. Test equipment manufacturer, model number, and last calibration date.
6. The manufacturer, model number and, as applicable, trip unit model number and available adjustments of tested equipment.
7. Statement of "As Left" conditions.
8. Pass/Fail statement.
9. Recommendations if any.

D. The Contractor shall submit the testing schedule to the Architect two weeks prior to initiation of testing activity.

END OF SECTION 28 05 00

FIRE ALARM ACCESSIBILITY / CLEARANCE CHECKLIST (See Paragraph 3.8.E)									
Bldg.	Location	Unit #	Acceptable Access		Conflict	Date	Action	Observer	
			Yes	No				Owner	Contractor

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SECTION 28 05 01

SCOPE OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. The work under this Division includes furnishing all labor, material and equipment necessary for the installation and placing into operation of the electrical systems as indicated on the drawings.

B. The work shall also include the completion of such minor details of electrical work not mentioned or shown which are necessary for the successful operation of all electrical systems described on the drawings or required by these specifications.

1.2 SCOPE

A. The work includes, but is not necessarily limited to, furnishing and installing the following:

1. Complete fire alarm and all accessories, branch circuits, etc.
2. All equipment and materials specified in this Division.
3. Empty conduit systems as indicated on the drawings.
4. All other items and/or work indicated on the drawings.
5. Equipment lists and maintenance manuals.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 28 05 01

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SECTION 28 05 10

SECURITY ELECTRONICS GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

A. The conditions of the Contract (General, Supplementary and other Conditions) and the General Requirements (Sections of Division 1) are hereby made a part of this Section.

1.2 WORK INCLUDED

A. The work covered under this Section of the Specifications consists of furnishing all labor, equipment, supplies and materials, and in performing all operations, including cutting, channeling, chasing, excavating, and backfilling necessary for the complete installation of security equipment in accordance with the specifications and the accompanying drawings, except as specifically noted otherwise.

B. The Work includes:

1. Raceways
2. Conductors and Cables
3. Grounding and Surge Protection
4. Cabinets and Enclosures
5. Maintenance and Service
6. Door Control and Monitoring System
7. Security Monitoring and Control System
8. Closed Circuit Television System
9. Card Access System
10. Motion Detectors
11. Uninterruptible Power Systems

C. Coordinate with the construction supervisor the environmental and construction conditions necessary in each of the control areas and equipment rooms for systems installation and operation.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Refer to Division 8 for hardware specifications.

B. Refer to Division 26 for conduit, raceway and electrical box specifications. Provide all Division 28 raceways in accordance with the Division 26 Specifications.

1.4 SECURITY ELECTRONICS COMPANY QUALIFICATIONS

A. General Requirements: The Security Electronics Company (SEC) shall have total responsibility for the coordination and installation of the work shown and described in the Division 28 Drawings and Specifications. The company shall specialize in the design, fabrication, and installation of integrated security electronics and communications control systems.

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1.5 DEFINITIONS

A. Provide: Furnish and install completely ready for use, including all accessories required for operation.

B. Furnish: Purchase and deliver to the project site complete with every necessary appurtenance, support and accessory required for operation.

C. Install: Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project.

D. Concealed: Embedded in masonry or other construction installed behind wall furring, with double partitions or hung ceilings, in crawl spaces, in shafts.

E. Exposed: Not concealed.

F. Listed: Equipment is "listed" if of a kind mentioned in a list which:

1. Is published by a nationally recognized laboratory which makes periodic inspection of the production of such equipment.
2. States that such equipment meets nationally recognized standards or has been tested and found safe for use in a specified manner.

G. Labeled: Equipment is "labeled" if:

1. It embodies a valid label, symbol, or other identifying mark of a nationally recognized testing laboratory such as Underwriters' Laboratories, Inc.
2. The laboratory makes periodic inspections of the production of such equipment.
3. The labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner.

H. Certified: Equipment is "certified" if:

1. Equipment has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner.
2. Production is periodically inspected by a nationally recognized testing laboratory.
3. It bears a label, tag, or other record certification.

I. Nationally recognized testing laboratory: A testing laboratory which is approved in accordance with OSHA regulations, by the Secretary of Labor.

J. Security Electronics Company (SEC): Shall mean the company responsible for completing the work described in the Drawings and Specifications for Division 28.

1.6 REFERENCE SPECIFICATIONS, MATERIALS, AND/OR CODES

A. Submit all items necessary to obtain all required permits to the appropriate Regulatory Agencies, obtain all required permits, and pay all required fees.

B. All work shall conform to the following Building Codes:

1. National Electrical Code (NEC)
2. National Fire Protection Association (NFPA)

C. All work shall conform to all federal, state and local ordinances.

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D. Where applicable, all fixtures, equipment, and materials shall be as approved or listed by the following:

1. Factory Mutual Laboratories (FM).
2. Underwriters Laboratories, Inc. (UL).
3. National Electrical Manufacturers Association (NEMA).

E. References to the National Electrical code (NEC) and National fire Protection Association (NFPA) are a minimum installation requirement standard. Design drawings and specification sections shall govern in those instances where requirements are greater than those specified in the NEC and NFPA.

F. UL Listing:

1. All material and equipment shall be listed, labeled or certified by Underwriters' Laboratories, Inc. where such standards have been established. Equipment and material which are not covered by UL Standard will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe will be considered if inspected or tested in accordance with national industrial standards such as NEMA, ICEA or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.
2. All custom equipment assemblies shall be UL listed 508A Standard for Industrial Control Panels. All equipment and devices connected to Class I circuits shall be UL listed. Class 2 power supplies must be clearly labeled as listed Class 2 supplies in accordance with NEC 725. Equipment and devices connected to class 2 circuits on the load side of a class 2 power supply are not required to be UL listed, unless specifically required by the Authority Having Jurisdiction. All work shall meet or exceed the standards and procedures of the following:

G. All work shall meet or exceed the standards and procedures of the following:

1. National Fire Protection Association (NFPA):

a. NFPA 70 National Electrical Code
b. NFPA 101 Life Safety Code

2. Underwriters Laboratory (UL)

H. Include all items of labor and material required to comply with such standards and codes. Where quantity, sizes or other requirements indicated on the drawings or herein specified are in excess of the standard or code requirements, the specifications or drawings, respectively, shall govern.

1.7 INTERPRETATION OF CONTRACT DOCUMENTS

A. This Section of the Specifications and related Drawings describes the general provisions applicable to every Section of Division 28.

B. Attention is directed to the Instructions to Bidders and to Division 1, General Conditions, which are binding in their entirety on this portion of the work.

C. Unless specifically noted otherwise, mention (or reasonable implication) of any articles, materials, operations or methods related to the execution of the work in these Specifications of Drawings requires the execution of each such item of work and the provision of all labor, materials, equipment, and appurtenances required for its execution.

D. The language used in the Drawings or Specifications shall not be interpreted as meaning that appurtenances or accessories necessary to complete any required system or item of equipment are to be

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omitted. The omission of express reference to any parts necessary for, or reasonably incidental to, a complete installation shall not be construed as a release from furnishing such parts.

E. The drawings or necessity utilize symbols and schematic diagrams to indicate various items of work. Neither of these have any dimensional significance nor do they delineate every item required for the intended installations. The work shall be installed in accordance with the dimensions indicated on final Architectural and Structural Drawings and on equipment shop drawings. No interpretation shall be made from the limitations of symbols and diagrams that any elements necessary for complete work are excluded. When abbreviations appear on the Drawings or Specifications in lower case letters with or without periods, their meanings shall be the same as stated above.

F. Certain details appear on the Drawings that are specific with regard to the dimensioning and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field coordination for the indicated work.

G. Information as to the general construction shall be derived from Structural and Architectural Drawings and Specifications only.

H. The use of words in the singular shall not be considered as limited where other indications denote that more than one item is referred to.

I. The Drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions or detail drawings of 1/4" = 1'-0" scale or larger. For exact locations of building elements, refer to dimensioned drawings; however, field measurements take precedence over dimensioned drawings. Report any discrepancies discovered between the Security Electronics Drawings and the Drawings for other Divisions of Work.

J. Conduit and raceway systems shown on the drawings are diagrammatic only. The exact routing of conduits shall be determined in the field. Lock pockets and other devices cannot necessarily be used a junction boxes. Provide and locate junction boxes as required to provide a functional raceways system in compliance with the Specifications and the NEC.

1.8 QUALITY ASSURANCE

A. All equipment and materials required for installation under these Specifications shall be new (less than one year from manufacturer) and without blemish or defect.

B. All equipment subject to Underwriters Laboratories' label service shall bear labels attesting to approval by Underwriters Laboratories.

C. All equipment and materials manufacturers shall have been engaged in the manufacture of similar products for a minimum of three years. If requested, manufacturers shall furnish proof of their ability by submitting affidavits and descriptive data on their products.

D. Except for custom-fabricated control panels, each major component of equipment shall have the manufacturer's name, address, model number and rating on a plate securely affixed in a conspicuous place. The nameplate of a distributing agent will not be acceptable.

E. Performance criteria delineated in the Specifications shall be interpreted as minimum performance levels.

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1.9 COOPERATION WITH OTHER TRADES

A. Coordinate the Work of this Section with that of other Sections as required to ensure that the entire work of this Project will be carried out in an orderly, complete and coordinated fashion.

B. Check equipment against space available as indicated on the Drawings, and make sure that the proposed equipment can be accommodated. If interferences occur, bring them to the attention of Architect/Engineer, in writing. Otherwise, the SEC shall, at his own expense, provide proper materials, equipment, and labor to correct any damage due to defects in his work caused by such interferences.

1.10 SUBSTITUTIONS AND APPROVALS

A. Request for approvals and substitutions will be considered only if submitted in accordance with procedures outlined in the Special Conditions regarding prior approval and equipment and material approvals and substitutions.

B. "Or Equal" Clause: Notwithstanding, any reference in the specifications to any article, device, product, software, material, fixture, form or type of construction by name, make, or catalog number shall be interpreted as establishing a standard of quality.

C. Any additional labor, materials, equipment, components, accessories, or other items required for the satisfactory installation and operation of approved substitute equipment shall be provided at no additional cost to the Owner. This includes changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels, and interfaces with other work. All changes must be approved by the Engineer.

D. Verify all dimensions and field conditions and advise the Architect/Engineer of any discrepancies. Submit shop drawings for approval of any proposed changes before starting the work.

1.11 SHOP DRAWINGS

A. Submittals are for information and coordination only. The Engineer will diligently review the submittals and attempt to verify compliance with the project requirements. Such review, however, does not constitute approval or disapproval of obligation to comply with all project requirements. The submittals are not to be construed to be contract documents. Any failure by the Engineer to note a point of non-compliance shall not be construed to be acceptance or approval of the discrepancy.

B. Product Information Sheets: Provide manufacturer's literature which includes the information required by the Product Data paragraph of the applicable Specification Section. Where Product Information Sheets show multiple models or options, clearly mark the model and options to be provided.

C. Assembly: Assemble all required submittal information for each specification section and submit in PDF formats.

1. Assemble PDF submittals in one PDF file for each Division. Separate and order sections within each file by corresponding specification number. Provide bookmarks at the first page of each section and label each bookmark with the specification number and name to allow for easy navigation of the submittal.
2. Partial submittals will be returned without review. Floor Plans with calculations may be Submitted for the Fire Alarm System separately.

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D. Identification and Information:

1. Name the PDF file with the Project name, Division number and sequential submittal number. (I.E. The first submittal shall be No. 1, the second submittal shall be No. 2.)
2. Provide a cover sheet at the front of each submittal with the following information:

   a. Project name.
   b. Date.
   c. Name of Engineer.
   d. Name of Contractor.
   e. Name of subcontractor.

3. Provide a cover sheet at the front of each submittal section with the following information:

   a. Name of supplier.
   b. Name of manufacturer.
   c. Number and title of appropriate Specification Section.
   d. Drawing number and detail references, as appropriate.
   e. Other necessary identification.

E. Options:

1. Identify options requiring selection by the Engineer.
2. Identify options included with submittal item.

F. Deviations: Identify deviations from the Contract Documents on submittals

G. Prior to purchasing materials and installing the work, prepare and submit shop drawings for approval in accordance with the General Conditions and as hereinafter specified. Shop drawings are required for all materials, equipment and systems.

H. Shop drawings shall be prepared based upon the specific equipment and materials intended for installation. Consult all Contract Drawings and Specifications and obtain manufacturer's recommended installation instructions before preparing shop drawings.

I. Review of shop drawings or schedules by the Engineer shall not constitute acceptance of deviations from the Drawings or Specifications unless they have been specifically delineated in written letter form at the time of submission and secured written approval; nor shall it relieve the SEC from responsibility for errors in shop drawings or schedules.

J. Submittals must be legible. Illegible submittals will be rejected and returned without review.

1.12 AS-BUILT DOCUMENTS

A. As-Built Documents shall be detailed documentation of the installed system configuration. A minimum of three identical sets of As-Built Documents shall be submitted in accordance with the General Conditions. As-Built documentation shall include:

1. Updated shop drawings. Conduit and conductor drawings, system drawings, and video screen drawings shall be updated to include all system modifications made during construction.
2. Wire marking, wiring connection and programming schedules.
3. Equipment and materials list. For each item the manufacturer, part number and the quantity used on the project shall be listed. A list of manufacturers' names, addresses and phone numbers shall also be provided.

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4. All software, including source codes, on 3.5" disks or CD ROM.
5. Electronic copies of all drawing files, spreadsheets and schedules on 3.5" disks or CD ROM.

1.13 OWNER'S MANUALS

A. Submit three-ring binders containing manufacturer's operational, maintenance and installation manuals for all equipment and materials installed on the project. A minimum of three identical sets of Owner's Manuals shall be submitted in accordance with the General Conditions.

B. The cover of the Owner's Manual shall state the following information:

1. Project name, location and date of completion
2. Owner
3. Architect
4. Security Electronics Engineer
5. Security Electronics Company's name, address and phone number

C. The binders shall be subdivided into separate sections with tab dividers to identify subsystems of the integrated system.

D. A section for Maintenance Procedures shall be provided that shall include the following:

1. Recommended inspection and maintenance schedules for all equipment.
2. A list of manufacturers' names, addresses and phone numbers.
3. Troubleshooting procedures for all systems and equipment.
4. Emergency instructions for warranty service, including the name and phone number of the 24-hour/day response contact.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Manufactured Products:

1. All products shall be new, unused and without blemish or defect.
2. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items and for which replacement parts are available.
3. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer.
4. Equipment Assemblies and Components:

a. All components of an assembled unit need not be products of the same manufacturer; however, all components must be acceptable to the Architect/Engineer.
b. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
c. Components shall be compatible with each other and with the total assembly for the intended service.
d. Constituent parts which are similar shall be the product of a single manufacturer.
e. Moving parts of any element of equipment of the unit normally requiring lubrication, shall have means provided for such lubrication, and shall be adequately lubricated at the factory prior to delivery.

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PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment shall be installed as close as practicable to the locations shown on the Drawings.

B. Coordinate location of equipment and conduit with other trades to minimize interferences.

C. Where the Architect/Engineer determines that equipment has been installed in a manner or location not accessible for operation or maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Owner.

D. Secure equipment using fasteners suitable for the use, materials, and loads encountered. If requested, submit evidence proving suitability. Do not attach electrical materials to roof decking, removable or knockout panels, or temporary walls and partitions, unless indicated otherwise.

E. Hangers and other supports shall support only equipment and materials. Provide not less than a safety factor of 5, which shall conform with any specific requirements as shown on the drawings or in the specifications.

F. In security areas, exposed equipment and materials, including screws and other fasteners, shall be tamperproof. Cover plates shall have beveled edges.

G. Provide adequate support for all equipment to satisfy the specific local seismic requirements.

H. All footings shall extend below frost line and comply with applicable building codes.

3.2 PROTECTION AND CLEANING OF SYSTEMS AND EQUIPMENT

A. Protect all materials and equipment from physical damage, dirt, moisture, cold and rain during transportation, storage and throughout the construction period.

B. During construction, cap the top of all conduits and raceways installed vertically.

C. During installation, equipment shall be covered to protect against entry of dust and other foreign matter. Vacuum clean all equipment both inside and outside before operating.

D. Damaged equipment shall be returned to "like-new" condition.

E. Painted surfaces shall be protected with removable heavy kraft paper, sheet vinyl or similar protective material. The protective material shall be installed at the factory and removed prior to final inspection.

F. Damaged paint on equipment and materials shall be repainted and finished with the same quality of paint and workmanship used by manufacturer so repaired areas are not obvious.

3.3 EXCAVATING, TRENCHING, BACKFILLING AND RESURFACING

A. Perform all work in accordance with the Sitework Specifications.

B. All excavation depths indicated are below finished grade.

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C. Do not excavate below required depth except as necessary for removal of unstable soil or when rock is encountered. When rock is encountered, excavate six inches below the required depth. Unless indicated otherwise, pitch all electrical conduit runs downward.

D. Where backfill compaction is critical (e.g. under floor slabs, roadways, sidewalks, trenches deeper than four feet), test the degree of compaction every 75 linear feet of trench and every two feet of depth. Compact backfill until density is acceptable.

E. Repair the excavated area to original pre-excavation condition. Repair and replace sidewalks, roadways, etc.

3.4 POWER DISTRIBUTION

A. Electrical power shall be provided by Division 26 to locations and equipment as described by the Division 26 Specifications and associated Drawings. Division 28 shall provide power distribution and associated overcurrent protection for all circuits deriving power from the point of power supply furnished and installed by Division 26.

B. For three-phase supplies, the connected load shall be balanced on all phases.

3.5 COMPLETION

A. Upon completion of the work, remove all debris, materials and equipment and leave the premises clean, neat and orderly. All bright metal or plated work shall be thoroughly polished. All pasted labels, dirt and stains shall be removed from the devices.

B. Prior to final system demonstration, all systems shall be complete and operational, all controls shall be set and calibrated, and all testing, start-up and cleaning work shall be complete.

C. Demonstration:

1. Upon completion, write a letter to the Architect/Engineer stating that all systems are complete, operational and tested. If the Architect/Engineer arrives at the site for the final demonstration and the systems are not complete, the SEC shall be responsible for compensating the Architect/Engineer for all time and expenses incurred in making the trip.
2. Provide at least two competent employees to perform the system demonstration for the Architect/Engineer. Items that function incorrectly or do not comply with the Contract Documents will be listed for correction.

D. Spare parts, equipment and any special tools required for the proper operation or maintenance of the electronic security systems shall be delivered to the Owner's Representative. Obtain a receipt for any materials transfer.

3.6 TRAINING

A. At least five (5) weeks prior to the estimated date of substantial completion, request a training schedule and a list of all individuals that are to receive operational, maintenance and both operational and maintenance training. Operational training shall be provided for staff and maintenance personnel. Maintenance personnel shall be thoroughly trained to maintain and troubleshoot all of the installed systems. Coordinate the times and locations for the training and the space and equipment requirements.

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B. After all final tests, adjustments and punchlist items have been completed, provide competent employees to instruct facility personnel in the operation and maintenance of the electronic security systems. The trainers shall be thoroughly familiar with the system's equipment, installation and operation. The training shall be inclusive of all Division 28 equipment and systems and shall be coordinated with the training for the detention equipment systems. Where delineated in other Sections of the Specifications, manufacturers I representatives shall conduct the training on specialized electronic systems.

C. Training shall be conducted for a minimum of one (1) eight hour day for operational training and one (1) eight hour day for maintenance training.

D. Structure:

1. Training shall consist of oral, written and hands-on instruction for the operation, trouble shooting, maintenance and repair of all system components. Provide a detailed outline that specifies each major training topic to be covered. The training program on the security electronic equipment shall include the sequences and instructions for the proper use and maintenance of all system equipment and control systems. The material content shall be in simple layman I s terminology and shall describe and demonstrate the step-by-step operations necessary for the proper operation of each system.
2. At a minimum, the training program shall be subdivided into the following topics:

a. Operation.

1) Operational characteristics and features of each system.
2) Specific operation of each control panel and video control terminal, to include all control and monitoring functions included at each control location.
3) Specific instructions on how to manage systems in the case of component failures.

b. Maintenance and repair.

1) Trouble shooting, general maintenance, equipment adjustments, and repair and replacement of all security electronic system components.
2) Interfaces with electrical, mechanical and detention equipment systems, including all locking devices and operators.

E. Electronically digitally record each training session in a format acceptable to NAU. Structure the digital video files for easy reference and prepare an index delineating the location on the tape where each training module begins and ends.

3.7 SUPPORT

A. Provide for a qualified employee to support the facility for 30 days after Substantial Completion to assure that the Users are qualified to take over operation and maintenance procedures.

END OF SECTION 28 05 10

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SECTION 28 05 13

SECURITY ELECTRONIC CONDUCTORS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

A. General: The Conditions of the Contract (General, Supplementary, and other Conditions) and the General Requirements (Sections of Division 1) are hereby made a part of this Section.

1.2 WORK INCLUDED

A. The work under this Section consists of providing, installing, and connecting a complete security electronics cable and wiring system to perform the functions shown on the Drawings and hereinafter specified.

1.3 REFERENCE SPECIFICATIONS, MATERIALS, AND/OR CODES

A. The following specifications and standards, except as hereinafter modified, are incorporated herein by reference and form a part of this specification to the extent indicated by the references thereto. Except where a specific date is given, the issue in effect (including amendments, addenda, revisions, supplements, and errata) on the date of Invitation for Bids shall be applicable. In text such specifications and standards are referred to by basic designation only.

1. National Fire Protection Association (NFPA) Publications

   a. No. 70 National Electric Code (NEC)

2. Underwriters' Laboratories, Inc. (UL) Publications:

   a. No. 44 Rubber-Insulated Wire and Cables
   b. No. 83 Thermoplastic-Insulated Wires
   c. No. 493 Thermoplastic-Insulated Underground Feeder and Branch Circuit Cables.
   d. No. 486 Wire Connectors and Soldering Lugs

1.4 COORDINATION WITH OTHER TRADES

A. The Contractor shall coordinate the work of this Section with that of other Sections as required to ensure that the entire work of this Project will be carried out in an orderly, complete, and coordinated fashion.

1.5 SUBMITTALS

A. General: Submittals shall be made in accordance with the General Provisions (Section 28 05 00) of these specifications.

B. Specific requirements include the following:

1. Equipment and materials product information.
2. Plan drawings (to scale) showing all devices and conduit and conductor routing. Each conduit segment shall be tagged with the conduit size, the number and type of conductors the conduit

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will contain, and the percentage of conduit filled by the conductors. The drawings shall contain a conductor legend that shows the conductor tags used on the drawings, a description of each conductor type, the system application of the conductor, the manufacturer's name and product number, and the diameter and cross-sectional area of each conductor. A typical conductor legend is shown in Table 28 05 13.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Power Conductors:

1. Insulated wire conductors for circuit voltage, 600 volts or less, shall be copper. Conductors shall have U.L. approved 600 volt insulation of the type specified below or elsewhere in the specifications.
2. Conductors No. 8 AWG and smaller shall be solid or stranded type THWN or XHHW, unless otherwise indicated.
3. Conductors No. 6 AWG and larger shall be stranded type THWN or XHHW, unless otherwise indicated.
4. Minimum size of power conductors - No. 14 AWG, unless otherwise indicated.
5. Conductors underground or outside buildings shall be type THWN.
6. Conductors installed in exposed conduit outside of buildings and conduit within or just under roofing material shall be type THWN.
7. All conductor insulation shall be color coded to indicate phase leg, voltage, and use. For power conductors, each phase shall be the same color throughout the entire facility and shall be a different color from the other phases. The following color code shall be used for all branch circuits:

    a. Neutral. . . . . White
    b. Ground. . . . . .Green
    c. Phase A . . . . . Black for 120/208
    d. Phase B . . . . . Red for 120/208
    e. Phase C . . . . . Blue for 120/208

8. Conductor insulation type, wire gauge and U.L. approval shall be printed with permanent white paint on all conductor insulation, continually repeating.

B. Data and Signal Conductors:

1. Cables and conductors furnished for the electronic security systems shall be of the types recommended by the equipment manufacturers to support the intended functions. Conductor transmission properties and wire size shall be selected to satisfy system requirements.
2. Cables routed underground shall be rated for direct burial.
3. Cables routed through grade-level slabs shall be rated for use in wet locations.
4. Conductors for data and audio circuits shall be shielded.
5. All conductor insulation shall be color coded to indicate its function. Color codes shall be consistent throughout the project.
6. Conductor insulation type, wire gauge, and U.L. approval shall be printed with permanent white paint on all conductor insulation, continually repeating.

C. CCTV Video Cable:

1. Coaxial video cables shall have a copper center conductor and a copper shield providing a minimum 93% coverage.
2. Nominal dc resistance shall not exceed 12 ohms/1000 ft. for 59/U-type cables, 8 ohms/WOO ft. for 6/U-type cables, and 4 ohms/1000 ft. for 11/U-type cables.

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3. Nominal impedance shall be 75 ohms.
4. Cable runs shall not exceed 1000 ft. for 59/U-type cables, 1500 ft. for 6/U-type cables, and 3000 ft. for 11/U-type cables.
5. Utilize cable with flexible center conductor for movable cameras.
6. Cable installed in exterior locations shall have a moisture-proof jacket.
7. Manufacturer:

    a. Indoor:

        1) West Penn 815 (RG-59), 811 (RG-11), 806 (RG-6)
        2) Belden 543945 (RG-59), 513945 (RG-ll), 533945 (RG-6)
        3) Or approved equal

    b. Exterior:

        1) West Penn 4815 (RG-59), 4811 (RG-11), 4806 (RG-6)
        2) Or approved equal.

    c. Miniature:

        1) West Penn 825
        2) Belden 8218
        3) Or approved equal.

D. Cable Connectors for Copper Branch Circuit Conductors:

1. For #10 AWG and #12 AWG, connector body shall consist of a cone shaped, expandable coil spring insert, insulated with a nylon shell and 2 wings placed opposite to each other to serve as a "built-in" wrench. Shell shall be molded one-piece as manufactured by Ideal Industries "Wing Nut" connectors or approved equal.
2. For #8 AWG, connectors shall be screw pressure lugs made of high strength structural aluminum alloy and UL approved for use with both copper and/or aluminum wire as manufactured by Ilsco, T&B Burndy, O.Z. Companies, or approved equal.

E. Cable tags shall be pre-marked, self-adhesive, wrap-around cloth type.

F. Special cables required but not defined herein shall be in conformance with the equipment manufacturer's recommendations for the intended application.

PART 3 - EXECUTION

3.1 EXECUTION

A. Deliver all conductors to the site on their original cable reels or in their original unbroken packages.

B. Make all copper conductor branch circuits and fixture joints for #10 AWG and smaller wire with U.L. approved listed for 600 volts, approved for use with copper and/or aluminum wire and for No. 8 AWG and larger use screw pressure lugs.

C. Control and communications cables shall not be spliced except as approved by the Engineer.

D. Tape all connections made with non-insulated type connectors with half-lapped, rubber type tape, to 1-1/2 times the thickness of the conductor insulation, then cover with Scotch No. 33 Tape.

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E. All wiring must conform to the specified sequence of operation and the manufacturer' wiring diagrams, to control the equipment in the manner specified under the appropriate Division 28 section of the specifications. Color code all wiring.

F. Where conductors in conduit pass through exterior walls, a sealing compound of moisture resistive materials shall be applied in the ends of the conduits to seal around the conductors.

G. Permanently label all conductors and cables. Labeling system shall be an industry standard type approved by the manufacturer for the conductor and cable types and locations required. Conductors and cables shall be labeled in each junction box, pull box, wireway or auxiliary gutter, at each device, outlet, panel, switch, or other conductor termination and at the distribution panel or headend equipment termination location.

H. Wiring within all equipment and panel enclosures shall be neatly grouped and laced 0 taped together.

I. Wire lubricating compound shall be suitable for the wire insulation and conduit used with it and shall not harden or become adhesive. Do not use lubricant on isolated type electrical power systems.

J. Install a red warning indicator on the handle of the branch circuit breaker feeding for the power supply circuit for each system to prevent accidental de-energizing of Division 28 systems.

K. General: Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and the like and leave the premises clean, neat, and orderly.

TABLE 28 05 13-1
SAMPLE TYPICAL CONDUCTOR SCHEDULE*

Cable			Manufacturer/ Product Number	Diameter (inches)	Max Area (in2)
Mark	Application	Description			
A	Interior CCTV video	RG-6/U Coax « 1500 ft.	XYZ #0000	0.28	0.06
B	Exterior CCTV video	RG-6/U Coax « 1500 ft. Direct Burial	XYZ #0000	0.33	0.09
C	Door Control	14 AWG THWN Camera Power	XYZ #0000	0.11	0.01
D	DPS Indication	18 AWG, 2 condo	XYZ #0000	0.18	0.025
E	Intercom Station	20 AWG, 2 pair 1-Shielded, 1-Unshielded	XYZ #0000	0.21	0.035
G	PLC/LAN Network	24 AWG, 4 pair Cat 5	XYZ #0000	0.22	0.04
H	Access Reader	18 AWG, 8 cond Shielded	XYZ #0000	0.29	0.07

Modify and complete the table to reflect the correct data for all conductor types required for the electronic security systems.

*Note: This schedule is provided for example only. It is not intended to be complete or to necessarily represent the cable types required for this project. The actual cable types and conductor gauges must be selected based upon the system requirements and the specific requirements of the Specifications.

END OF SECTION 28 05 13

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SECTION 28 05 15

GROUNDING & SURGE PROTECTION

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

A. See the Conditions of the Contract (General, Supplementary, and Special Conditions) and the General Requirements (Division 1).

1.2 WORK INCLUDED

A. Furnish all materials and labor necessary to complete the installation of the grounding and surge protection systems as described herein and as shown on the Drawings, The work of this Section includes, but is not necessarily limited to, the following:

1. Grounding System
2. Surge Protectors

1.3 REFERENCE SPECIFICATIONS, MATERIALS, AND CODES

A. National Fire Protection Association (NFPA) Publications:

1. No. 70 National Electrical Code (NEC)
2. No. 780 Lightning Protection Code

B. EIA/TIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications.

C. Underwriters Laboratories (UL) Standards

1. UL 497, Protectors for Paired Conductor Communications Circuits
2. UL 497 A, Standard for Safety for Secondary Protectors for Communications Circuits
3. UL 497B, Standard for Safety for Protectors for Data Communication and Fire Alarm Circuits
4. UL 497C, Standard for Protectors for Coaxial Communications Circuit
5. UL 1449, Transient Voltage Surge Suppressors

1.4 SUBMITTALS

A. Submittals shall be made in accordance with the General Provisions, Section 28 05 00.

B. Specific requirements include the following:

1. Equipment and materials product information. Surge protector product submittals must address the specific criteria contained in the Specification and must include a circuit diagram of the protection device with the components identified.
2. Single-line drawings of the grounding and surge protection systems. All equipment cabinets, ground bars, grounding conductors and conductor sizes shall be shown.

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1.5 SYSTEM DESCRIPTION

A. Signal Ground System:

1. In each equipment room in which Division 28 systems are installed, a signal ground system shall be provided to affect a ground reference level for all Division 28 systems installed within the space. Equipment racks and equipment shall be bonded to the common signal ground system.
2. The Signal Reference Ground (SRG) system backbone shall be provided by Division 26 as shown on the electrical drawings. Division 26 shall provide a SRG bus bar in each security electronics equipment room or Telecommunication Room as shown on drawings. Division 28 shall connect all signal grounds, signal and data line surge protector grounds, outside cable sheaths equipment cabinet ground busses and equipment enclosure to the SRG bus bar.
3. Each equipment cabinet shall be individually grounded to the SRG. Grounding conductors shall not be looped between cabinets to ground multiple cabinets with a single conductor.
4. Signal ground systems shall be isolated from the power ground system except at the point where the signal ground system connects to the power ground system electrode.

B. Exterior Equipment Grounding System:

1. Division 28 shall ground all exterior CCTV camera poles and security enclosures.
2. Exothermic welding-type connectors shall be used to connect the grounding conductors to the ground rods.

C. Surge Protection:

1. Surge protection devices shall be installed on signal wiring entering a building from the exterior.

PART 2 - PRODUCTS

2.1 GROUND SYSTEM

A. Conductors:

1. All ground wire shall be in accordance with Underwriter Laboratories (UL) and NEC requirements, as shown on the drawings and as specified herein.
2. All grounding conductors shall be continuous from connector to connector with no splices.
3. Interior grounding conductors from equipment to the SRG buss bars shall be a minimum No. 6 AWG insulated stranded copper unless otherwise indicated. Conductor size shall be increased as required to meet NEC requirements.
4. Exterior grounding conductors from poles, exterior cabinets, and exterior equipment to ground rods shall be a minimum No. 2/0 AWG bare, stranded copper conductor unless otherwise specified. Conductor size shall be increased as required to NEC requirements.

B. Connectors:

1. Interior connectors shall be solid bronze, compression type, suitable for intended use.
2. Exterior connectors for connecting grounding conductors to the ground rods shall be exothermic welding-type. Connectors shall be CADWELD as manufactured by Erico Products, Inc., or approved equal.

C. Ground Rods: Sectional, copper-clad 3/4" x 10'-0"

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2.2 SURGE PROTECTION

A. Data, Signal, and Low Voltage Power Circuits:

1. Shall incorporate Silicon Avalanche Diode devices as the primary protection means.
2. Shall have a surge life of at least 10 operations for 1,000 Amp, 8 X 20 microsecond wave.
3. Shall have an initial clamping voltage suitable to the application and shall not exceed 200% of the peak signal voltage rating of the device.
4. Shall have a peak clamping voltage suitable to the application and shall not exceed 300% of the peak signal voltage rating of the device.
5. Select as required for particular data frequency and signal level characteristic of the application.
6. Shall be ULA97B compliant.

B. Video Coaxial Lines:

1. Shall incorporate Silicon Avalanche Diode devices as the primary protection means.
2. Shall have a surge life of at least 10 operations for 1,000 Amp, 8 x 20 microsecond wave.
3. Shall be specifically designed for CCTV coaxial video applications.
4. Shall have an initial clamping voltage suitable to the application and shall not exceed 200 % of the peak signal voltage rating of the device.
5. Shall have a peak clamping voltage suitable to the application and shall not exceed 30V.
6. Select as required for the particular data frequency and signal level characteristics of the application.
7. Shall be UL497C compliant.

PART 3 - EXECUTION

3.1 GROUNDING

A. All equipment shall be grounded in accordance with the NEC, the Specifications and Drawings, and the equipment manufacturers' recommendations.

B. Each equipment cabinet shall be bonded directly to the Signal Reference Ground System.

C. Cable shields shall only be grounded at one end, unless required otherwise by the equipment manufacturer. Ground shields for field devices only at the equipment room end.

3.2 SURGE PROTECTION

A. All metallic data, communications, video, and sensor lines entering or leaving a building shall be protected with surge protection devices.

B. Grounding of protective devices shall be in accordance with the manufacturers' recommendations and as described in the Specifications and Drawings.

C. All signal line protective devices shall be located at the terminal point nearest the cable interface with the exterior cable plant. Devices shall be mounted to the backpanel of the cabinet.

END OF SECTION 28 05 15

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SECTION 28 05 20

CABINETS & ENCLOSURES

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

A. See the Conditions of the Contract (General, Supplementary and Special Conditions) and the General Requirements.

1.2 WORK INCLUDED

A. This section covers all equipment cabinets and enclosures as shown on the drawings or as required to house the specified devices and equipment. The work under this section consists of furnishing materials and equipment, performing labor and services necessary for the installation of the cabinets and enclosures required for the security system.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Refer to all other Division 28 specification sections and drawings, and to the specifications and drawings under the General Construction Contract to ascertain the extent of work included.

1.4 REFERENCED SPECIFICATIONS, MATERIALS AND/OR CODES

A. National Electrical Code

1.5 COOPERATION WITH OTHER TRADES

A. The Contractor shall coordinate the work of the section with that of other sections as required to ensure that the entire work of this Project will be carried out in an orderly, complete and coordinated fashion.

1.6 SUBMITTALS

A. General: Submittals shall be made in accordance with the General Provisions (Section 28 05 00) of these specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cabinets - Wall Mounted

1. All equipment cabinets installed indoors shall be NEMA 1 enclosures.
2. All equipment cabinets installed outside or exposed to weather shall be NEMA 3 enclosures.

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3. Cabinets shall be constructed of 14 gauge rolled steel.
4. Cabinet doors shall be furnished with key lockable doors with all cabinets under Division 28 keyed alike.
5. All cabinets shall be furnished with removable steel back panels for mounting equipment.
6. Cabinets shall be furnished with appropriate size and quantity of knock outs for conduit entry.
7. Cabinets shall be grounded as specified in Section 28 05 20.
8. Cabinets shall be provided with adequate vents.
9. All cabinets shall be furnished with black-on-white laminated plastic name plates identifying each cabinet as noted on the drawings.
10. Cabinet finish shall be ANSI 61 gray inside and out.
11. Cabinets shall be sized in strict accordance with the NEC.
12. Cabinet back panels shall be furnished with a ground buss bar.
13. Door size shall be selected to allow a minimum door swing of 90 degrees within the dimensional constraints of the equipment room.

B. Power Strips:

1. Furnish and install plug-in or hardwired outlet strips as required to support the installed equipment.
2. Power strips shall have a metallic case.
3. Plug-in power strips shall be equipped with a locking plug and shall only be used with a compatible locking-type receptacle.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Cabinets:

1. Provide cabinets as necessary for proper installation of the equipment specified and in compliance with all codes and regulations.
2. Secure all cabinets in place with lead shield anchors and lag bolts.
3. Unused openings in cabinets shall be closed to afford protection equivalent to that of the wall of the cabinet.

B. Ventilation:

1. Furnish and install ventilation fans, vents, and filters for all cabinets where forced air cooling is required to maintain interior cabinet temperature at or below 95°F.
2. For cabinets with forced ventilation, doors and side panels shall be solid with no louvers.
3. Division 28 Subcontractor shall select vented vs. forced air cabinets based on the environment's conditions of the equipment room and equipment to be installed in each cabinet.

3.2 COMPLETION

A. General:

1. Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and the like and leave the premises clean, neat and orderly.
2. All cables shall be dressed neatly in each cabinet and enclosure. Excess cable shall be trimmed and disposed of.

END OF SECTION 28 05 20

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SECTION 28 16 00

SECURITY INTRUSION, ACCESS & SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. During the initial phases of the project construction, Northern Arizona University (NAU) representatives from the User groups and the NAU Lock Shop, shall assess the security needs of the project. Discussion shall include the project specific system, maintenance and service responsibilities of the individual system, and the system's interface with the University's Central Reporting system to the NAU Police Department (where applicable). The entire system is referred to as the Northern University's Physical Access Security System (NAUPASS). This specification references the Security Intrusion, Access & Surveillance System as the Security Management System (SMS).

B. This standard shall apply to perimeter building intrusion, door access, alarms, and video surveillance systems. The electronic door access system shall include at all entries from the exterior, and all interior entries indicated on the drawings as a minimum.

C. Contractor shall furnish and install intrusion, access control, and surveillance related software to allow the system to be expanded in the future. Software shall include required license addition for access control readers and electrified portals, etc.

D. Contractor shall fully coordinate door hardware components as specified by the Architect with the intrusion and access control systems.

1.2 PROGRAMMING

A. Lenel On Guard Pro shall be used to control access at all exterior (zone) doors and at certain interior access control zones, such as specialty areas, meeting rooms, locker rooms, and other zones with specific access concerns.

B. To facilitate the implementation of On Guard Pro, certain programming issues need consideration during design. These include:

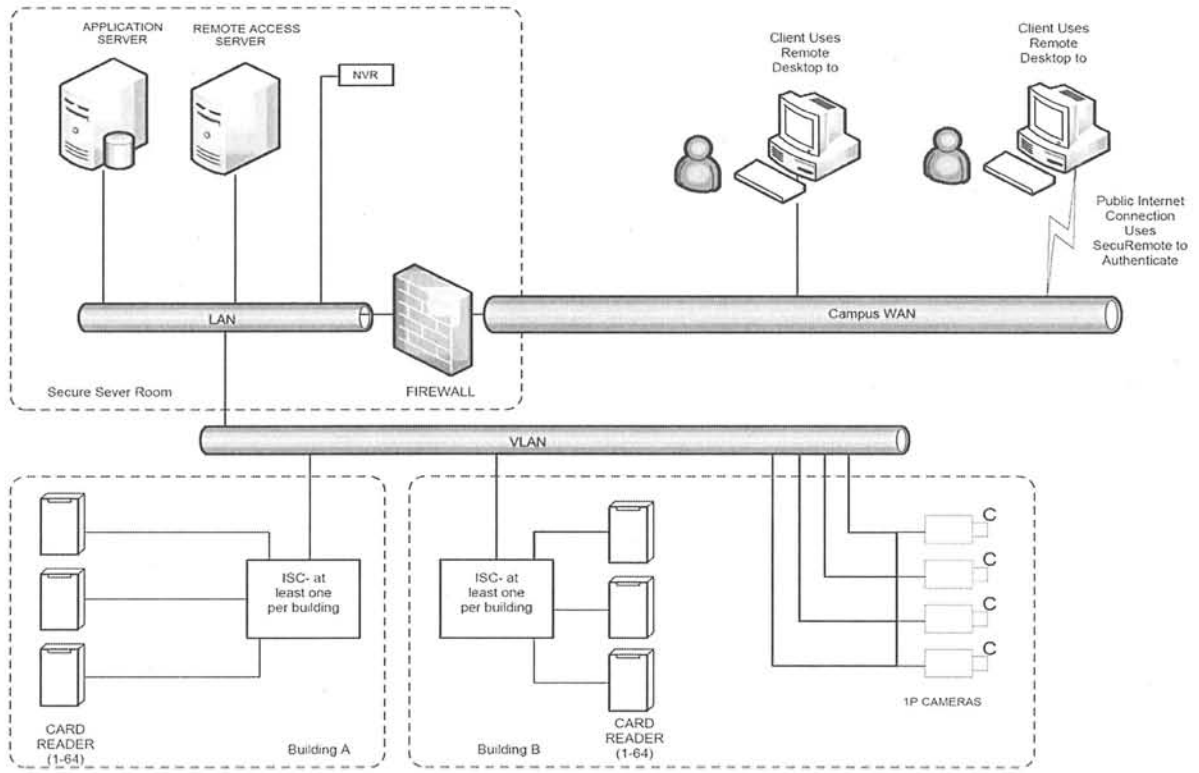
1. Physical separation between public/non-public areas.
2. Physical separation between different departments/operating units in the same building.
3. Access during periods of time on weekends and after hours.
4. Conflicts between access control and life safety, i.e., egress, latching of fire doors.
5. Conflicts between access control and ADA accessibility.
6. Minimum levels of security to be afforded to specialty areas within the building.

C. At a minimum, all exterior zone openings (doors) shall receive rough-in for card access installation based on requirements determined during project design phases.

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1.3 DESIGN STANDARDS

A. Basic Systems Architecture: The following sample diagram shows the major components and how they are connected to each other.



1.4 ARCHITECTURE DIAGRAM NOTES

A. The architecture diagram depicts the way that major components work together at NAU:

1. A secure server room contains the database & applications server remote access server, which runs MS terminal server and the Lenel client software. These servers are on a LAN that is connected to the campus WAN behind a firewall.
2. Administrators, such as Segment Administrators, access the database by using MS Remote Desktop to log in to remote access server. Once in, they log in to the Lenel client software that is running on remote access server. The number of clients that can be simultaneously be logged in to application server is limited by the number of Lenel clients licensed and installed on remote access server. User computers may be connected directly to the campus WAN, or may access the campus WAN remotely through a public connection. User computers must be running SecuRemote.
3. A private application VLAN connects the application hardware (Intelligent System Controllers, NVR's, IP cameras) to the secure server room LAN.
4. There is at least one Intelligent System Controller (ISC) in each building connected to the ISAAC VLAN. Card readers are connected to the ISC's – up to 64 readers per ISC.
5. A Network Video Recorder (NVR) server can also be connected to the application VLAN.

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B. ISAAC Database and Segments:

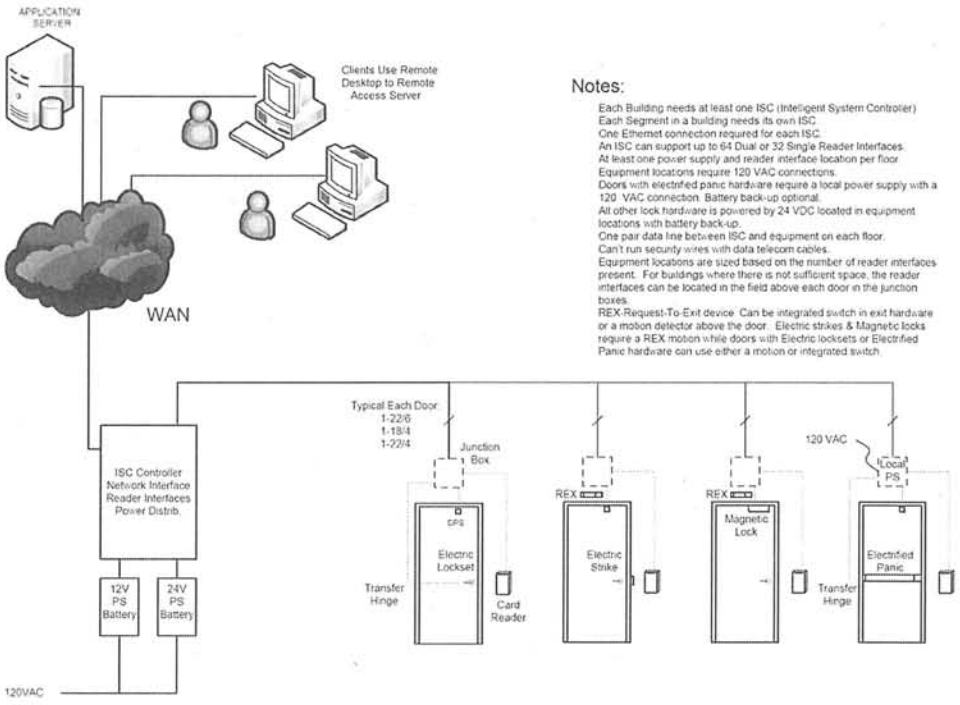
1. Software Standard: LENEL Software shall be On Guard Enterprise.
2. Hardware Standard: HID I Class Smart Card and Smart Card Readers. All interfaces will have to be compatible with the (insert here)
3. Application has a single shared cardholder database that contains information on all current faculty, staff, students, and those NAU affiliates who have an ASURITE userID.
4. Application has a segmented database for information about readers and access controllers, schedules, permissions and relationships.

   Note: Segmentation is the means used to allow a unit or group of units to control the spaces for which they are responsible – a segment is created for an area or set of areas that will be separately managed. There are application segments for some campuses, some colleges, some research group, for Lock Shop-managed areas, and so forth. Each segment name identifies the unit or group that has overall responsibility for its management. Information created and maintained in one segment is not visible from any other segment, although the overall application system administrators can see and deal with information in all segments.

5. Reader interface units cannot be split among segments, so readers that are physically connected (wired) to a particular reader interface unit must be all in the same segment. This might occasionally mean that there is a need to install more reader interface units than would be required in a non-segmented database, or to require a reader from one reader interface unit to another when responsibilities change.

C. Typical Hardware Diagram:

1. The following sample diagram shows the application server and remote client PCs connected to the WAN.



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2. The remote client PC's connect via remote access server. Also connected to the WAN is a box labeled: ISC (intelligent system controller), network interface, reader interfaces, and power distribution.
3. Connected to the ISC box are:

    a. A 12 V and 24V Power Supply (PS) battery. These are connected to 120V AC.
    b. Doors with electric lock, electric strike, magnetic lock or electrified panic bar. Each door has a junction box or local power supply over it and each junction box or local power supply is connected to the ISC controller complex. Each junction box is also wired to a card reader next to the door. Typical wiring for each door is: 1 – 22/6 (one 22 gauge/6 conductor), 1- 18/4, 1-22/4.
    c. The doors with the electric lock and the electrified panic bar show wiring through the door, through the transfer hinge, to the junction box or, in the case of the door with the electrified panic bar, to the local power supply. The door with the electric lock also shows a door position sensor (DPS) at the top that is wired to the junction box.
    d. The doors with the electric strike and the magnetic lock have request to exit (REX) over the door.
    e. Each building needs at least one ISC (Intelligent System Controller).
    f. Each Segment in a building needs its own ISC.
    g. One Ethernet connection is required for each ISC.
    h. An ISC can support up to 64 dual or 32 single reader interfaces.
    i. At least one power supply and reader interface location is required per floor.
    j. Equipment locations require 120 VAC connections.
    k. Door with electrified panic hardware require a local power supply with a 120 VAC connection. Battery backup is optional.
    l. All other lock hardware is powered by a 24 VDC located in the equipment locations with battery backup.
    m. There is one pair data line between the ISC and the equipment on each floor.

4. Surveillance Systems – Network Video Recorders (NVR, Video Surveillance Systems etc.)

    a. A private application VLAN connects the application hardware (Intelligent System Controllers, NVR's, IP cameras) to the secure server room LAN.
    b. There is at least one Intelligent System Controller (ISC) in each building connected to the VLAN. Card readers are connected to the ISC's – up to 64 readers per ISC.
    c. A Network Video Recorder (NVR) server can also be connected to the VLAN.

5. Alarms and Alarm Monitoring:

    a. It is the responsibility of NAU to ensure the NAU Security Group representative reviews the security design.
    b. Discussion shall include the project specific system, maintenance and service responsibilities of the individual system, and the system's interface with the University's Central Reporting system to DPS NAU Police (where applicable). It should be noted that Call Center Services are becoming more common to "triage" for DPS NAU Police.

6. Door Hardware: Install Indoor Electric Strike VDC (voltage is most important) in the door frame in place of a normal strike. This usually requires cutting the frame to make it fit. A power source above the door is not necessary except for electrified crash bars – but avoid electrified crash bars if at all possible.
7. Conduit and Electrical Specifications: Install ¾" conduit to an electrical duplex box in the wall next to the strike at ADA height, within a foot or so. Include a pull string. The duplex box should be roughly level with the strike. Conduit should extend to above the ceiling to a point where we can get at it to run wire into it. Drill a hole from behind the strike to the electric box to run the strike wires.

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8. Accessible Door Requirements: If the door has a handicap opener on it with a motor unit mounted above the door, be sure there is a ¾ inch conduit path from above the ceiling to the motor unit.
9. Communications Closet:

    a. There shall be at least one dedicated closet for the location of access control related equipment. In multi-story buildings where access control equipment is located above grade, there shall be a closet on each floor where controlled doors are located.
    b. Identify and reserve an area of about 7 feet wide, floor to ceiling in a communications closet (TR/IDF room) on each floor. Normally, doing this will require coordination with Information Technology. Mount ¾ inch plywood as backing board, if it is not already there. Allow a 3-foot clearance in front of the identified area for door swing.
    c. Install a 4-plex power on its own circuit into each IDF of each floor in the identified area, running the conduit down the right or left side boundary edge of the area. In other words, don't run the power down the middle of the area where we have to mount the equipment.
    d. If magnetic locks are used such that there are no crash bars, include a relay contact in the applicable data closet that closes when the fire alarm goes off so the mag-lock doors can be unlocked. The relay should provide both open and closed contacts.
    e. Select one floor, usually centrally located, to mount the primary intelligent controller(s) (64 doors each) and run one standard NAU Ethernet network connection to this location. IT Data Communications will configure this port to operate on the security VLAN: all communication between access control system controllers and the host will be on a VLAN.

10. Wiring Requirements: Run two of each of the wiring types Belden 88760 and 9536 from the floor TR/IDF to each door. This allows for extra needs such as door contacts or input sensors.
11. Cabling Installation:

    a. All cabling shall be plenum and UL listed.
    b. All wall and floor penetrations shall be sleeved and fire stopped.
    c. All cabling shall be self-supported with J-Hooks either from the wall or with self-supported hanger wire.
    d. All vertical and horizontal pathways shall be 12 inches away from any voice/data cabling.
    e. If the system controller is installed within a telecommunication room the space will be pre-approved with NAU Information Technology.
    f. The system controller location(s) will be denoted on the floor plan and will be mounted in a locked cabinet.
    g. The NAU Ethernet connection or connections required for the individual security system will be denoted on the floor plans.

12. Electrified Locks:

    a. The A/E shall review all technical requirements of the proposed system with NAU and NAU Lock Shop prior to design development.
    b. D-Series locks are available for electrically locking and unlocking controls for high security and fire safety applications. They are UL Listed and rated for both fire and electrical single point locking on labeled doors. Refer to the lock function pages for functions and design availability.
    c. Electrical Requirements: 24V AC, .35 amps or 24V DC, .15 amps.
    d. Operating Temperature: Maximum +151 1/2 deg F, Minimum -31 1/2 deg F.

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13. Latches & Strikes:

    a. Adjustable brass or bronze latch faceplates and strikes, furnished in compatible lock trim finishes.
    b. Latch Bolt: Steel, ½" (12 mm) throw, deadlocking on keyed and exterior functions. ¾" (19 mm) throw anti-friction latch available for pairs of fire doors.
    c. Strikes: ANSI curved lip strike 1 ¼" x 4 7/8" (32 mm x 124 mm), 1 3/16" (30 mm) to center standard. Optional strikes, lip lengths and ANSI strike box available.

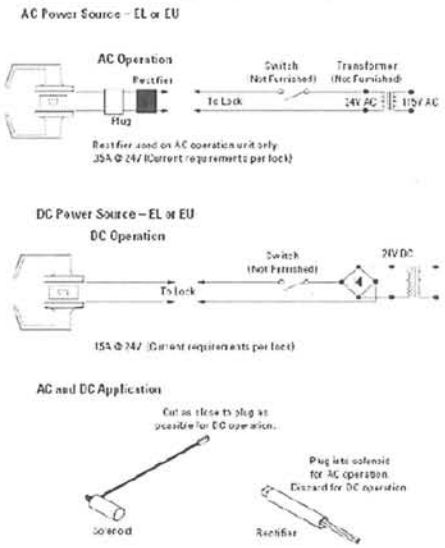
14. Standard Features for Lock housing:

    a. Cylindrical lock housing. Cold rolled steel, corrosion treated for normal atmospheric conditions.
    b. Key removable outside knobs for easy cylinder replacement.
    c. Solid brass 6-pin cylinders.
    d. No exposed mounting screws.
    e. Exceeds 800,000 cycle ANSI Grade 1 requirements by nearly 4 times (3,000,000 cycles).

15. Diagrams:

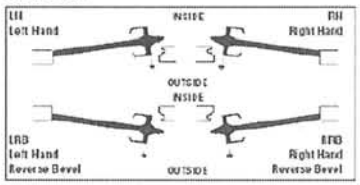
    a. Typical Lock Installation of Door – Need Updated THIS IS ONLY AN EXAMPLE.

Typical Wiring Diagram for Electrified Locks



Door Handing

All Schlage® locks are reversible. Hand information is necessary to ensure proper finish of latchbolt and strike for split-finish locks. Follow the diagram to determine the hand of the door. The outside is the secure side or the corridor side.



Accessories

1-3/8" D-Series Lever Door Spacer



16. Intrusion System Programming:

    a. Alarm Control Center (ACC): The system shall be fully programmable from the LCD keypads and shall also allow event buffer viewing at the keypads.
    b. Remote Programming Software (RPS): Provide separate PC-based upload/download software which shall allow programming and operation from a

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directly connected local computer, or from a remote computer via a telephone line or TCP/IP LAN/WAN communications. Remote access shall be controlled by the Owner to prevent unauthorized access.

c. All system programming shall be maintained in nonvolatile memory so that programming information is retained even if all AC and battery power is removed.

17. Intrusion System shall bear the following listings as necessary to meet the requirements of governing authorities:

a. UL1610 Central Station Burglar Alarm Units.
b. UL609 Local Burglar Alarm Units.
c. UL365 Police Station Burglar Alarm Units.
d. UL1635 Digital Alarm Communicator System Units.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. SMS Software: The Security Management System (SMS) software shall be manufactured by Lenel Systems International OnGuard Total Security Knowledge Management System Series Enterprise.

B. SMS Field Hardware as needed:

1. Intelligent System Controllers – (ISC) LNL-500/1000/2000
2. Single Reader Interface Modules – (SRM) LNL-1300)
3. Dual Reader Interface Module – (DRM) LNL-1320
4. Input Modules – (ICM) LNL-1100
5. Intelligent Dual Reader Controller (IDR) LNL-2220
6. Output Modules – (OCM) LNL-1200
7. Communication Multiplexers – LNL-8000
8. Ancillary devices as required
9. Wireless Gateway Interface – LNL-500W
10. Recognition Source Wireless Modules
11. Bosch 9412 and 7412 series Intrusion Alarm Panels
12. Detection Systems 7400xi and 7400xi 4+ series Intrusion Alarm Panels
13. Honeywell (Galaxy) 8, 18, 60, 128, 500, 504 and 512 Intrusion Alarm Panels

C. SMS Authentication Hardware: HID Proximity Readers.

D. SMS Credential Printers: The SMS credential management module shall be compatible with printers and printer/encoders from Eltron, Magicard and Nisca that support Windows XP drivers.

E. SMS Third Party Integrated Devices: The SMS shall seamlessly interface with select devices from the following manufacturers:

1. Notifier NFS-640 and AM2020
2. Cisco Alarm Internet Controller

2.2 MANUFACTURED UNITS

A. Security Management System Server: The SMS Server is existing on campus.

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B. Network Video Recorder (NVR) Hardware Platform:

1. The Network Video Recorder, a device for recording IP based video from IP output cameras or analog cameras that have been converted to IP output, shall consist of a PC Compatible Chassis and other specified components, as shown in the following sub sections that together create the Network Video Recorder.
2. NVR Chassis Configuration: NVR Chassis which shall support a maximum of four video capture boards, one hard drive for OS and Software and up to eight (8) Serial ATA hard drives using Multi-Drive hard disk controller for video storage. RAID 5 hard disk controller configuration shall be available as an additional cost option.
3. The end-user shall have the option of providing their own NVR chassis under the condition that it meet or exceeds the specifications as follows:

    a. Intel Motherboard
    b. Dual Core 2.8 Ghz Processor Or Greater
    c. 4 GB Of RAM or Greater
    d. 16MB on board cache
    e. 800 Mhz Front Side Bus
    f. Microsoft Windows XP Professional or Microsoft Windows 7 SP1 Pro
    g. Server 2008 R2/SP2 operating System on a dedicated OS Drive
    h. 10/100/1000 Ethernet
    i. Storage on SATA, SCSI or Fibre (internal or external) Minimum 500GB hard drive capacity
    j. Net Meeting
    k. CD-ROM Drive
    l. Mouse, keyboard and monitor (for initial setup)
    m. 1, 2 or 3 RU rack mountable.
    n. Lenel Video Suite 7.0.825 or better

C. Power over Ethernet PoE Cameras:

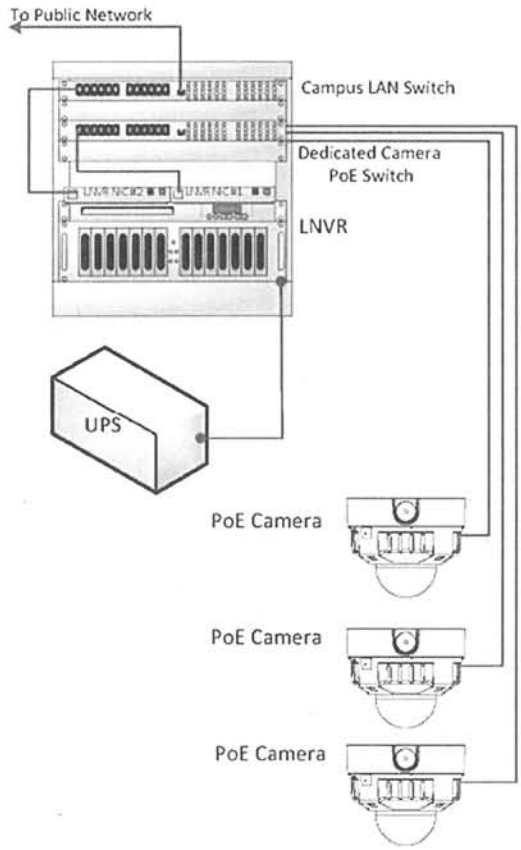
1. The PoE cameras shall be wired to the dedicated camera PoE switch mounted above the NVR within the rack.
2. Cameras shall be digital and transmit data utilizing Internet Protocol (IP).
3. Resolution shall be a minimum of 720 X 1280.
4. Be powered via Power over Ethernet (PoE) capable.
5. Support motion detection.
6. Cameras shall be Open Network Video Interface Forum (ONVIF) compliant.
7. Acceptable indoor camera manufacturers:

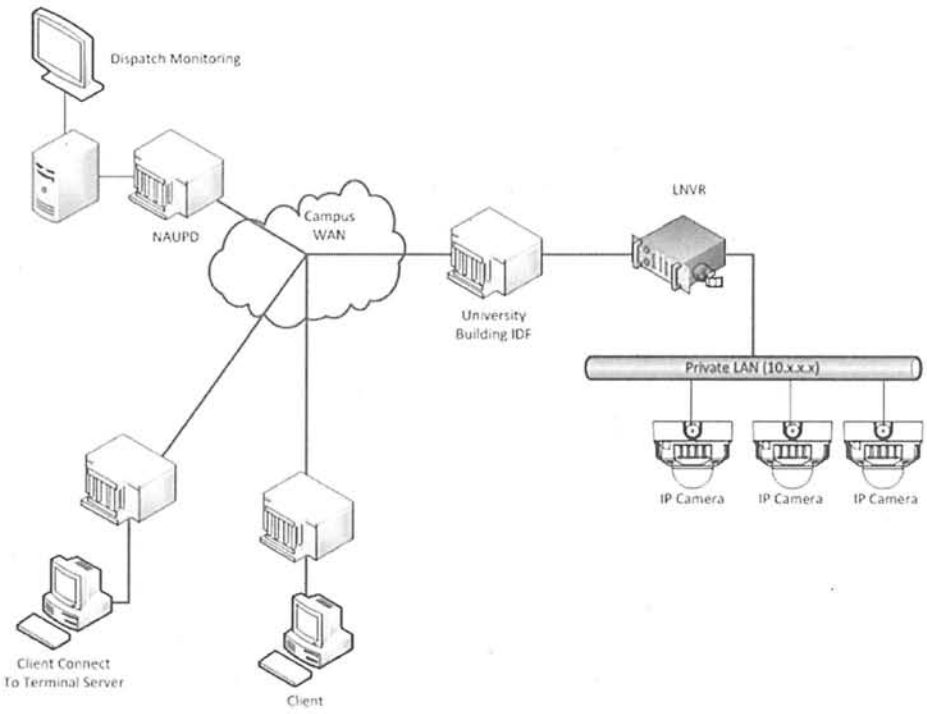
    a. Axis Q7406
    b. Panasonic WV-NF302
    c. Panasonic WV-SP306
    d. Sony SNC-DH140
    e. Sony SNC-DH180
    f. Approved substitutions as listed by NAU

8. Acceptable outdoor camera manufacturers:

    a. Axis Q1755
    b. Sony SNC-DM160
    c. Approved substitutions as listed by NAU

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D. Intelligent System Controller (ISC):

1. The Intelligent System Controller (ISC) shall link the SMS Software to all "down-stream" field hardware components (RIMs, ICMs and IOMs). The ISC shall provide full distributed processing of access control / Alarm Monitoring rules and operations. A fully loaded and configured ISC with shall respond in less than one-half (0.5) second to grant or deny access to cardholder.
2. The ISC shall continue to function normally (stand-alone) in the event that it loses communication with the SMS software. While in this off-line state, the ISC shall make access granted/denied decisions and maintain a log of the events that have occurred. Events shall be stored in local memory, and then uploaded automatically to the SMS database after communication has been restored.
3. In addition, the ISC shall incorporate the following features:

    a. UL 294, ULC, and CE Certified
    b. Support for Host Communications Speed of 115,200 bps
    c. Support for Direct Connect, Remote Dial Up, or Local Area Network (LAN) Connection
    d. Support for Dual Path Host Communications - Secondary Path shall be either Direct Connect, Local Area Network (LAN) Connection, or Remote Dial Up Connection.
    e. Support for up to 8 MB of On-Board Memory
    f. LAN Support shall utilize RJ45 (10/100baseT) Ethernet Interface or Token Ring 4 MB connectivity
    g. Flash Memory for real time program updates and overall host communications
    h. Support for four 2 wire downstream ports, two 4 wire downstream ports, or combination one 4 wire downstream port and two 2 wire downstream ports. Downstream ports shall be for connecting card readers and data gathering and output control panels via RS-485 multi-drop wiring configuration
    i. Memory storage of up to LNL-2000: 350,000 with 8 MB memory expansion cardholders.
    j. Initial base memory download between ISC with standard memory from the SMS shall require no more than ten (10) seconds
    k. Support for up to 32 devices consisting of RIMs, ICMs, and OCMs in any combination desired with a maximum of 16 I/OCM devices
    l. Support of multiple card technologies
    m. Supervised Communications between ISC and SMS Software
    n. AES 128 bit Symmetrical Block Encryption conforming to the FIPS-197 standard between ISC and SMS Software communications driver.
    o. Multi – drop support for up to eight ISCs per SMS communications port
    p. Support of up to eight card formats and facility codes
    q. Support for SEIWG card formats
    r. RS-485 Full Duplex, UL 1076 Grade AA communication channel to the SMS head-end
    s. Integration to other manufacturer's card readers
    t. Uninterruptible Power Supply (UPS) with battery backup with 30 minute back-up time
    u. 32-bit Microprocessor
    v. Biometric Interface Support
    w. An ISC downstream serial port shall multi-drop 16 access control field hardware devices using an RS-485 UL 1076 Grade A communication format allowing a distance of 4,000 feet using Belden 9842 cable or equivalent
    x. 12 VAC or 12 VDC input power
    y. Issue Code Support for both Magnetic and Wiegand Card Formats
    z. Individual Shunt Times (ADA Requirement)
    aa. Up to Nine Digit PIN Codes
    bb. Downstream serial RS-232 device support
    cc. Status LEDs for normal component and communication status
    dd. RoHS Compliance

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ee. Support for RS-485 over CAT 5, 6e cable

E. Input Control Module (ICM):

1. The Input Control Module shall provide 16 UL 1076 Grade B, A or AA alarm input zones and monitor / report line fault conditions, alarm conditions, power faults and tampers. Status LEDs shall provide information about the sixteen alarm zone inputs, cabinet tamper, and power fault.
2. In addition, the ICM shall incorporate the following features:

a. UL 294, ULC, and CE Certified
b. Alarm contact status scanning at up to 180 times per second for each zone
c. Eight configuration DIP switches to assign unit addresses and communications speed
d. Elevator control support for 128 floors
e. Variable resistor values for line supervision
f. A low power CMOS microprocessor
g. Filtered data for noise rejection to prevent false alarms
h. Up to 16 Grade B, A, or AA Supervised Inputs in any Combination
i. 12 or 24 VDC Input Power
j. 2 Form C 5A, 30 VDC Contacts for load switching
k. 2 dedicated inputs for tamper and power status
l. RoHS Compliance
m. Support for RS-485 over CAT 5, 6e cable

F. Output Control Module (OCM):

1. The Output Control Modules shall provide 16 Form-C 5A 30 VDC relay contacts for load switching. The relays shall be configurable for fail-safe or fail-secure operation. Each relay shall support "On" "Off" and "Pulse"

a. 12 or 24 VDC input power
b. Two dedicated digital inputs for tamper and power failure status
c. RS-485 communications, multi-dropped (2-wire or 4-wire RS-485)
d. Up to 16 OCMs per Intelligent System Controller
e. Onboard termination jumpers
f. DIP switch selectable addressing
g. Status LEDs for communication to the host, heartbeat and relay status
h. Elevator control, support for 64 floors
i. RoHS Compliance
j. Support for RS-485 over CAT 5, 6e cable

G. Single Reader Interface Module (SRI):

1. The SRI shall provide an interface between the ISC and authentication devices. The SRI must operate with any authentication device that produces a standard Wiegand, Data 1 / Data 0) or Clock and Data communication output.
2. In addition the SRI shall incorporate the following features:

a. 12 or 24 VDC power supply
b. Reader communications (Clock/Data or Wiegand Data1/Data0) - more than 150 different readers approved for use
c. Two Form-C relay outputs (5 A Door Strike and 1 A Aux relays)
d. Up to 16 different card formats (8 card and 8 asset)
e. Issue code support for Magnetic and Wiegand formats
f. Door contact Open or Closed, Supervised or Non-supervised
g. REX push-button monitor - Supervised or Non-supervised

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h. Strike Control output
i. Dedicated tamper and power failure circuits
j. Bicolor or two wire status LED support
k. Beeper control
l. Support for offline reader access mode
m. Elevator control, support for 64 floors
n. UL 294 listed and CE approved
o. RoHS Compliance
p. Support for RS-485 over CAT 5, 6e cable

H. Dual Reader Interface Module (DRI):

1. The DRI shall provide a dual interface between the ISC and authentication devices. The DRI must operate with any authentication device that produces a standard Wiegand (Data 1 / Data 0 or Clock and Data) communication output.
2. In addition the DRI shall incorporate the following features:

a. 12 or 24 VDC power supply
b. Reader communications (Clock/Data or Wiegand Data1/Data0) - more than 150 different readers approved for use
c. Six Form-C 5 A at 30 VDC relay outputs
d. Up to 16 different formats (8 card and 8 asset)
e. Issue code support for Magnetic and Wiegand formats
f. Door contact supervision (Open/Closed)
g. REX push-button monitor
h. Strike Control output
i. Bi-color status LED support and 2-wire LED support
j. Beeper control
k. Dedicated tamper and power failure circuits
l. Support for offline reader access mode
m. Onboard jumpers for termination
n. Onboard jumpers for 5 VDC or 12 VDC reader support
o. Elevator control, native support for 6 floors
p. DIP switch selectable addressing
q. UL 294 listed and CE approved
r. RoHS Compliance
s. Support for RS-485 over CAT 5, 6e cable

I. Intrusion Detection System:

1. Control System:

a. All Equipment must be UL Commercial listed for Burglary.
b. System must be able to support all zones, relays, keypads and other input devices that may be required. Provide 20% spare capacity for all zones, operational hardware as well as software.
c. Bosch is the Owners' acceptable manufacturer for this project.
d. The intrusion detection system shall have the ability to integrate with the access control system.
e. Provide concealed duress pushbutton stations as indicated. Activation of the duress pushbutton shall activate the auto dialer contact to the off-site monitoring system.

2. Keypads: Keypads shall be alpha numeric with LCD screen and be white in color. Provide volume control for input feedback and alarm tones.

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3. Sensors: All Sensors, including motion detectors, door contracts, etc. shall be white in color. Exceptions to the standard color white shall be where the Architect determines the door jamb surface color shall be matched for door contacts.

J. Emergency Standby Power:

1. Control Panel and other 120VAC Equipment: Provide a UPS battery with sufficient time for power transfer from the failed normal power source. Provide battery capacity to allow the system to run for a minimum of 24 Hours.
2. Low-Voltage Equipment: EACS Remote Controllers, peripheral devices and Lock Power Supplies shall also have their own 4-hour battery back-up systems.

   a. Power back-up may be in the form of direct DC battery power back-up or by 120VAC Uninterruptable Power Supplies (UPS), depending upon equipment requirements.
   b. Lock Power Supplies shall allow fail-secure locks to be operated by the system a minimum of 100 times-per-hour, during this time period. Fail-safe locks shall be maintained for the full 4-hours.
   c. Battery back-up systems may be distributed throughout the facility to provide the required emergency power to individual components.
   d. Battery back-up systems shall include battery chargers to keep storage batteries at their peak charge.

PART 3 - EXECUTION

3.1 GENERAL

A. Equipment shall be installed at locations as shown on the drawings. Remote processors, input monitors, and control output devices shall be installed in the SCC's to be furnished and installed under this Division of work.

B. Programming of the system shall be performed by the Contractor. Control and/or reporting functions shall be coordinated with the hardware requirements and with the Owner selected options.

C. All network components which integrate/interface with NAUPASS and are assigned IP addresses on the NAU network according to the IP Subnet Table: Public IP Subnet 134.114.x.x, Private IP Subnet 10.x.x.x, and Secure Wireless Subnet 10.18.x.x will also be required to a have network Hostname assigned that follows the following naming conventions: LNL-{Building Number}-{Device Type}.ss.nau.edu, (LNL-30-DVR1.ss.nau.edu. Reference the appropriate building number per NAU assignment.

D. Installer shall be a Lenel Certified Technician. Apply for and secure Affiliate Status with the University. Visit http:/www4.nau.edu/louie/affiliation.html for additional information.

3.2 COMPLETION

A. General: Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and the like and leave the premises clean, neat and orderly.

B. Testing: The entire system shall be tested by the Contractor prior to acceptance tests by the Owner or the Owner's representative.

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C. Commissioning and Validation

1. Provide commissioning and validation services to prove and improve the effectiveness of the system, in accordance with manufacturers' standards.
2. Coordinate with the Owner, or the Owner's representative, for the provision of these services.

D. Training: The Contractor shall provide complete operational training for the Owner's personnel as a part of this contract.

END OF SECTION 28 16 00

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SECTION 28 31 00

FIRE DETECTION & ALARM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section of the specification includes the furnishing, installation, and connection of an intelligent reporting, microprocessor controlled, addressable, fire detection system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, annunciators, power supplies, voice evacuation, and wiring as shown on the drawings and specified herein.

B. The fire alarm system shall comply with requirements of NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

C. The system shall be an active/interrogative type system where each addressable device is repetitively scanned, causing a signal to be transmitted to the main fire alarm control panel (FACP) indicating that the device and its associated circuit wiring is functional. Loss of this signal at the main FACP shall result in a trouble indication as specified hereinafter for the particular input.

D. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Command Center (FCC) and designated personnel in other buildings at the site via a multiplex communication network.

E. The fire alarm system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.

F. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.

G. The installing company shall employ a NICET Level IV (Fire Alarm Technology) technician on site to guide the final check-out and to ensure the systems integrity.

H. The installing company shall employ NICET Level IV (Fire Alarm Technology) Designer for system compliance.

I. The installing company shall a factory certified authorized distributor of Notifier equipment.

J. The installing company shall have a full time Quality Assurance Manager (QAM) with a Quality Assurance Program (QAP) reviewed and approved by Northern Arizona University.

1.2 SCOPE

A. A new intelligent reporting, microprocessor controlled fire detection system shall be installed in accordance with the specifications and drawings.

B. The system shall be designed such that each signaling line circuit (SLC) is limited to only 70% of its total capacity at initial installation.

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C. Basic Performance:

1. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Style 4 (Class B) Signaling Line Circuits (SLC).
2. Initiation Device Circuits (IDC) shall be wired Class B (NFPA Style A) as part of an addressable device connected by the SLC Circuit.
3. Notification Appliance Circuits (NAC) shall be wired Class B (NFPA Style Y) as part of an addressable device connected by the SLC Circuit.
4. On Style 6 or 7 (Class A) configurations a single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
5. Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.

D. Basic System Functional Operation:

1. When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:

    a. The System Alarm LED shall flash.
    b. A local piezo electric signal in the control panel shall sound.
    c. The 640-character LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
    d. Printing and history storage equipment shall log the information associated each new fire alarm control panel condition, along with time and date of occurrence.
    e. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

1.3 SUBMITTALS

A. General:

1. Two copies of all submittals shall be submitted to the Architect/Engineer for review.
2. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. Equivalent compatible UL-listed equipment from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.
3. All substitute equipment proposed as equal to the equipment specified herein, shall meet or exceed the following standards. For equipment other than that specified, the Contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.

B. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
3. Show annunciator layout, configurations, and terminations.

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C. Manuals:

1. Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets.
2. Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.
3. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.
4. Approvals will be based on complete submissions of manuals together with shop drawings.

D. Software Modifications:

1. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
2. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.

E. Certifications: Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

1.4 GUARANTY

A. All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least two (2) years from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this period shall be included in the submittal bid.

1.5 POST CONTRACT MAINTENANCE

A. Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of five (5) years after expiration of the guaranty.

B. As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, tests, and repairs described below. Include also a quote for unscheduled maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.

C. Maintenance and testing shall be on a semiannual basis or as required by the AHJ. A preventive maintenance schedule shall be provided by the Contractor describing the protocol for preventive maintenance. The schedule shall include:

1. Systematic examination, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, waterflow switches and all accessories of the fire alarm system.

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2. Each circuit in the fire alarm system shall be tested semiannually.
3. Each smoke detector shall be tested in accordance with the requirements of NFPA 72 Chapter 7.

1.6 POST CONTRACT EXPANSIONS

A. The Contractor shall have the ability to provide parts and labor to expand the system specified, if so requested, for a period of five (5) years from the date of acceptance.

B. As part of the submittal, include a quotation for all parts and material, and all installation and test labor as needed to increase the number of intelligent or addressable devices by ten percent (10%). This quotation shall include intelligent smoke detectors, intelligent heat detectors, addressable manual stations, addressable monitor modules and addressable modules equal in number to one tenth of the number required to meet this specification (list actual quantity of each type).

C. The quotation shall include installation, test labor, and labor to reprogram the system for this 10% expansion. If additional FACP hardware is required, include the material and labor necessary to install this hardware.

D. Do not include cost of conduit or wire or the cost to install conduit or wire.

E. Submittals that do not include this estimate of post contract expansion cost will not be accepted.

1.7 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only.

1. National Fire Protection Association (NFPA) - USA:

No. 13	Sprinkler Systems
No. 70	National Electric Code (NEC)
No. 72-1996	National Fire Alarm Code
No. 90A	Air Conditioning Systems
No. 92A	Smoke Control Systems
No. 101	Life Safety Code

2. Underwriters Laboratories Inc. (UL) - USA:

No. 50	Cabinets and Boxes
No. 268	Smoke Detectors for Fire Protective Signaling Systems
No. 864	Control Units for Fire Protective Signaling Systems
No. 268A	Smoke Detectors for Duct Applications
No. 521	Heat Detectors for Fire Protective
No. 228	Door Closers-Holders for Fire Protective Signaling Systems
No. 464	Audible Signaling Appliances
No. 38	Manually Actuated Signaling Boxes
No. 346	Waterflow Indicators for Fire Protective Signaling Systems
No. 1481	Power supplies for Fire Protective Signaling Systems
No. 1076	Control Units for Burglar Alarm Proprietary Protective Signaling Systems
No. 1971	Visual Notification Appliances

3. Local and State Building Codes.
4. All requirements of the Authority Having Jurisdiction (AHJ).

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1.8 APPROVALS

A. The system shall have proper listing and/or approval from the following nationally recognized agencies:

1. UL Underwriters Laboratories Inc.
2. ULC Underwriters Laboratories Canada
3. FM Factory Mutual
4. FM6320 Approved for Gas Detection

B. The Fire Alarm Control Panel and all transponders shall meet the modular listing requirements of the ninth edition UL Standard 864 (Control Units). Each subassembly, including all printed circuits, shall include the appropriate UL modular label. This includes all printed circuit board assemblies, power supplies, and enclosure parts. Systems that do not include modular labels may require return to the factory for system upgrades, and are not acceptable.

C. The system shall be listed by the national agencies as suitable for extinguishing release applications. The system shall support release of high and low pressure CO2.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL, GENERAL

A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system.

B. All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data.

C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

2.2 CONDUIT AND WIRE

A. Conduit:

1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
2. Where possible, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
3. Cable must be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per NEC Article 760.
4. Wiring for 24 volt control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

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5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or back boxes, except where conduit entry is specified by the FACP manufacturer.
6. Conduit shall be 3/4 inch (19.1 mm) minimum and all raceway components shall be painted red.

B. Wire:

1. All fire alarm system wiring must be new.
2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for initiating device circuits, signaling line circuits, and notification appliance circuits.
3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
4. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).
5. The system shall permit the use of IDC and NAC wiring in the same conduit with the multiplex communication loop.
6. All field wiring shall be completely supervised. In the event of a primary power failure, disconnected standby battery, removal of any internal modules, or any open circuits in the field wiring; a trouble signal will be activated until the system and its associated field wiring are restored to normal condition.
7. All analog voice speaker and analog telephone circuits shall use twisted/shielded pair to eliminate cross talk.

C. Terminal Boxes, Junction Boxes and Cabinets: All boxes and cabinets shall be UL listed for their intended purpose.

D. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.

E. The fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded securely to either a cold water pipe or grounding rod.

2.3 MAIN FIRE ALARM CONTROL PANEL OR NETWORK NODE

A. The main FACP Central Console shall be a NOTIFIER Model NFS2-3030 and shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, control circuits, and notification appliance circuits, local and remote operator terminals, printers, annunciators, and other system controlled devices.

B. X The control panel shall incorporate the integrated Digital Voice Command option utilizing a female voice. The microphone for the one-way communications and telephone handset for the two-way voice communications, including all required zone select and manual override control switches and the following LED indicators:

1. 3-Position Switch – Provide 3-position switch for each evacuation signaling zone, with "Voice," "Auto" and "Evacuate" positions identified and two LED status indicators for each audio visual evacuation signaling 'zone", one red and one yellow. These LED's shall illuminate to indicate respectively: 1) Evacuation signals activated (red), 2) Trouble in audio (speaker) or visual (strobe) circuit(s) (yellow).

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2. All Call Switch 2-Position – Provide 2-position switch for "All-Call" to activate all the evacuation signaling zones, with "Voice" and "Auto" positions identified and two LED status indicators for each audio visual evacuation signaling "zone", one red and one yellow. These LED's shall illuminate to indicate respectively: 1) Evacuation signals activated (red), 2) Trouble in audio (speaker) or visual (strobe) circuits(s) (yellow).

C. In conjunction with intelligent Loop Control Modules and Loop Expander Modules, the main FACP shall perform the following functions:

1. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
2. Supervise all initiating signaling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.
3. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all SLC loop modules shall fallback to degrade mode. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection devices as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.
4. Visually and audibly annunciate any trouble, supervisory, security or alarm condition on operator's terminals, panel display, and annunciators.
5. When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

    a. The system alarm LED shall flash.
    b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.
    c. The 640-character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
    d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
    e. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

6. When a trouble condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

    a. The system trouble LED shall flash.
    b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.
    c. The 640-character backlit LCD display shall indicate all information associated with the trouble condition, including the type of trouble point and its location within the protected premises.
    d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
    e. All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (trouble notification appliances and/or relays) shall be activated.

7. When a supervisory condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

    a. The system trouble LED shall flash.

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b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.
c. The 640-character backlit LCD display shall indicate all information associated with the supervisory condition, including the type of trouble point and its location within the protected premises.
d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
e. All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

8. When a security alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

a. The system security LED shall flash.
b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.
c. The 640-character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
e. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

9. When a pre-alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

a. The system pre-alarm LED shall flash.
b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.
c. The 640-character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
e. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

D. Operator Control:

1. Acknowledge Switch:

a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition. In addition, the FACP shall support Block Acknowledge to allow multiple trouble conditions to be acknowledged with a single depression of this switch.
b. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.

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2. Signal Silence Switch: Depression of the Signal Silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition. The selection of notification circuits and relays that are silenceable by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.
3. Drill Switch: Depression of the Drill switch shall activate all programmed notification appliance circuits. The drill function shall latch until the panel is silenced or reset.
4. System Reset Switch: Depression of the System Reset switch shall cause all electronically latched initiating devices to return to their normal condition. Initiating devices shall re-report if active. Active notification appliance circuits shall not silence upon Reset. Systems that de-activate and subsequently re-activate notification appliance circuits shall not be considered equal. All programmed Control-By-Event equations shall be re-evaluated after the reset sequence is complete if the initiating condition has cleared. Non-latching trouble conditions shall not clear and re-report upon reset.
5. Lamp Test: The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal.
6. Scroll Display Keys: There shall be Scroll Display keys for FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. Depression of the Scroll Display key shall display the next event in the selected queue allowing the operator to view events by type.
7. Print Screen: Depression of the PRINT SCREEN switch shall send the information currently displayed on the 640-character display to the printer.

E. System Capacity and General Operation:

1. The control panel shall be capable of expansion via up to 10 SLC modules. Each module shall support a maximum of 318 analog/addressable devices for a maximum system capacity of 3180 points. The system shall be capable of 3072 annunciation points per system regardless of the number of addressable devices.
2. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit 640-character liquid crystal display, individual, color coded system status LEDs, and a QWERTY style alphanumeric keypad for the field programming and control of the fire alarm system. Said LCD shall also support graphic bit maps capable of displaying the company name and logo of either the owner or installing company.
3. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.
4. The FACP shall be able to provide the following software and hardware features:

    a. Pre-signal and Positive Alarm Sequence: The system shall provide means to cause alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15-second time period for acknowledging an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local and remote outputs shall automatically activate immediately.
    b. Smoke Detector Pre-alarm Indication at Control Panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of Pre-alarm indication shall be available at the control panel: alert and action.
    c. Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.

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d. Action: If programmed for Action and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition. Sounder bases installed with either heat or smoke detectors shall automatically activate on action Pre-Alarm level, with general evacuation on Alarm level.

e. The system shall support a detector response time to meet world annunciation requirements of less than 3 seconds.

f. Device Blink Control: Means shall be provided to turn off detector/module LED strobes for special areas.

g. NFPA 72 Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meets the requirements of NFPA 72.

h. Programmable Trouble Reminder: The system shall provide means to automatically initiate a reminder that troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.

i. On-line or Off-line programming: The system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected and on-line. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop.

j. History Events: The panel shall maintain a history file of the last 4000 events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall also maintain a 1000 event Alarm History buffer, which consists of the 1000 most recent alarm events from the 4000 event history file.

k. Smoke Control Modes: The system shall provide means to perform FSCS mode Smoke Control to meet NFPA-92A and 90B and HVAC mode to meet NFPA 90A.

l. The system shall provide means for all SLC devices on any SLC loop to be auto programmed into the system by specific address. The system shall recognize specific device type ID's and associate that ID with the corresponding address of the device.

m. Drill: The system shall support means to activate all silenceable fire output circuits in the event of a practice evacuation or "drill". If enabled for local control, the front panel switch shall be held for a minimum of 2 seconds prior to activating the drill function.

n. Passwords and Users: The system shall support two password levels, master and user. Up to 9 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.

o. Two Wire Detection: The system shall support standard two wire detection devices specifically all models of System Sensor devices, Fenwal PDS-7125/7126 and CPD-7021, Hochiki model SLK-24F/24FH, Edwards 6250B/6270B and 6264B and Simplex models 2098-9201/9202 and 9576.

p. Block Acknowledge: The system shall support a block Acknowledge for Trouble Conditions

q. Sensitivity Adjust: The system shall provide Automatic Detector Sensitivity Adjust based on Occupancy schedules including a Holiday list of up to 15 days.

r. Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.

s. Custom Action Messages: The system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point.

t. Print Functions: The system shall provide means to obtain a variety of reports listing all event, alarm, trouble, supervisory, or security history. Additional reports shall be available for point activation for the last Walk Test performed, detector maintenance report containing the detector maintenance status of each installed addressable detector,

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all network parameters, all panel settings including broad cast time, event ordering, and block acknowledge, panel timer values for Auto Silence, Silence Inhibit, AC Fail Delay time and if enabled, Proprietary Reminder, and Remote Reminder timers, supervision settings for power supply and printers, all programmed logic equations, all custom action messages, all non-fire and output activations (if pre-programmed for logging) all active points filtered by alarms only, troubles only, supervisory alarms, prealarms, disabled points and activated points, all installed points filtered by SLC points, logic zones, annunciators, releasing zones, special zones, and trouble zones.

u. Local Mode: If communication is lost to the central processor the system shall provide added survivability through the intelligent loop control modules. Inputs from devices connected to the SLC and loop control modules shall activate outputs on the same loop when the inputs and outputs have been set with point programming to participate in local mode or when the type codes are of the same type: that is, an input with a fire alarm type code shall activate an output with a fire alarm type code.

v. Resound based on type for security or supervisory: The system shall indicate a Security alarm when a monitor module point programmed with a security Type Code activates. If silenced alarms exist, a Security alarm will Resound the panel sounder. The system shall indicate a Supervisory alarm when a monitor module point programmed with a supervisory Type Code activates. If there are silenced alarms, a Supervisory alarm will Resound the panel sounder.

w. Read status preview - enabled and disabled points: Prior to re-enabling points, the system shall inform the user that a disabled device is in the alarm state. This shall provide notice that the device must be reset before the device is enabled thereby avoiding activation of the notification circuits.

x. Custom Graphics: When fitted with an LCD display, the panel shall permit uploading of a custom bit-mapped graphic to the display screen.

y. Multi-Detector and Cooperating Detectors: The system shall provide means to link one detector to up to two detectors at other addresses on the same loop in cooperative multi-detector sensing. There shall be no requirement for sequential addresses on the detectors and the alarm event shall be a result or product of all cooperating detectors chamber readings.

z. Tracking/Latching Duct (ion and photo): The system shall support both tracking and latching duct detectors either ion or photo types.

aa. ACTIVE EVENT: The system shall provide a Type ID called FIRE CONTROL for purposes of air-handling shutdown, which shall be intended to override normal operating automatic functions. Activation of a FIRE CONTROL point shall cause the control panel to (1) initiate the monitor module Control-by-Event, (2) send a message to the panel display, history buffer, installed printer and annunciators, (3) shall not light an indicator at the control panel, (4) Shall display ACTIVE on the LCD as well a display a FIRE CONTROL Type Code and other information specific to the device.

bb. NON-FIRE Alarm Module Reporting: A point with a type ID of NON-FIRE shall be available for use for energy management or other non-fire situations. NON-FIRE point operation shall not affect control panel operation nor shall it display a message at the panel LDC. Activation of a NON-FIRE point shall activate control by event logic but shall not cause any indication on the control panel.

cc. Security Monitor Points: The system shall provide means to monitor any point as a type security.

dd. One-Man Walk Test: The system shall provide both a basic and advanced walk test for testing the entire fire alarm system. The basic walk test shall allow a single operator to run audible tests on the panel. All logic equation automation shall be suspended during the test and while annunciators can be enabled for the test, all shall default to the disabled state. During an advanced walk test, field-supplied output point programming will react to input stimuli such as CBE and logic equations. When points are activated in advanced test mode, each initiating event shall latch the input. The advanced test shall be audible and shall be used for pull station verification, magnet activated tests on input devices, input and output device and wiring operation/verification.

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ee. Control By Event Functions: CBE software functions shall provide means to program a variety of output responses based on various initiating events. The control panel shall operate CBE through lists of zones. A zone shall become listed when it is added to a point's zone map through point programming. Each input point such as detector, monitor module or panel circuit module shall support listing of up to 10 zones into its programmed zone map.

ff. Permitted zone types shall be general zone, releasing zone and special zone. Each output point (control module, panel circuit module) can support a list of up to 10 zones including general zone, logic zone, releasing zone and trouble zone. It shall be possible for output points to be assigned to list general alarm. Non-Alarm or Supervisory points shall not activate the general alarm zone.

gg. 1000 General Zones: The system shall support up to 1000 general purpose software zones for linking inputs to outputs. When an input device activates, any general zone programmed into that device's zone map will be active and any output device that has an active general zone in its map will be active. It shall also be possible to use general zone as arguments in logic equations.

hh. 1000 Logic Equations: The system shall support up to 1000 logic equations for AND, OR, NOT, ONLY1, ANYX, XZONE or RANGE operators that allow conditional I/O linking. When any logic equation becomes true, all output points mapped to the logic zone shall activate.

ii. 10 trouble equations per device: The system shall provide support for up to 10 trouble equations for each device, which shall permit programming parameters to be altered, based on specific fault conditions. If the trouble equation becomes true, all output points mapped to the trouble zone shall activate.

jj. Control-By-Time: A time based logic function shall be available to delay an action for a specific period of time based upon a logic input with tracking feature. A latched version shall also be available. Another version of this shall permit activation on specific days of the week or year with ability to set and restore based on a 24 hour time schedule on any day of the week or year.

kk. Multiple agent releasing zones: The system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross-zone and four abort options to satisfy any local jurisdiction requirements.

ll. Alarm Verification, by device, with timer and tally: The system shall provide a user-defined global software timer function that can be set for a specific detector. The timer function shall delay an alarm signal for a user-specified time period and the control panel shall ignore the alarm verification timer if another alarm is detected during the verification period. It shall also be possible to set a maximum verification count between 0 and 20 with the "0" setting producing no alarm verification. When the counter exceeds the threshold value entered, a trouble shall be generated to the panel.

F. Central Processing Unit:

1. The Central Processing Unit shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the Central Processing Unit.
2. The Central Processing Unit shall contain and execute all control-by-event (including Boolean functions including but not limited to AND, OR, NOT, ANYx, and CROSSZONE) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost with system primary and secondary power failure.
3. The Central Processing Unit shall also provide a real-time clock for time annotation, to the second, of all system events. The time-of-day and date shall not be lost if system primary and secondary power supplies fail.
4. The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.

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5. Consistent with UL864 standards, the CPU and associated equipment are to be protected so that voltage surges or line transients will not affect them.
6. Each peripheral device connected to the CPU shall be continuously scanned for proper operation. Data transmissions between the CPU and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques.
7. The CPU shall provide an EIA-232 interface between the fire alarm control panel and the UL Listed Electronic Data Processing (EDP) peripherals.
8. The CPU shall provide two EIA-485 ports for the serial connection to annunciation and control subsystem components.
9. The EIA-232 serial output circuit shall be optically isolated to assure protection from earth ground.
10. The CPU shall provide one high-speed serial connection for support of network communication modules.
11. The CPU shall provide double pole relays for FIRE ALARM, SYSTEM TROUBLE, SUPERVISORY, and SECURITY. The SUPERVISORY and SECURITY relays shall provide selection for additional FIRE ALARM contacts.
12. The EIA-485 interface may be used for network connection to a proprietary-receiving unit.

G. System Display:

1. The system display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.
2. The display assembly shall contain, and display as required, custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones.
3. The system display shall provide a 640-character backlit alphanumeric Liquid Crystal Display (LCD). It shall also provide ten Light-Emitting-Diodes (LEDs) that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, OTHER EVENT, SIGNALS SILENCED, POINT DISABLED, and CPU FAILURE.
4. The system display shall provide a QWERTY style keypad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels with up to ten (one Master and nine User) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming.
5. The system display shall include the following operator control switches: ACKNOWLEDGE, SIGNAL SILENCE, RESET, DRILL, and LAMP TEST. Additionally, the display interface shall allow scrolling of events by event type including, FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. A PRINT SCREEN button shall be provided for printing the event currently displayed on the 640-character LCD.

H. Loop (Signaling Line Circuit) Control Module:

1. The Loop Control Module shall monitor and control a minimum of 318 intelligent addressable devices. This includes 159 intelligent detectors (Ionization, Photoelectric, or Thermal) and 159 monitor or control modules.
2. The Loop Control Module shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.
3. The Loop Control Module shall provide power and communicate with all intelligent addressable detectors and modules on a single pair of wires. This SLC Loop shall be capable of operating as a NFPA Style 6 (Class B) circuit.
4. The SLC interface board shall be able to drive an NFPA Style 6 twisted unshielded circuit up to 12,500 feet in length. The SLC Interface shall also be capable of driving an NFPA Style 6, no twist, no shield circuit for limited distances determined by the manufacturer. In addition, SLC

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wiring shall meet the listing requirements for it to exit the building or structure. "T"-tapping shall be allowed in either case.

5. The SLC interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. Each SLC Loop shall be isolated and equipped to annunciate an Earth Fault condition. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.

I. Enclosures:

1. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.
2. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.
3. The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right or left-hand side.
4. The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.

J. Power Supply:

1. The Addressable Main Power Supply shall operate on 120/240 VAC, 50/60 Hz, and shall provide all necessary power for the FACP.
2. The Addressable Main Power Supply shall provide the required power to the CPU using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual-rate charging techniques for fast battery recharge.
3. The Addressable Main Power Supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 7-200 amp-hours within a 48-hour period.
4. The Addressable Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.
5. The Addressable Main Power Supply shall be power-limited per UL864 requirements.

K. Auxiliary Field Power Supply - Addressable:

1. The auxiliary addressable power supply is a remote 24 VDC power supply used to power Notification Devices and field devices that require regulated 24VDC power. The power supply shall also include and charge backup batteries.
2. The addressable power supply for the fire alarm system shall provide up a minimum of 6.0 amps of 24 volt DC regulated power for Notification Appliance Circuit (NAC) power or 5 amps of 24 volt DC general power. The power supply shall have an additional .5 amp of 24 VDC auxiliary power for use within the same cabinet as the power supply. It shall include an integral charger designed to charge 7.0 - 25.0 amp hour batteries.
3. The addressable power supply shall provide four individually addressable Notification Appliance Circuits that may be configured as two Class "A" and two Class "B" or four Class "B" only circuits. All circuits shall be power-limited per UL 864 requirements.
4. The addressable power supply shall provide built-in synchronization for certain Notification Appliances on each circuit without the need for additional synchronization modules. The power supply's output circuits shall be individually selected for synchronization. A single addressable power supply shall be capable of supporting both synchronized and non-synchronized Notification Devices at the same time.
5. The addressable power supply shall operate on 120 or 240 VAC, 50/60 Hz.

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6. The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signaling Line Circuit (SLC) or other multiplexed means Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire. Data on the SLC shall be transmitted between 24 VDC, 5 VDC and 0 VDC at approximately 3.33k baud.
7. The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.
8. The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of eight or sixteen hours shall be Dip-switch selected.
9. The addressable power supply shall have an option for Canadian Trouble Reporting and this option shall be Dip-switch selectable.
10. The addressable power supply mounts in either the FACP back box or its own dedicated surface mounted back box with cover.
11. Each of the power supply's four output circuits shall be DIP-switch selected for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.
12. The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of and end-of-line resistor. When the power supply's output circuit is selected as General 24VDC power, the circuit shall be individually supervised when an end-of-line relay is used.
13. When selected for Notification Appliance Circuits, the output circuits shall be individually DIP-switch selectable for Steady, March Time, Dual Stage or Temporal.
14. When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.
15. The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.
16. An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.

L. Field Charging Power Supply (FCPS): The FCPS is a device designed for use as either a remote 24 volt power supply or used to power Notification Appliances.

1. The FCPS shall offer up to 6.0 amps (4.0 amps continuous) of regulated 24 volt power. It shall include an integral charger designed to charge 7.0 amp hour batteries and to support 60 hour standby.
2. The Field Charging Power Supply shall have two input triggers. The input trigger shall be a Notification Appliance Circuit (from the fire alarm control panel) or a relay. Four outputs (two Style Y or Z and two style Y) shall be available for connection to the Notification devices.
3. The FCPS shall include an attractive surface mount back box.
4. The Field Charging Power Supply shall include the ability to delay the AC fail delay per NFPA requirements.
5. The FCPS include power limited circuitry, per 1995 UL standards.

M. System Circuit Supervision:

1. The FACP shall supervise all circuits to intelligent devices, transponders, annunciators and peripheral equipment and annunciate loss of communication with these devices. The CPU shall continuously scan above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate which device or devices are not responding and print the information in the history buffer and on the printer.

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2. Transponders that lose communication with the CPU shall sound an audible trouble and light an LED indicating loss of communications.
3. Sprinkler system valves, standpipe control valves, PIV, and main gate valves shall be supervised for off-normal position.
4. All speaker and emergency phone circuits shall be supervised for opens and shorts. Each transponder speaker and emergency phone circuit shall have an individual ON/OFF indication (green LED).

N. Field Wiring Terminal Blocks: All wiring terminal blocks shall be the plug-in/removable type and shall be capable of terminating up to 12 AWG wire. Terminal blocks that are permanently fixed to the PC board are not acceptable.

O. Controls with associated LED Indicators:

1. Speaker Switches/Indicators:

   a. The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.
   b. The speaker circuit control panel shall include switches to manually activate or deactivate each speaker circuit in the system.

2. Emergency Two-Way Telephone Control Switches/Indicators:

   a. The emergency telephone circuit control panel shall include visual indication of active and trouble status for each telephone circuit in the system.
   b. The telephone circuit control panel shall include switches to manually activate or deactivate each telephone circuit in the system.

P. Remote Transmissions:

1. Provide local energy or polarity reversal or trip circuits as required.
2. The system shall be capable of operating a polarity reversal or local energy or fire alarm transmitter for automatically transmitting fire information to the fire department.
3. Provide capability and equipment for transmission of zone alarm and trouble signals to remote operator's terminals, system printers and annunciators.
4. Transmitters shall be compatible with the systems and equipment they are connected to such as timing, operation and other required features.

Q. System Expansion: Design the main FACP and required components so that the system can be expanded in the future (to include the addition of twenty percent more circuits or zones) without disruption or replacement of the existing control panel. This shall include hardware capacity, software capacity and cabinet space.

R. Field Programming:

1. The system shall be programmable, configurable and expandable in the field without the need for special tools, laptop computers, or other electronic interface equipment. There shall be no firmware changes required to field modify the system time, point information, equations, or annunciator programming/ information.
2. It shall be possible to program through the standard FACP keyboard all system functions.
3. All field defined programs shall be stored in non-volatile memory.
4. Two levels of password protection shall be provided in addition to a key-lock cabinet. One level shall be used for status level changes such as point/zone disable or manual on/off commands (Building Manager). A second (higher-level) shall be used for actual change of the life safety program (installer). These passwords shall be five (5) digits at a minimum. Upon entry of an

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invalid password for the third time within a one minute time period an encrypted number shall be displayed. This number can be used as a reference for determining a forgotten password.

5. The system programming shall be "backed" up via an upload/download program, and stored on compatible removable media. A system back-up disk shall be completed and given in duplicate to the building owner and/or operator upon completion of the final inspection. The program that performs this function shall be "non-proprietary", in that, it shall be possible to forward it to the building owner/operator upon his or her request.
6. The installer's field programming and hardware shall be functionally tested on a computer against known parameters/norms which are established by the FACP manufacturer. A software program shall test Input-to-Output correlations, device Type ID associations, point associations, time equations, etc. This test shall be performed on an IBM-compatible PC with a verification software package. A report shall be generated of the test results and two copies turned in to the engineer(s) on record.

S. Specific System Operations:

1. Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analog intelligent smoke detectors in the system from the system keypad or from the keyboard of the video terminal. Sensitivity range shall be within the allowed UL window.
2. Alarm Verification: Each of the Intelligent Addressable Smoke Detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification function shall be programmable from 0 to 60 seconds and each detector shall be able to be selected for verification during the field programming of the system or any time after system turn-on. Alarm verification shall not require any additional hardware to be added to the control panel. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

T. System Point Operations:

1. Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad or video terminal.
2. System output points shall be capable of being turned on or off from the system keypad or the video terminal.
3. Point Read: The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:

    a. Device Status.
    b. Device Type.
    c. Custom Device Label.
    d. Software Zone Label.
    e. Device Zone Assignments.
    f. Analog Detector Sensitivity.
    g. All Program Parameters.

4. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system statuses:
5. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 4000 system events. Each of these events will be stored, with time and date stamp, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed; one event at a time, and the actual number of activations may also be displayed and or printed. History events shall include all alarms, troubles, operator actions, and programming entries.
6. The history buffer shall use non-volatile memory. Systems which use volatile memory for history storage are not acceptable.

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7. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.
8. If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular Intelligent Detector will be annunciated on the system display, and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
9. The system shall include the ability (programmable) to indicate a "pre-alarm" condition. This will be used to alert maintenance personal when a detector is at 80% of its alarm threshold in a 60 second period.

2.4 SYSTEM COMPONENTS

A. Speakers:

1. Provide ceiling mounted 8" round speaker designed for broadcasting high quality, integrated, emergency voice communications, alert and alarm tones. Speakers shall be 25 vrms with multi-tap wattage from ½ watt (78dBA) to 4 watts (87dBA) and shall include DC blocking capacitor to permit supervision of the audio distribution circuit. Provide round steel baffle (baked white epoxy polyester finish) with back box.
2. Provide wall mounted 4" speaker designed for broadcasting high quality, integrated, emergency voice communications, alert and alarm tones. Speakers shall be 70 vrms with multi-tap wattage. From ¼ watt (81dBA) to 2 watts (90dBA) shall include DC blocking capacitor to permit supervision of the audio distribution circuit. Provide square fire retardant, high impact plastic, white finish cover and backbox.
3. Provide wall mounted re-entrant speaker designed for broadcasting high quality, integrated, emergency voice communication, alert and alarm tones. Speakers shall be 70 vrms with multi-tap wattage from 2 watts (93 dBA) to 15 watts (102 dBA) and shall include DC blocking capacitor to permit supervision of the audio distribution circuit. Provide square, fire retardant, high impact plastic, white finish cover and backbox.
4. Speakers in corridors and public spaces shall produce a nominal sound output of 84 dBA at 10 feet (3m).
5. Frequency response shall be a minimum of 400 HZ to 4000 HZ.
6. The back of each speaker shall be sealed to protect the speaker cone from damage and dust.

B. Audible/Visual Combination Devices:

1. Shall meet the applicable requirements of Section A listed above for audibility.
2. Shall meet the requirements of Section B listed above for visibility.

C. Programmable Electronic Sounders:

1. Electronic sounders shall operate on 24 VDC nominal.
2. Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dBA measured at 10 feet from the device.
3. Shall be flush or surface mounted as shown on plans.

D. Strobe lights shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:

1. The maximum pulse duration shall be 2/10 of one second
2. Strobe intensity shall meet the requirements of UL 1971.
3. The flash rate shall meet the requirements of UL 1971.

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E. Horn/Strobes:

1. Operate on 24 VDC
2. Have two selectable tone options of temporal 3 and non-temporal continuous pattern.
3. Have at least 2 audibility options
4. Maximum Pulse Duration: 0.2 second.
5. Strobe Intensity: UL 1971.
6. Flash Rate: UL 1971.
7. Strobe Candela Rating: Determine by positioning selector switch on back of device.

F. Manual Fire Alarm Stations:

1. Manual fire alarm stations shall be non-code, non-breakglass type, equipped with key lock so that they may be tested without operating the handle.
2. Stations must be designed such that after an actual activation, they cannot be restored to normal except by key reset.
3. An operated station shall automatically condition itself so as to be visually detected, as operated, at a minimum distance of 100 feet (30.5 m) front or side.
4. Manual stations shall be constructed of high impact Lexan, with operating instructions provided on the cover. The word FIRE shall appear on the manual station in letters one half inch (12.7 mm) in size or larger.

G. Duct Smoke Detectors as Applicable: Duct smoke detectors shall be a 24 VDC type with visual alarm and power indicators, and a reset switch. Each detector shall be installed upon the composite supply/return air ducts(s), with properly sized air sampling tubes.

H. Projected Beam Detectors as Applicable:

1. The projected beam type shall be a 4-wire 24 VDC device.
2. The detector shall be listed to UL 268 and shall consist of a separate transmitter and receiver capable of being powered separately or together.
3. The detector shall operate in either a short range (30' - 100') or long range (100' - 330') mode.
4. The temperature range of the device shall be -22 degrees F to 131 degrees F.
5. The detector shall feature a bank of four alignment LEDs on both the receiver and the transmitter that are used to ensure proper alignment of unit without special tools.
6. Beam detectors shall feature automatic gain control which will compensate for gradual signal deterioration from dirt accumulation on lenses.
7. The unit shall be both ceiling and wall mountable.
8. The detector shall have the ability to be tested using calibrated test filters or magnet activated remote test station.

I. Automatic Conventional Heat Detectors:

1. Automatic heat detectors shall have a combination rate of rise and fixed temperature rated at 135 degrees Fahrenheit (57.2 Celsius) for areas where ambient temperatures do not exceed 100 degrees (37.7 Celsius), and 200 degrees (93.33 Celsius) for areas where the temperature does not exceed 150 degrees (65.5 Celsius).
2. Automatic heat detectors shall be a low profile, ceiling mount type with positive indication of activation.
3. The rate of rise element shall consist of an air chamber, a flexible metal diaphragm, and a factory calibrated, moisture-proof, trouble free vent, and shall operate when the rate of temperature rise exceeds 15 degrees F (9.4 degrees C) per minute.
4. The fixed temperature element shall consist of a fusible alloy retainer and actuator shaft.
5. Automatic heat detectors shall have a smooth ceiling rating of 2500 square feet (762 square meters).

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J. Waterflow Indicator:

1. Waterflow Switches shall be an integral, mechanical, non-coded, non-accumulative retard type.
2. Waterflow Switches shall have an alarm transmission delay time which is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds.
3. All waterflow switches shall come from a single manufacturer and series.
4. Waterflow switches shall be provided and connected under this section but installed by the Mechanical Contractor.
5. Where possible, locate waterflow switches a minimum of one (1) foot from a fitting which changes the direction of the flow and a minimum of three (3) feet from a valve.

K. Sprinkler and Standpipe Valve Supervisory Switches:

1. Each sprinkler system water supply control valve riser, zone control valve, and standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.
2. PIV (post indicator valve) or main gate valves shall be equipped with a supervisory switch.
3. The switch shall be mounted so as not to interfere with the normal operation of the valve and adjusted to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.
4. The supervisory switch shall be contained in a weatherproof aluminum housing, which shall provide a 3/4 inch (19 mm) conduit entrance and incorporate the necessary facilities for attachment to the valves.
5. The switch housing shall be finished in red baked enamel.
6. The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed, or if the unit is removed from its mounting.
7. Valve supervisory switches shall be provided and connected under this section and installed by Mechanical Contractor.

    a. This unit shall provide for each zone: alarm indications, using a red alarm and yellow trouble long-life LEDs and control switches for the control of fire alarm control panel functions. The annunciator will also have an ON-LINE LED, local piezo electric signal, local acknowledge/lamp test switch, and custom slide-in zone/function identification labels.
    b. Switches shall be available for remote annunciation and control of output points in the system, system acknowledge, telephone zone select, speaker select, global signal silence, and global system reset within the confines of all applicable standards.

L. Alphanumeric LCD Type Annunciator:

1. The alphanumeric display annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.
2. The LCD annunciator shall display all alarm and trouble conditions in the system.
3. An audible indication of alarm shall be integral to the alphanumeric display.
4. The display shall be UL listed for fire alarm application.
5. It shall be possible to connect up to 32 LCD displays and be capable of wiring distances up to 6,000 feet from the control panel.
6. The annunciator shall connect to a separate, dedicated "terminal mode" EIA-485 interface. This is a two-wire loop connection and shall be capable of distances to 6,000 feet. Each terminal mode LCD display shall mimic the main control panel.
7. The system shall allow a minimum of 32 terminal mode LCD annunciators. Up to 10 LCD annunciators shall be capable of the following system functions: Acknowledge, Signal Silence and Reset, which shall be protected from unauthorized use by a key switch or password.
8. The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above.

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M. Interactive Display:

1. The system shall be an ONYX FirstVision™.
2. The system shall operate on an UL listed Embedded platform operating at no less than 700 MHz on the Microsoft® Windows® XP Embedded platform.
3. The Embedded platform shall have: no less than 256 megabytes of RAM, a flash drive with no less than 1 Gigabytes of storage space, 100 Base-T Ethernet NIC card, and USB ports.
4. The Embedded platform shall have a minimum 17" touch screen display.
5. The Embedded platform shall come equipped with all necessary gateway modules to allow connection to the network it monitors as standard equipment.

    a. A UL listed Ethernet Hub shall be provided for connection of multiple interactive displays and/or gateways.

N. Universal Digital Alarm Communicator Transmitter (UDACT). The UDACT is an interface for communicating digital information between a fire alarm control panel and an UL-Listed central station.

1. The UDACT shall be compact in size, mounting in a standard module position of the fire alarm control cabinet. Optionally, the UDACT shall have the ability for remote mounting, up to 6,000 feet from the fire alarm control panel. The wire connections between the UDACT and the control panel shall be supervised with one pair for power and one pair for multiplexed communication of overall system status. Systems that utilize relay contact closures are not acceptable.
2. **The FACP shall provide both communication capabilities; Universal Digital Alarm Communication/Transmitter utilizing the Ademco contact ID format. Panel/UDACT shall be programmed to communicate "point" programming; and Notifier NFN Gateway and all required**
3. The UDACT shall include connections for dual telephone lines (with voltage detect), per UL/NFPA/FCC requirements. It shall include the ability for split reporting of panel events up to three different telephone numbers.
4. The UDACT shall be completely field programmable from a built-in keypad and 4 character red, seven segment display.
5. The UDACT shall be capable of transmitting events in at least 15 different formats. This ensures compatibility with existing and future transmission formats.
6. Communication shall include vital system status such as:

    a. Independent Zone (Alarm, trouble, non-alarm, supervisory)
    b. Independent Addressable Device Status
    c. AC (Mains) Power Loss
    d. Low Battery and Earth Fault
    e. System Off Normal
    f. 12 and 24 Hour Test Signal
    g. Abnormal Test Signal (per UL requirements)
    h. EIA-485 Communications Failure
    i. Phone Line Failure

7. The UDACT shall support independent zone/point reporting when used in the Contact ID format. In this format the UDACT shall support transmission of up to 2,040 points. This enables the central station to have exact details concerning the origin of the fire or response emergency.
8. AN IP Communicator option shall be available to interface to the UDACT and be capable of transmitting signals over the internet/intranet to a compatible receiver.

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2.5 SYSTEM COMPONENTS - ADDRESSABLE DEVICES

A. Addressable Devices - General:

1. Addressable devices shall provide an address-setting means using rotary decimal switches. Addressable devices that require the address be programmed using a programming utility are not an allowable substitute.
2. Addressable devices shall use simple to install and maintain decade (numbered 0 to 15) type address switches. Devices which use a binary address or special tools for setting the device address, such as a dip switch are not an allowable substitute.
3. Detectors shall be Analog and Addressable, and shall connect to the fire alarm control panel's Signaling Line Circuits.
4. Addressable smoke and thermal detectors shall provide dual (2) status LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the flashing mode operation of the detector LEDs can be programmed off via the fire control panel program.
5. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. Sensitivity can be automatically adjusted by the panel on a time-of-day basis.
6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
7. The detectors shall be ceiling-mount and shall include a separate twist-lock base which includes a tamper proof feature.
8. The following bases and auxiliary functions shall be available:

    a. Sounder base rated at 85 DBA minimum.
    b. Form-C Relay base rated 30VDC, 2.0A
    c. isolator base

9. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
10. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (example: ION, PHOTO, THERMAL).

B. Addressable Manual Fire Alarm Box (manual station):

1. Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
3. Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.

C. Intelligent Photoelectric Smoke Detector: The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

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D. Intelligent Laser Photo Smoke Detector:

1. The intelligent laser photo smoke detector shall be a spot type detector that incorporates an extremely bright laser diode and an integral lens that focuses the light beam to a very small volume near a receiving photo sensor. The scattering of smoke particles shall activate the photo sensor.
2. The laser detector shall have conductive plastic so that dust accumulation is reduced significantly.
3. The intelligent laser photo detector shall have nine sensitivity levels and be sensitive to a minimum obscuration of 0.03 percent per foot.
4. The laser detector shall not require expensive conduit, special fittings or PVC pipe.
5. The intelligent laser photo detector shall support standard, relay, isolator and sounder detector bases.
6. The laser photo detector shall not require other cleaning requirements than those listed in NFPA 72. Replacement, refurbishment or specialized cleaning of the detector head shall not be required.
7. The laser photo detector shall include two bicolor LEDs that flash green in normal operation and turn on steady red in alarm.

E. Intelligent Multi Criteria Acclimating Detector:

1. The intelligent multi criteria Acclimate detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.
2. The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).
3. The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

F. Intelligent Thermal Detectors: Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

G. Intelligent Duct Smoke Detector:

1. The smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.
2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

H. Advanced Multi-Criteria Intelligent Detector:

1. The intelligent multi criteria IntelliQuad detector shall be an addressable device combining four sensing elements in a single sensing device providing the ability to detect all four major

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elements of a fire. The detector design shall allow sensitivity setting between 1% to 4% per foot obscuration.

2. The detector shall include a photoelectric sensing element, thermal sensing element, IR (Infrared) sensing element and CO (carbon monoxide) sensor.

I. Addressable Dry Contact Monitor Module:

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.
2. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
3. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.
4. For multiple dry contact monitoring a module shall be available that provides 10 Style B or 5 Style D input circuits.

J. Two Wire Detector Monitor Module:

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device).
2. The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
3. For multiple 2-wire smoke detector circuit monitoring a module shall be available that provides 6 Style B or 3 Style D input circuits.

K. Addressable Control Module:

1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances.
2. The control module NAC may be wired for Style Z or Style Y (Class A/B) with a current rating of 2 Amps for Style Z and 3 Amps for Style Y. For speaker applications the module is rated for 50 watts at 25 or 70.7.
3. Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised UL listed remote power supply.
4. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.
5. For multiple circuit control a module shall be available that provides 6 Style B or 3 Style D control circuits.

L. Addressable Relay Module:

1. Addressable Relay Modules shall be available for HVAC control and other building functions. The module shall provide two form C relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary devices energize at the same time on the same pair of wires.
2. For multiple relay control a module shall be available that provides 6 programmable Form-C relays.

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M. Addressable Releasing Control Module:

1. An addressable FlashScan releasing module shall be available to supervise and control compatible releasing agent solenoids.
2. The module shall operate on a redundant protocol for added protection.
3. The module shall be configurable for Style Z or Style Y (Class A/B) and support one 24 volt or two 12 volt solenoids.

N. Isolator Module:

1. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.
2. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
3. The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
4. The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

O. Smoke Control Annunciator:

1. On/Auto/Off switches and status indicators (LEDS) shall be provided for monitoring and manual control of each fan, damper, HVAC control unit, stairwell pressurization fan, and smoke exhaust fan. To ensure compliance the units supplied shall meet the following UL categories: UUKL, PAZX, UDTZ, QVAX as well as the requirements of NFPA 90A, HVAC, and NFPA 92A & 92B, Smoke Control. The control System shall be field programmable for either 90A operation or 92A/B operation to allow for future use and system expansion.
2. The OFF LED shall be Yellow, the ON LED shall be green, the Trouble/Fault LED shall be Amber/Orange for each switch. The Trouble/Fault indicator shall indicate a trouble in the control and/or monitor points associated with that switch. In addition, each group of eight switches shall have two LEDS and one momentary switch which allow the following functions: An Amber LED to indicate an OFF-NORMAL switch position, in the ON or OFF position; A Green LED to indicate ALL AUTO switch position; A Local Acknowledge/Lamp Test momentary switch.
3. Each switch shall have the capability to monitor and control two addressable inputs and two addressable outputs. In all modes, the ON and OFF indicators shall continuously follow the device status not the switch position. Positive feedback shall be employed to verify correct operation of the device being controlled. Systems that indicate on/off/auto by physical switch position only are not acceptable.
4. All HVAC switches (i.e., limit switches, vane switches, etc.) shall be provided and installed by the HVAC Contractor.
5. It shall be possible to meet the requirements mentioned above utilizing wall mounted custom graphic.

P. Serially Connected Annunciator Requirements:

1. The annunciator shall communicate to the fire alarm control panel via an EIA 485 (multi-drop) two-wire communications loop. The system shall support two 6,000 ft. EIA-485 wire runs. Up to 32 annunciators, each configured up to 96 points, may be connected to the connection, for a system capacity of 3,072 points of annunciation.

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2. An EIA-485 repeater shall be available to extend the EIA-485 wire distance in 3,000 ft. increments. An optional version shall allow the EIA-485 circuit to be transmitted over Fiber optics. The repeater shall be UL864 approved.
3. Each annunciator shall provide up to 96 alarm and 97 trouble indications using a long-life programmable color LED's. Up to 96 control switches shall also be available for the control of Fire Alarm Control Panel functions. The annunciator will also have an "ON-LINE" LED, local piezo sounder, local acknowledge and lamp test switch, and custom zone/function identification labels.
4. The annunciator may be field configured to operate as a "Fan Control Annunciator". When configured as "Fan Control," the annunciator may be used to manually control fan or damper operation and can be set to override automatic commands to all fans/dampers programmed to the annunciator.
5. Annunciator switches may be programmed for System control such as, Global Acknowledge, Global Signal Silence, Global System Reset, and on/off control of any control point in the system.
6. An optional module shall be available to utilize annunciator points to drive EIA-485 driven relays. This shall extend the system point capacity by 3,072 remote contacts.
7. The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above.

2.6 BATTERIES AND EXTERNAL CHARGER

A. Battery:

1. Shall be 12 volt, Gell-Cell type.
2. Battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 5 minutes of alarm upon a normal AC power failure.
3. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks refilling, spills and leakage shall not be required.

B. External Battery Charger:

1. Shall be completely automatic, with constant potential charger maintaining the battery fully charged under all service conditions. Charger shall operate from a 120/240-volt 50/60 hertz source.
2. Shall be rated for fully charging a completely discharged battery within 48 hours while simultaneously supplying any loads connected to the battery.
3. Shall have protection to prevent discharge through the charger.
4. Shall have protection for overloads and short circuits on both AC and DC sides.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

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C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

D. Manual Pull Stations shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor.

3.2 TYPICAL OPERATION

A. Actuation of any manual station, smoke detector heat detector or water flow switch shall cause the following operations to occur unless otherwise specified:

1. Activate all programmed speaker circuits.
2. Actuate all strobe units until the panel is reset.
3. Light the associated indicators corresponding to active speaker circuits.
4. Release all magnetic door holders to doors to adjacent zones on the floor from that the alarm was initiated.
5. Return all elevators to the primary or alternate floor of egress.
6. A smoke detector in any elevator lobby shall, in addition to the above functions, return all elevators to the primary or alternate floor of egress.
7. Smoke detectors in the elevator machine room or top of hoistway shall return all elevators in to the primary or alternate floor. Smoke detectors or heat detectors installed to shut down elevator power shall do so in accordance with ANSI A17.1 requirements and be coordinated with the Electrical Contractor.
8. Duct type smoke detectors shall, in addition to the above functions shut down the ventilation system or close associated control dampers as appropriate.
9. Activation of any sprinkler system low pressure switch or valve tamper switch shall cause a system supervisory alarm indication.

3.3 TEST

A. Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.

B. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.

C. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.

D. Verify activation of all flow switches.

E. Open initiating device circuits and verify that the trouble signal actuates.

F. Open signaling line circuits and verify that the trouble signal actuates.

G. Open and short notification appliance circuits and verify that trouble signal actuates.

H. Ground initiating device circuits and verify response of trouble signals.

I. Ground signaling line circuits and verify response of trouble signals.

J. Ground notification appliance circuits and verify response of trouble signals.

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K. Check presence and audibility of tone at all alarm notification devices.

L. Check installation, supervision, and operation of all intelligent smoke detectors during a walk test.

M. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.

N. When the system is equipped with optional features, the manufacturer's manual should be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

3.4 FINAL INSPECTION

A. At the final inspection a NICET IV and factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.

3.5 INSTRUCTION

A. Provide instruction as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

B. The Contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

END OF SECTION 28 31 00

SECTION 31 10 00

SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Removing existing vegetation.
2. Clearing and grubbing.
3. Stripping and stockpiling topsoil.
4. Removing above- and below-grade site improvements.
5. Disconnecting, capping or sealing site utilities.
6. Temporary erosion- and sedimentation-control measures.

1.2 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.3 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

C. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.

D. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are indicated on the grading and drainage drawings of the Contract Documents.

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.

B. Interrupting Existing Utilities: Do not interrupt utilities serving occupied facilities.

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches (450 mm) below exposed subgrade.
2. Use only hand methods for grubbing within protection zones.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth indicated on Drawings in a manner to prevent intermingling with underlying subsoil or other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.6 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 10 00

SECTION 31 20 00

EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade, walks, and pavements.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for concrete slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Subbase course and base course for asphalt paving.
6. Excavating and backfilling for utility trenches.

1.2 DEFINITIONS

A. Geotechnical Engineer: Qualified geotechnical engineering testing agency to perform tests and inspections who is consultant to the Owner and the Architect.

B. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

C. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

D. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

E. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

F. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

G. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

H. Fill: Soil materials used to raise existing grades.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 QUALITY ASSURANCE

A. Pre-excavation Conference: Conduct conference at Project site.

1.4 PROJECT CONDITIONS

A. Exiting Conditions: Refer to Section 00 00 25 – Informational Documents, for Geotechnical Reports available for review.

1. These reports were obtained only for the Architect's use in design and are not part of the Contract Documents.

B. Contractor and subcontractors are responsible for their own determination of the subsurface conditions. They may satisfy themselves as to site and subsurface conditions with their own subsurface investigations.

C. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Backfill Material: Granular fill capped with 2 feet of engineered clay fill.

C. Building Pad Fill: Geotechnical Engineer approved granular materials or inorganic silty clays of low to medium plasticity.

D. Base Course: ADOT gradation specification .

E. Engineered Fill: Geotechnical Engineer approved granular materials or inorganic silty clays of low to medium plasticity.

F. Bedding Course: Geotechnical Engineer approved granular materials or inorganic silty clays of low to medium plasticity.

G. Drainage Course: Engineer approved narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel.

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored to comply with local practice or requirements of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.3 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: As indicated or 12 inches (300 mm) each side of pipe or conduit, if not indicated.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material, 4 inches (100 mm) deeper elsewhere, to allow for bedding course.

3.6 SUBGRADE INSPECTION

A. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired dump truck to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Geotechnical Engineer, without additional compensation.

3.7 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Geotechnical Engineer.

3.8 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations.

3.9 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches (450 mm) of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in "Cast-in-Place Concrete"

D. Trenches under Driveways and Roadways: Provide 4-inch- (100-mm-) thick, concrete-base slab support for piping or conduit less than 30 inches (750 mm) below surface of roadways. After installing and testing, completely encase piping or conduit in concrete before backfilling or placing roadway subbase course. Concrete is specified in "Cast-in-Place Concrete"

E. Place and compact initial backfill to a height of 12 inches (300 mm) over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Place and compact final backfill of satisfactory soil to final subgrade elevation.

G. Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as indicated.

3.11 SOIL MOISTURE CONTROL

A. Moisture control is important in the compaction of all soil types. Maintain water content of fill within 3 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 3 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 9 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to the Modified Proctor test (ASTM D 1557):

1. Backfill against building foundations, basement walls, and retaining walls: Between 90 and 95 percent compaction. Do not exceed 95 percent.
2. Building Pad: 95 percent minimum compaction.
3. Pavement Areas: 90 percent minimum compaction with the upper 2 feet compacted to a minimum or 95 percent.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch (25 mm).

2. Walks: Plus or minus 1 inch (25 mm).
3. Pavements: Plus or minus 1/2 inch (13 mm).

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

3.14 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subbase course and base course under pavements and walks as follows:

1. Shape subbase course and base course to required crown elevations and cross-slope grades.
2. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.15 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.16 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Geotechnical Engineer.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.17 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 20 00

SECTION 31 31 16

TERMITE CONTROL

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. Soil treatment with termiticide.

1.3 PERFORMANCE REQUIREMENTS

A. Service Life of Soil Treatment: Soil treatment by use of a termiticide that is effective for not less than 5 years against infestation of subterranean termites.

1.4 SUBMITTALS

A. Product Data: For termiticide.

1. Include the EPA-Registered Label for termiticide products.

B. Product Certificates: For termite control products, signed by product manufacturer.

C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's record information, including the following:

1. Date and time of application.
2. Moisture content of soil before application.
3. Brand name and manufacturer of termiticide.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes, and rates of application used.
6. Areas of application.
7. Water source for application.

D. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located.

B. Regulatory Requirements: Formulate and apply termiticides according to the EPA-Registered Label.

1. Treatment shall be performed by a licensed pest control operator and the termiticide shall be applied in a manner consistent with the product label.

C. Source Limitations: Obtain termite control products through one source.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.

1.7 COORDINATION

A. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOIL TREATMENT

A. Termiticide: Provide an EPA-registered termiticide complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for interfaces with earthwork, slab and foundation work, landscaping, and other conditions affecting performance of termite control.

1. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparation before beginning application of termite control treatment. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.

B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.

1. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

3.3 APPLYING SOIL TREATMENT

A. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.

1. Slabs-on-Grade: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
2. Foundations: Adjacent soil including soil along the entire inside perimeter of foundation walls, along both sides of interior partition walls, around plumbing pipes and electric conduit penetrating the slab, and around interior column footers, piers, and chimney bases; also along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
3. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.

B. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

C. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

D. Post warning signs in areas of application.

E. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 31 31 16