PROJECT MANUAL

ROOFTOP UNIT REPLACEMENT DESIGN

McHenry County Administration Building
Woodstock, IL

This Project Manual contains Bidding Requirements, Contract Form, Conditions of the Contract and the Specifications for the Project. The contents of this Project Manual, the accompanying Drawings and any Addenda constitute the Bidding Documents for this Project.

GBA #23-0998-01

GRUMMAN|BUTKUS
ENERGY EFFICIENCY CONSULTANTS
AND SUSTAINABLE DESIGN ENGINEERS

PROJECT MANUAL CONTENTS

EXHIBITS (BOUND SEPARATELY)

- PRE-PURCHASED ROOFTOP UNIT SPECIFICATION SECTION 23 7413
- PRE-PURCHASED ROOFTOP UNIT AND TRANSITION CURB SHOP DRAWINGS
- RTU INSTALLATION AND START-UP MANUAL (IM 1287-6)
- RTU OPERATIONS MANUAL (OM1373)
- RTU NETWORK INTEGRATION GUIDE (19117-4)
- MT6210 A2L LEAK MITIGATION CONTROL (IM 1365)

TECHNICAL SPECIFICATIONS

DIVISION 01 - GENERAL REQUIREMENTS

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SECTION 01 1100
SUMMARY OF WORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Scope of work

B. Contracts

C. Work by Owner

D. Owner-furnished products

E. Contractor use of site and premises

F. Future work

G. Work sequence

H. Owner occupancy and utilization

1.2 OWNER-FURNISHED PRODUCTS

A. Products furnished to the site and paid for by Owner:

1. Packaged 60-ton rooftop units.
2. Transition roof curb

B. Owner's responsibilities:

1. Arrange for and deliver Owner-reviewed shop drawings, product data and samples, to Contractor.
2. Pay for product delivery to site.
3. On delivery, inspect products jointly with Contractor.

C. Contractor's responsibilities:

1. Review Owner-reviewed shop drawings, product data and samples.
2. Receive and unload products at site; inspect for completeness or damage, jointly with Owner.
3. Handle, store, install and finish products.
4. Repair or replace items damaged after receipt.
5. Equipment pre-purchased by Owner will be assigned to the successful contractor so that, once selected, that contractor becomes (1) responsible for coordination of the installation and (2) the single construction and warranty period contact for the project thereafter. Bidder agrees to accept, honor and acknowledge Owner's assignment of its obligations under the prepurchase agreement.
6. Arrange for product delivery to site.
7. Submit claims for transportation damage and replace damaged, defective, or deficient items.
8. Arrange for manufacturers' warranties, inspections and service.

1.3 CONTRACTOR USE OF SITE AND PREMISES

A. Limit use of site and premises to allow:

1. Owner occupancy.

2. Use of premises by Owner to conduct normal activities.

B. Tie-ins to existing systems must be done in a manner so as to minimize interference with Owner's operations (i.e., during premium time).

1.4 WORK SEQUENCE

A. Install work in to accommodate Owner’s occupancy requirements during the construction period. Coordinate mechanical or electrical schedule and operations with Owner.

1.5 OWNER OCCUPANCY AND UTILIZATION

OR

A. Owner will occupy the premises during entire period of construction for the conduct of normal operations.

B. Cooperate with Owner to minimize conflict and to facilitate Owner’s operations.

C. Schedule the work to accommodate this requirement.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

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SECTION 01 3102
ALTERATION PROJECT PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Demolition, alterations, cutting and protection

B. Products and installation for patching and extending Work

C. Transition and adjustments

D. Repair of damaged surfaces, finishes and cleaning

1.2 SEQUENCE AND SCHEDULES

A. Schedule work in sequences and within times specified in Division 01 Section 01 0000, “Summary of Work.”

B. Submit separate detailed sub-schedule for alterations work, coordinated with Master Construction Schedule. Show:

1. Each stage of work; occupancy dates of areas
2. Date of Substantial Completion for each area of alteration work
3. Crafts and subcontractors employed in each stage

C. Schedule noisy or hazardous work to avoid problems with Owner’s operations.

1.3 DEMOLITION, ALTERATIONS, CUTTING AND PROTECTION

A. Assign demolition, moving, removal, cutting and patching work to crafts qualified to perform work in manner to cause least damage to each type of work and provide means of restoring surfaces to appearance of new work.

B. Perform cutting and removal work to remove minimum necessary and in manner to avoid damage to adjacent work.

1. Cut finish surfaces such as masonry, tile, plaster or metals by methods to terminate surfaces in straight line at natural point of division.

C. Perform cutting and patching as specified in Division 01 Section 01 7329, “Cutting and Patching.”

D. Protect existing finishes, equipment and adjacent work which are scheduled to remain from damage.

1. Protect existing and new work from weather and temperature extremes.
    a. Maintain existing interior work above 60°F.
    b. Provide weather protection, waterproofing, heat and humidity control to prevent damage to remaining existing work and to new work.

PART 2 - PRODUCTS

2.1 SALVAGED MATERIALS

A. Salvage sufficient quantities of cut or removed materials to replace damaged work of existing construction, when material is not readily obtainable on current market.

B. Store salvaged items in a dry, secure place on site.

C. Items not specified for use in repair work remain property of Owner.

D. Do not use salvaged or used material in new construction except with prior written authorization from Engineer.

2.2 PRODUCTS FOR PATCHING AND EXTENDING WORK

A. Ensure that work is complete.

B. Provide same materials or types of construction as that in existing structure, to patch, extend or match existing work.

1. Contract Documents may not define products or standards of workmanship present in existing construction.

2. Determine products by inspection and testing.

3. Determine workmanship by use of existing as sample of comparison.

C. Presence of a product, finish or type of construction requires that patching, extending or matching be performed to make work complete and consistent to identical quality standards.

PART 3 - EXECUTION

3.1 EXAMINATION (PRE-DEMOLITION)

A. Verify if all hazardous waste materials (asbestos, PCB/transformers, etc.) have been removed from work areas. If this is not verified, notify Owner/Engineer in writing.

B. Demolition drawings are based on casual field observation and existing record documents. Review site conditions and report discrepancies to Engineer before disturbing existing installation.

C. Beginning of demolition work means acceptance of existing conditions.

3.2 PERFORMANCE

A. Patch and extend existing work using skilled craftsmen capable of matching existing quality of workmanship. For patched or extended work, provide quality equal to that specified for new work.

3.3 PREPARATION

A. Cut, move, or remove items as necessary for access to alterations and renovation Work. Replace and restore at completion.

B. Remove unsuitable material not marked for salvage, such as rotted wood, corroded metals and deteriorated masonry and concrete. Replace materials as specified for finished Work.

C. If, during course of project, hazardous materials are in any way suspected, including but not limited to asbestos, pollutants, or PCB, inform Owner immediately and suspend action on that portion of work.

D. Remove or repair dangerous or unsanitary conditions.

E. Remove debris and abandoned items from area and from concealed spaces.

F. Remove abandoned piping, conduit and wiring.

G. Prepare surface and remove surface finishes to provide for proper installation of new work and finishes.

H. Close openings in exterior surfaces to protect existing work and salvage items from weather and extremes of temperature and humidity. Insulate ductwork and piping to prevent condensation in exposed areas.

3.4 EXAMINATION (PRE-INSTALLATION)

A. Verify that demolition is complete and areas are ready for installation of new Work.

B. Beginning of restoration Work means acceptance of existing conditions.

3.5 INSTALLATION

A. Coordinate work of alterations and renovations to expedite completion sequentially and to accommodate Owner occupancy.

B. Remove, cut and patch work in a manner to minimize damage and to provide a means of restoring Products and finishes to specified condition.

C. Refinish visible existing surfaces to remain in renovated rooms and spaces, to specified condition for each material, with a neat transition to adjacent finishes.

D. In addition to specified replacement of equipment and electrical systems to full operational condition.

E. Install products as specified in individual Sections of Divisions 20, 21, 22, 23, 26, 27, and 28.

3.6 TRANSITIONS

A. Where new work abuts or aligns with existing, perform a smooth and even transition. Patched Work to match existing adjacent work in texture and appearance.

B. When finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to Engineer.

3.7 ADJUSTMENTS

A. Where removal of partitions or walls results in adjacent spaces becoming one, rework floors, walls and ceilings to a smooth plane without breaks, steps, or bulkheads.

B. Fit work at penetrations of surfaces as specified in Division 01 Section 01 7329, “Cutting and Patching.”

3.8 REPAIR OF DAMAGED SURFACES

A. Patch or replace portions of existing surfaces which are damaged, lifted, discolored, or showing other imperfections. This includes equipment and duct insulation.

B. Repair substrate prior to patching finish.

3.9 FINISHES

A. Finish patches to product uniform finish and texture over entire area. When finish cannot be matched, refinish entire surface to nearest intersections.

3.10 CLEANING

A. Perform construction cleaning as specified in Division 01 Section 01 7700, “Project Closeout.”

1. Clean Owner-occupied areas daily.

2. Clean all spillage, overspray and heavy dust collections in Owner-occupied areas immediately.

B. At completion of work of each craft, clean area and make surfaces ready for work of successive crafts.

C. At completion of alterations work in each area, provide final cleaning in accord with Section 01700 and return space to a condition suitable for use of Owner.

END OF SECTION

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SECTION 01 3103
STARTING OF SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Starting systems

B. Demonstration and instructions

C. Testing, adjusting, and balancing

1.2 STARTING SYSTEMS

A. Coordinate schedule for start-up of various equipment and systems.

B. Notify Owner seven calendar days prior to start-up of each item.

C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions which may cause damage.

D. Verify that tests, meter readings and specified electrical characteristics agree with those required by the equipment or system manufacturer.

E. Verify wiring and support components for equipment are complete and tested.

F. Verify utilities, connections and controls are complete and equipment is in operable condition.

G. Observe start-up and adjustments: Record time and date of start-up and results.

H. Observe equipment demonstrations to Owner: Record times and additional information required for Operation and Maintenance Manuals.

I. Execute start up under supervision of responsible manufacturer's representative in accordance with manufacturers' instructions.

J. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check and approve equipment or system installation prior to start up and to supervise placing equipment or system in operation.

K. Submit a written report in accordance with Division 01 Section 01 4000, “Quality Control Services,” that equipment or system has been properly installed and is functioning correctly.

1.3 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of Products to Owner's personnel prior to date of Substantial Completion.

B. Demonstration and instructions shall be provided by a qualified manufacturers' representative who is knowledgeable about the Project.

C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.

D. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owners’ personnel in detail to explain all aspects of operation and maintenance.

E. Demonstrate start up, operation, control, adjustment, trouble shooting, servicing, maintenance and shutdown of each item of equipment at agreed upon times, at equipment location.

F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

G. The amount of time required for instruction on each item of equipment and system is that specified in individual sections.

1.4 INSPECTION AND ACCEPTANCE OF EQUIPMENT

A. Prior to inspection, verify that equipment is tested, operational and clean.

B. Assist Engineer with inspection. Prepare list of items to be completed and corrected.

1.5 TESTING, ADJUSTING AND BALANCING

A. Owner will appoint, employ and pay for services of an independent firm to perform testing, adjusting and balancing.

B. The independent firm will perform services specified in Division 23 Section 23 0593, “Testing, Adjusting, and Balancing for HVAC,” except for factory tests.

C. Reports will be submitted by the independent firm to the Engineer indicating observations and results of tests and indicating compliance or non-compliance with specified requirements and with the requirements of the Contract Documents.

1.6 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

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SECTION 01 3300
SUBMITTALS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Submittal procedures

B. Proposed products list

C. Contractor-prepared shop drawings

D. Preventive maintenance (PM) tasks/schedule

E. Product data

F. Samples

G. Manufacturers' instructions

H. Manufacturers' certificates

1.2 SUBMITTAL PROCEDURES

A. Refer also to provisions of the General Conditions.

B. Identify Project, Contractor, Subcontractor or supplier; pertinent Drawing sheet, equipment tag, system designation number(s) and specification Section number, as appropriate.

C. Where possible, submit shop drawings and product data grouped to include complete submittals of related systems, products and accessories in a single submittal so long as this does not delay individual items whose review is time-critical.

D. If only part of required drawings in one group are submitted, action will be withheld on them until remaining drawings are submitted.

E. Catalog cuts showing more than one model of a product shall be clearly marked indicating which model is being proposed.

F. Capacity and performance data shall be given in same form, units and completeness presented in Contract Documents.

G. Identifying symbols and tags used on drawings shall be clearly cross-referenced on shop drawings.

H. Identify room names and numbers in which various products will be used.

I. Schedule submittals to expedite the Project and deliver electronically to Engineer at business address.

J. Mark in units to match those specified.

K. Apply Contractor's stamp, signed or initialed, certifying that review, verification of Products required, field dimensions, adjacent construction Work and coordination of information is in accordance with the requirements of the Work and Contract Documents.

L. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of the completed Work. See General Conditions, paragraph 6.17.

M. Revise and resubmit submittals as required, identifying all changes made since previous submittal.

N. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

1.3 CONSTRUCTION PROGRESS SCHEDULES

A. Submit estimated progress schedule in duplicate within 15 business days after date of Owner-Contractor Agreement for Engineer review.

B. Revise and resubmit as required.

C. Revise and resubmit work schedule affected by accepted alternates.

1.4 PROPOSED PRODUCTS LIST

A. Within 15 business days after date of Owner's Contract Agreement, submit complete list of major products proposed for use, with name of manufacturer, trade name and model number of each product.

B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation and reference standards.

C. Mark dimensions and values in units to match those specified.

1.5 CONTRACTOR-PREPARED SHOP DRAWINGS

A. Submit the number of hard copies as established at the preconstruction conference. Alternatively, shop drawings may be submitted electronically in .pdf format.

B. After review, distribute in accordance with Article on Procedures above and provide copies for Record Documents described in Division 01 Section 01 7700, "Project Closeout."

1.6 PREVENTIVE MAINTENANCE (PM) TASKS/SCHEDULE

A. Submit complete listing of PM tasks within 10 business days after date of Notice to Proceed.

1.7 PRODUCT DATA

A. Submit the number of hard copies as established at the preconstruction conference. Alternatively, shop drawings may be submitted electronically in .pdf format.

B. Mark each copy to identify applicable products, models, systems, equipment tags and other data. Supplement manufacturers' standard data to provide information unique to this Project.

C. After review, distribute in accordance with Article on Procedures above and provide copies for Record Documents described in Division 01 Section 01 7700, "Project Closeout."

1.8 MANUFACTURER'S INSTRUCTIONS

A. When specified in individual specification Sections, submit manufacturers' printed instructions for assembly, installation, start up, adjusting, testing, in quantities specified for Product Data.

B. Identify conflicts between manufacturers' instructions and Contract Documents.

1.9 MANUFACTURER'S CERTIFICATES

A. When specified in individual specification Sections, submit manufacturer's certificate to Engineer for review in quantities specified for Product Data.

B. Indicate that material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits and certifications as appropriate.

C. Certificates may be recent or previous test results on material or Product but must be acceptable to Engineer.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

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SECTION 01 4000
QUALITY CONTROL SERVICES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Quality assurance and control of installation

B. References

C. Manufacturers' field services and reports

1.2 QUALITY ASSURANCE/CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, Products, services, site conditions and workmanship to produce Work of specified quality.

B. Comply fully with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes or specified requirements indicate higher standards or more precise workmanship.

E. Work to be performed by persons qualified to produce workmanship of specified quality.

F. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement.

1.3 REFERENCES

A. Conform to reference standard by date of Contract Documents when there are no Bids date specified in product Sections.

1.4 MANUFACTURERS' FIELD SERVICES, FIELD TESTS AND REPORTS

A. When specified in individual specification Sections, Contractor shall require material or Product suppliers, Subcontractors, or manufacturers to provide qualified staff personnel to observe site conditions; testing; conditions of installation; quality of workmanship; start-up of equipment; testing, adjusting and balancing of equipment and materials; and troubleshooting as applicable B and to initiate instructions when necessary. Submit report per paragraph C below, this section.

B. Report observations and site decisions or instructions given to Owner, applicators or installers that are supplemental or contrary to manufacturers' written instructions.

C. Submit written report within 10 days of observation, start-up, testing, etc. to Engineer for review.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

SECTION 01 6000
MATERIAL AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Products

B. Transportation and handling

C. Storage and protection

D. Product options

E. Substitutions

1.2 PRODUCTS

A. Products: Means new material, machinery, components, equipment, fixtures and systems forming the work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components required for reuse.

B. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.

C. Provide interchangeable components of the same manufacturer for similar components.

1.3 TRANSPORTATION AND HANDLING

A. Transport and handle products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to assure that products comply with requirements, quantities are correct and products are undamaged.

C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement or damage.

1.4 STORAGE AND PROTECTION

A. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather tight, climate-controlled enclosures.

B. For exterior storage of fabricated products, place on sloped supports above ground.

C. Provide off site storage and protection when site does not permit on site storage or protection.

D. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.

E. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

F. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement or damage.

G. Arrange storage of products to permit access for inspection. Periodically inspect to assure products are undamaged and are maintained under specified conditions.

1.5 PRODUCT OPTIONS

A. Products specified by Reference Standards or by description only: Any product meeting those standards or description.

B. Products specified by naming one or more manufacturers: Products of manufacturers named and meeting specifications; no options or substitutions allowed.

C. Product specified by naming one manufacturer as a base and naming others as acceptable: Obligations listed in the following “Substitutions” paragraph apply when an “Acceptable Other” is used. Manufacturer named on the drawings and in equipment scheduling are to be considered as a Base; with respect to the particular product described, other manufacturers named in those documents are acceptable others.

D. When an “Acceptable Other” manufacturer is used in lieu of Specified, Contractor shall coordinate mechanical, plumbing and electrical requirements and will bear any additional costs required by other subcontractors as a result of the proposed product.

1.6 SUBSTITUTIONS

A. Instructions to Bidders specify time restrictions for submitting requests for Substitutions during the bidding period to requirements specified in this Section.

B. Substitutions may be considered when a product becomes unavailable through no fault of the Contractor.

C. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.

D. A request constitutes a representation that the Bidder:

1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
2. Will provide the same warranty for the substitution as for the specified product.
3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
4. Has investigated that the proposed product can be installed in the space available with access for servicing and maintenance.
5. Has coordinated mechanical, plumbing and electrical requirements and will bear any additional costs required by other subcontractors as a result of the proposed product.
6. Waives claims for additional costs or time extension which may subsequently become apparent.
7. Will reimburse Owner for review or redesign services associated with re-approval by authorities.

E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, or when acceptance will require revision to the Contract Documents.

F. Substitution submittal procedure:

1. Submit electronic copies of request for substitution for consideration. Limit each request to one proposed substitution.
2. Submit shop drawings, product data and certified test results attesting to the proposed product equivalence.

3. The Engineer will notify Contractor, in writing, of decision to accept or reject request.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

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SECTION 01 7700
PROJECT CLOSEOUT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Closeout procedures

B. Final cleaning

C. Adjusting

D. Project record documents

E. Operation and maintenance data

F. Warranties

G. Spare parts and maintenance materials

1.2 CLOSEOUT PROCEDURES

A. Submit written certification that Contract Documents have been reviewed, Work has been inspected and that Work is complete in accordance with Contract Documents and ready for inspection by Engineer.

B. Provide submittals to Engineer that are required by governing or other authorities.

C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

D. Owner will occupy all portions of the building as specified in Division 01 Section 01 1100, “Summary of Work.”

1.3 FINAL CLEANING

A. Execute final cleaning prior to final inspection.

B. Clean interior surfaces exposed to view; remove temporary labels, stains, and foreign substances; vacuum carpeted and soft surfaces.

C. Clean debris from roofs, gutters, downspouts, and drainage systems.

D. Clean site; sweep paved areas, rake clean landscaped surfaces affected by installation.

E. Remove waste and surplus materials, rubbish and any construction facilities and equipment from the site.

1.4 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

1.5 PROJECT RECORD DOCUMENTS

A. Maintain on site, one set of the following record documents; record actual revisions to the Work:

1. Contract drawings

2. Specifications

3. Addenda
4. Change Orders and other modifications to the Contract
5. Reviewed shop drawings, product data, and samples

B. Store Record Documents separate from documents used for construction.

C. Record information concurrent with construction progress.

D. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:

1. Manufacturer's name and product model and number
2. Product substitutions or alternates utilized
3. Changes made by Addenda and Modifications

E. Record documents and shop drawings: Legibly mark each item to record actual construction including:

1. Field changes of dimension and detail
2. Details not on original Contract drawings

F. Submit changes to Record Documents in AutoCAD format.

G. Delete Engineer title block and seal from all documents.

H. Submit documents to Engineer with claim for final Application for Payment.

1.6 OPERATION AND MAINTENANCE DATA

A. Quality assurance

1. Instructions and data are to be prepared by personnel experienced in maintenance and operation of described products.

B. Binders: Commercial quality, 8½" x 11" 3-D side ring binders with hardback, cleanable, plastic covers; 1" maximum ring size. When multiple binders are used, correlate data into related consistent groupings.

C. Prepare binder covers with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS" and title of project. Include subject matter of binder when multiple binders are required.

D. Internally subdivide the binder contents with permanent page dividers, logically organized as described below with tab titling clearly printed under reinforced laminated plastic tabs.

E. Contents: Prepare a printed Table of Contents for each volume, with each Product or System description identified.

F. Part 1: Directory listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors and major equipment suppliers.

G. Part 2: Operation and maintenance instructions, arranged by system and subdivided by component. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:

1. Significant design criteria.
2. List of equipment.

3. Parts list for each component.
4. Operating instructions.
5. Maintenance instructions for equipment and systems.
6. Maintenance instructions for special finishes, including recommended cleaning methods and materials and special precautions identifying detrimental agents.

H. Part 3: Project documents and certificates, including the following:
1. Shop drawings and product data.
2. Air and water balance reports.
3. Certificates.
4. Photocopies of warranties.

I. Submit one copy of completed volumes in final form 15 days prior to final inspection. This copy will be returned after final inspection with Engineer comments. Revise content of documents as required prior to final submittal.

J. Submit final volumes revised within 10 days after final inspection.

1.7 WARRANTIES

A. Provide duplicate notarized copies.

B. Execute and assemble documents from Subcontractors, suppliers and manufacturers.

C. Provide Table of Contents and assemble in 3-D side ring binder with durable cover.

D. Submit prior to final Application for Payment.

E. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within 10 days after acceptance, listing date of acceptance as start of warranty period.

1.8 SPARE PARTS AND MAINTENANCE MATERIALS

A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification Sections.

B. Deliver to Project site and place in location as directed; obtain receipt from Owner prior to final payment.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

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SECTION 20 0500
BASIC REQUIREMENTS FOR MECHANICAL, PLUMBING, AND FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic mechanical requirements specifically applicable to Divisions 20, 22, and 23.

1.2 DEFINITIONS

A. The following words or phrases have special meaning when used in the article (of the division and in any other requirement) applicable to this discussion:

1. "Exposed to View" or "Exposed" — shall have reference to and mean that the pipes, ducts, etc., insulated or otherwise, in the completed structure are visible within any normally occupied space, room or area.
2. "In Concealed Spaces", "Concealed or "Not Exposed to View" — shall have reference to and mean that the pipes, duct, etc., insulated or otherwise are concealed and not exposed to view within furred spaces, above suspended ceilings, pipe chases, etc.
3. "Unfinished Spaces" or "Unfinished Rooms" — shall have reference to areas such as Machine Rooms, Equipment Rooms, or similar areas. Where the words "In Finished Areas" or "Finished Rooms" are used, it shall have reference to rooms or spaces, such as, Reading rooms, Offices, Public Corridors, etc.
4. "Finished Rooms or Spaces" shall refer to areas similar to offices, public corridors, and public toilet rooms.
5. "Provide" — shall be taken to mean "furnish and install" meaning to purchase and deliver to the job site and the installation thereof.
6. "Piping" — shall include, in addition to pipe all fittings, valves, hangers, and other supports, expansion compensators, anchors, and accessories related to such piping including associated insulation.
7. "Ductwork" — shall include, in addition to ducts, all fittings, transitions, dampers, hangers and other supports, fire dampers, access panels, associated insulation and accessories related to such ductwork.
8. "Contractor" in Specifications and Drawing refers to respective Contractor performing that portion of work.
9. "Invert Elevation" (I.E.) means elevation of inside bottom of pipe or duct.
10. "Mechanical Work" is work in Divisions 20, 21, 22, and 23.
    a. NOTE: The words "Contractor shall" are implied and shall be so understood wherever the directions "furnish," "install" or "provide" are used.

1.3 SPECIAL CONDITIONS

A. Minor items and accessories or devices reasonably inferable as necessary to the complete and proper operation of any system shall be provided by the Contractor for such system whether or not they are specifically called for by the specifications or drawings.

B. Where work specified in other sections of the specifications connects to equipment specified in Divisions 20, 22, and 23 Sections, check the required connection to such equipment.

1.4 WORK BY OWNER

A. Refer to General Conditions and Division 01.

1.5 OWNER-FURNISHED PRODUCTS

A. Refer to General Conditions and Division 01.

1.6 ASSIGNMENT

A. Equipment pre-purchased by Owner will be assigned to the successful contractor so that, once selected, that contractor becomes (1) responsible for coordination of the installation and (2) the single construction and warranty period contact for the project thereafter. Bidder agrees to accept, honor and acknowledge Owner's assignment of its obligations under the prepurchase agreement.

B. Pre-purchased packaged rooftop unit and transition curb specification, bid and submittal is included in specification exhibits.

1.7 PROJECT/SITE CONDITIONS

A. Install work in locations shown on drawings, unless prevented by project conditions.

B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to Work specified in other Sections. Obtain permission of Owner before proceeding.

1.8 CONTRACTORS' USE OF PREMISES

A. Refer to General Conditions and Division 01.

B. The Owner will be responsible for the identification and abatement of all hazardous materials and asbestos associated with the project. Although great care will be taken to eliminate any risks, the Contractor must be aware that hazardous materials may exist on site. Therefore, the Contractor shall immediately suspend work and notify the Owner if asbestos or other hazardous material is suspected in the work area of the project.

1.9 WORK SEQUENCE

A. Refer to General Conditions and Division 01.

1.10 FUTURE WORK

A. Refer to General Conditions and Division 01.

1.11 SUMMARY OF PROJECT

A. Refer to General Conditions and Division 01.

1.12 ALLOWANCES

A. Refer to General Conditions and Division 01.

1.13 ALTERNATES

A. Refer to General Conditions and Division 01.

1.14 REFERENCE STANDARDS

A. Refer to General Conditions and Division 01.

1.15 SUBMITTALS

A. Refer to General Conditions and Division 01.

1.16 PROPOSED PRODUCTS LIST

A. Refer to General Conditions and Division 01.

1.17 CONTRACTOR-PREPARED SHOP DRAWINGS

A. Refer to General Conditions and Division 01.

1.18 PRODUCT DATA

A. Refer to General Conditions and Division 01.

1.19 SAMPLES

A. Refer to General Conditions and Division 01.

1.20 MANUFACTURER'S INSTRUCTIONS

A. Refer to General Conditions and Division 01.

1.21 MANUFACTURER'S CERTIFICATES

A. Refer to General Conditions and Division 01.

1.22 QUALITY CONTROL SERVICES

A. Refer to General Conditions and Division 01.

1.23 MANUFACTURER'S FIELD SERVICES AND REPORTS

A. Refer to General Conditions and Division 01.

1.24 CONTRACT CLOSEOUT

A. Closeout procedures

1. Refer to General Conditions and Division 01.

B. Final cleaning

1. Refer to General Conditions and Division 01.

C. Adjusting

1. Refer to General Conditions and Division 01.

D. Project Record Documents

1. Refer to General Conditions and Division 01.

1.25 O&M DATA

A. Quality assurance

1. Refer to General Conditions and Division 01.

B. Format

1. Refer to General Conditions and Division 01.

C. Contents, each volume

1. Refer to General Conditions and Division 01.

D. Manual for materials and finishes

1. Refer to General Conditions and Division 01.

E. Manual for equipment and systems

1. Refer to General Conditions and Division 01.

F. Instruction of Owner personnel

1. Refer to General Conditions and Division 01.

G. Submittals

1. Refer to General Conditions and Division 01.

H. Warranties

1. Refer to General Conditions and Division 01.

1.26 REGULATORY REQUIREMENTS

A. Conform to International Mechanical Code with McHenry County Amendments, State of Illinois Plumbing Code with and NFPA 13, latest editions.

B. Obtain permits and request inspections from McHenry Building Department.

C. Conform to requirements of all other governing agencies and authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 MATERIAL AND EQUIPMENT

A. Refer to General Conditions and Division 01.

2.2 STORAGE AND PROTECTION

A. Refer to General Conditions and Division 01.

2.3 PRODUCT OPTIONS

A. Refer to General Conditions and Division 01.

2.4 SUBSTITUTIONS

A. Refer to General Conditions and Division 01.

PART 3 - EXECUTION

3.1 SCOPE

A. Work included under Divisions 20, 21, 22, and 23 shall include all labor, services, materials and equipment and performance of all work required for installation of mechanical, plumbing, and fire suppression systems as shown on drawings and as herein specified in following sections.

3.2 INTERPRETATION OF CONSTRUCTION DOCUMENTS

A. Should there be discrepancy or a question of intent, refer matter to Engineer for decision before ordering any equipment or materials or before starting any related work.

B. Drawings and specifications are to be taken together. Work specified and not shown, or work shown and not specified shall be performed or furnished as though mentioned in both specifications and drawings. If there is discrepancy between drawings and specifications as to quantity or quality to be provided, the greater quantity or better quality shall be provided.

C. Minor items and accessories or devices reasonably inferable as necessary to complete and proper installation and operation of any system shall be provided by Contractor for such system whether or not specifically called for by specifications or drawings.

D. Engineer may change location of any equipment 5’ and any piping, ductwork, conduit, etc. 10’ in any direction without extra charge, provided such changes are made before installation.

E. Locations of items not definitely fixed by dimensions are approximate only and exact locations necessary to secure the best conditions and results shall be determined at the site and shall be subject to review and approval by Architect.

F. Follow drawings in laying out work, check drawings of other trades to verify spaces in which work will be installed and maintain maximum headroom and space conditions at all points.

1. Where headroom or space conditions appear inadequate, notify Architect or Owner’s field representative before proceeding with installation.

2. Duct and pipe rerouting and duct size changes shall be made at no additional cost to the Owner.

G. Furnish advance information on locations and sizes of frames, boxes, sleeves and openings needed for the work, and also furnish information and shop drawings necessary to permit installation of other work without delay.

H. Where there is evidence that parts of the Work specified in Divisions 20, 21, 22, and 23 will interfere with other work, assist in working out space conditions to make satisfactory adjustments, revise and submit coordinated shop drawings.

I. After review and without additional cost to the Owner, make minor modifications in the work as required by structural interferences, by interferences with work of other sections or for proper execution of the work.

J. Work installed before coordinating with other work so as to cause interference with other work shall be changed and corrected without additional cost to the Owner.

K. Drawings are diagrammatic in nature and are a graphic representation of requirements and shall be followed as closely as actual building construction will permit. All changes from the plans necessary to make the work conform to the building as constructed and to fit the work of other trades or to conform to rules of the Governmental Authorities having jurisdiction, NFPA, OSHA and the Owner’s Insurance Underwriters, shall be made by the Contractor without extra cost to the Owner.

L. The layout of the piping, ductwork, equipment, etc., as shown on the drawings shall be checked and exact locations shall be determined by the dimensions of the equipment approved and the Contractor shall obtain approval for the revised layout before the apparatus is installed. The Contractor shall field measure or consult existing record architectural and structural drawings if available for all dimensions, locations of partitions, locations and sizes of structural supports, foundations, etc.

M. Omission in the drawings and/or specifications of any items necessary for the proper completion or operation of the work outlined in this specification shall not relieve the Contractor from furnishing same without additional cost to the Owner.

N. The equipment shop drawings will be furnished to the Contractor before roughing in. Contractor shall not install any piping or ductwork for said equipment until he has received approved shop drawings for same.

3.3 PROJECT/SITE CONDITIONS

A. Each Contractor shall visit the site prior to bid submission to determine all existing conditions that may affect his work and shall make appropriate allowances for such conditions in his bid. Failure to visit the site shall not be cause for a request for additional compensation later in the project during construction.

B. Install work in locations shown on drawings, unless prevented by project conditions.

C. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to work specified in other Sections. Obtain permission of Owner/Engineer before proceeding.

3.4 ALTERATIONS IN PRESENT BUILDING AND SYSTEMS

A. Contractor shall take particular note of the revisions and alterations to the existing systems, facilities and equipment due to the new construction as indicated on the drawings and/or in specification. Contractor shall remove, reroute or alter all services, ductwork, etc., as required or as indicated on the drawings.

1. The Contractor shall maintain all services in the existing building. In case, where new service connections are to be made to existing services and service interruptions can in no way be avoided, the service interruptions shall be with the minimum of inconvenience to the Owner and the work shall be done at such time of any day, Saturday and Sunday included, and only as directed by the Owner or the Architect.

3.5 ERECTION & WORKMANSHIP

A. Contractor is to be responsible for all work fitting into place in satisfactory, neat and workmanlike manner in every particular, to approval of Engineer.

B. Unless explicitly stated to contrary, each Contractor shall furnish and install each item of equipment or material hereinafter specified, complete with all necessary fittings, supports, trim, piping, insulation, etc., as required for complete and operating installation.

C. Equipment and materials shall be installed according to manufacturer's instruction unless otherwise specifically directed by Contract Documents.

D. Contractor shall provide all necessary OSHA approved rigging, scaffolding, tools, tackle, labor, etc., necessary for the complete installation of the equipment.

E. Contractor shall adapt his work to job conditions and make such changes as required and permitted by the Architect such as moving his work to clear beams, joints, light fixtures, etc., adjusting risers, etc. avoiding interferences with windows and openings, etc. raising or lowering his work to permit the passing of ductwork or the work of other trades, etc., all as required or as job conditions dictate, without any additional costs to the Owner.

F. All appliances and equipment shall be installed and connected with best engineering practices and in accordance with the manufacturer's best instructions and recommendations.

G. Work done by Contractor at the site in the execution of this project shall be performed only by skilled mechanics, recognized as such in their respective trades in the direct employ either of the Contractor proper or of affiliate firms which have a longstanding and continuing formal agreement with the Contractor for providing the rendered services on similar work of this type.

3.6 PROTECTION FROM INJURY

A. All pipes, fixtures, traps, equipment, and other parts of the Work shall be protected against injury by freezing or exposure to the weather during construction while stored or installed in place.

3.7 MECHANICAL AND ELECTRICAL WORK COORDINATION

A. Refer to General Conditions and Division 01.

3.8 CUTTING AND PATCHING

A. Refer to General Conditions and Division 01.

3.9 ACCESS PANELS

A. Where control valves, shutoff valves, drip traps, heating coils, dampers, pull boxes or other specialties, which require service or adjustment, are installed above inaccessible type furred ceilings or within furred walls, Contractor whose equipment is involved shall furnish and install access panels as required.

B. Access panels shall be of sufficient size to make possible servicing, adjustment, removal and replacement of concealed equipment through opening provided. Panels shall be sized as shown on drawings, or if sizes are not shown, shall be minimum of 16" x 24" in walls and 24" x 24" in ceilings.

C. Contractor shall confer with other trades with respect to access panel locations and shall, wherever practical, group valves, traps, dampers, etc. in such way as to be accessible from single panel and eliminate as many access panels as possible.

D. Submit shop drawings for review before ordering panels. Where fire rating is required, furnish label doors compatible with fire rating of assembly.

3.10 SOUND CONTROL

A. Piping, ductwork, etc. shall pass through sleeves tightly packed with glass fiber or oakum and caulked on both sides with non-hardening acoustical sealant. Refer to Division 20 Section 20 0517, "Penetrations for Mechanical, Plumbing, and Fire Suppression."

3.11 PROTECTION OF ELECTRICAL EQUIPMENT

A. Contractor shall furnish and install sheet metal drain pans beneath piping that is routed above electrical equipment and/or above the 3' access space in front of such equipment. Electrical equipment, for the purpose of addressing drain pan requirements, shall be defined as free-standing

or wall-mounted switchgear, transformers, distribution boards or motor control centers. Piping includes, but is not limited to, plumbing, fire suppression, mains (not branch piping with sprinkler heads), hydronic heating or cooling, steam and condensate, and fuel systems.

1. Drain pans shall be 20-gauge galvanized sheet metal with a minimum 4" high turned-up edge. Bottom of drain pan shall slope to a single drainage point at ⅛" per foot. A 1" diameter clear plastic tube shall allow collected fluid to drain to the nearest open site floor drain. Secure plastic tubing to building structure only.
2. Drain pan shall be hung from building structure with angle iron trapeze hangers (no hanger shall penetrate the drain pan). Consider drain pan to be full of water for hanger load calculations.
3. Drain pans shall include liquid detectors with alarms only if noted on the drawings.

B. Provide sprinkler heads beneath drain pan only as required by NFPA.

C. Contractor shall include provisions to adjust the local lighting layout, at no extra cost to Owner, in order to accommodate any detrimental effect the drain pan has on the illumination of the electrical equipment and access space.

3.12 STARTING OF SYSTEMS

A. Refer to General Conditions and Division 01.

3.13 TESTING, ADJUSTING AND BALANCING

A. Contractor shall appoint, employ and pay for services of independent firm to perform testing, adjusting and balancing.

B. Independent firm will perform services specified in General Conditions,[Division 01 Section 01 4000, "Quality Control Services" and Division 23 Section 23 0593, "Testing, Adjusting, and Balancing for HVAC," except for factory tests.

C. Reports will be submitted by independent firm to Engineer indicating observations and results of tests and indicating compliance or non-compliance with specified requirements and with requirements of Contract Documents.

3.14 ALTERATION PROJECT PROCEDURES

A. Refer to General Conditions, Division 01, and Division 20.

3.15 DEMONSTRATIONS AND INSTRUCTIONS TO OWNER PERSONNEL

A. Refer to General Conditions and Division 01.

END OF SECTION

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SECTION 20 0501
MINOR MECHANICAL, PLUMBING, AND FIRE SUPPRESSION DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Minor demolition specifically applicable to Divisions 20, 22, 23, 27, and 28.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Refer to General Conditions and Division 01.

B. Materials and equipment for patching and extending work: As specified in individual Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify field measurements, equipment location, piping and ductwork sizes and arrangements as shown on drawings.

B. Verify that abandoned piping, ductwork and equipment serve only abandoned facilities.

3.2 PREPARATION

A. Disconnect mechanical systems in walls, floors and ceilings scheduled for removal.

B. Existing mechanical systems: Maintain existing system in service until Owner approved shutdown. Obtain permission from Owner at least 7 days before completely disabling system. Minimize shut-down duration. Work to be performed with single shutdown and on premium time.

3.3 DEMOLITION AND EXTENSION OF EXISTING SYSTEMS

A. Demolish and extend existing work under provisions of General Conditions, Division 01, Division 02, and this Section.

B. In general, mechanical, plumbing and electrical remodeling work is shown on drawings but carefully study all drawings for all contracts for “demolition” and “remodeling” work in existing building and field check to verify locations where such work is being done to determine exact extent of work required. No extra will be allowed for additional work required because of demolition or remodeling whether or not work is specifically noted, itemized or shown on drawings.

C. Remove existing equipment and materials pertaining to contract as specified or as required, whether shown on drawings or not, to prepare for new work of all contracts.

D. Where necessary, reroute piping, ducts, etc. from within walls, floors, ceilings, etc. being removed. Contractor involved with interrupted service shall be responsible for accomplishing required work whether shown on drawings or not.

E. Cap all abandoned or terminated piping, etc. below floor, behind wall surface, above ceiling, etc., as required to be completely concealed after new work is complete.

F. Cap or plug all pipes, valves, fittings, etc. left open after demolition if they are not to be reused.

G. Maintain access to existing mechanical installations which remain active. Modify installation or provide access panel as appropriate.

H. Extend existing installations using materials and methods compatible with existing mechanical installations, or as specified.

3.4 DISPOSITION OF REMOVED EQUIPMENT

A. Where existing materials or equipment are specified to be removed from service, respective Contractor shall take possession of same, coordinate with Owner where items are to be stored or remove unwanted items from site promptly, except as specified below or unless otherwise noted on drawings.

B. Existing equipment or systems, etc. which are specified to be replaced by new equipment, or system etc. shall not be removed from service until the new equipment, materials, systems, etc. have actually arrived at project site.

3.5 CLEANING AND REPAIR

A. Refer to General Conditions and Division 01.

B. Clean and repair existing materials and equipment which remain or are to be reused.

END OF SECTION

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SECTION 20 0517
PENETRATIONS FOR MECHANICAL, PLUMBING, AND FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Sleeve and sleeve seal for penetration through walls, floors, and roofs, specifically applicable to Divisions 20, 21, 22, and 23 including:

1. Pipe sleeves and sleeve seals for pipe penetrations
2. Duct sleeves for duct penetrations
3. Firestopping
4. Flashing

1.2 DEFINITIONS

A. Firestopping (through-penetration protection system): Sealing or stuffing material or assembly placed in spaces between, and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.3 CODES AND STANDARDS

A. American Society of Mechanical Engineers (ASME):

1. ASME B31.1: Power Piping
2. ASME B31.9: Building Service Piping Code
3. ASME B36.10: Welded and Seamless Wrought Steel Pipe

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

1. ASTM A53: Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

C. National Fire Protection Association (NFPA):

1. NFPA 13: Installation of Sprinkler Systems
2. NFPA 14: Installation of Standpipe and Hose Systems

D. Underwriters Laboratories Inc. (UL):

1. UL 203: Pipe Hanger Equipment for Fire Protection Service
2. UL 1479: Fire Tests of Through-Penetration Firestops

1.4 SUBMITTALS

A. Preconstruction – Prior to construction provide the following in accordance with Division 01 and Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Product data: Submit product data on all sleeves and fire stopping materials including:
    a. Materials
    b. Finishes
    c. Approvals

d. Dimensional information

B. Contract Closeout – At contract closeout provide the following in accordance with Division 01 and Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Operating and Maintenance Data including:
   a. Product data
   b. Installation instructions
   c. Assembly drawings
   d. Replacement parts list
   e. Maintenance and operation instructions
2. Warranties

1.5 DELIVERY, STORAGE AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.6 SPARE PARTS

Not Applicable

1.7 WARRANTY

A. One-year warranty on products and complete installation commencing at the time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PIPE SLEEVES AND SLEEVE SEALS FOR PIPE PENETRATIONS

A. Roof

1. Plumbing vent stack sleeve fitting: Vent stack flashing sleeve; lacquered, coated cast iron body with adjustable combination membrane flashing flange and clamp. Basis of Design: Zurn Model Z-195-10.
2. All other penetrations: Provide and install a pipe penetration roof curb as specified in Division 20 Section 20 0529, “Hangers and Supports for Mechanical, Plumbing and Fire Suppression Systems.”

2.2 DUCT SLEEVES FOR DUCT PENETRATIONS

A. Non-fire rated walls

1. Field formed 18-gauge galvanized steel sleeve.
2. Size sleeves large enough to provide for continuous insulation wrapping.

B. Roof – Provide and install a duct penetration roof curb as specified in Division 20 Section “Hangers and Supports.”

2.3 FIRE STOPPING

A. Approved manufacturers

1. Hilti
2. 3M

B. Provide firestopping products that are compatible with one another, with the substrates forming openings, and with the items penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by firestopping products manufacturer based on testing and field experience.

C. Provide components for each firestopping system that are needed to install fill materials. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

D. Use only firestopping products that have been tested for specific fire-resistance-rated construction conditions conforming to construction assembly type, penetrating item type or joint opening width and movement capabilities, annular space requirements, and fire-rating involved for each separate instance.

E. Performance requirements

1. Provide products that upon curing, do not re-emulsify, dissolve, leach, breakdown, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during and after construction.
2. Provide firestop sealants sufficiently flexible to accommodate motion such as pipe vibration, water hammer, thermal expansion and other normal building movement without damage to the seal.
3. Pipe and duct insulation shall not be removed, cut away or otherwise interrupted through wall or floor openings. Provide products appropriately tested for the thickness and type of insulation utilized.
4. Penetrants passing through fire-resistance rated floor-ceiling assemblies contained within chase wall assemblies shall be protected with products tested by being fully exposed to the fire outside of the chase wall. Systems within the UL Fire Resistance Directory that meet this criterion are identified with the words “Chase Wall Optional”.
5. Provide through-penetration firestop systems subjected to an air leakage test conducted in accordance with the Standards, ANSI/UL1479 for penetration and ANSI/UL2079 for joint systems, with published L-Ratings for ambient and elevated temperatures as evidence of the ability of the firestop system to restrict the movement of smoke.
6. Provide T-rating collar devices tested in accordance with ASTM E-814 or ANSI/UL1479 for metallic pipe penetrations requiring T-Ratings per the applicable building code.

F. Materials

1. Firestopping sealants: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No. 1168.
2. Primers, sleeves, forms, insulation, packing, stuffing, and accessories: Type required for tested assembly design.

2.4 FLASHING

A. Built-up bituminous membrane roof flashing

1. Composition flashing system: Composition flashing system shall be by the same manufacturer as the roofing system, and shall be asphalt-saturated and coated felt, reinforced with woven cotton fabric.

2. Flashing cement: Bituminous product expressly recommended by the roofing materials manufacturer for flashing work on vertical surfaces, asphaltic flashing cement or flashing compound of troweling consistency.

3. Fabric reinforcement: Asphalt-saturated cotton fabric, treated with asphaltic resin, meeting requirements of ASTM D173, or woven glass fabric, treated with asphalt resin, meeting requirements of ASTM D1668, as applicable.

4. Bituminous plastic cement: Asphaltic plastic cement, meeting requirements of ASTM D2822 or D4586.

B. Modified bituminous membrane roof flashing

1. Provide sheet flashings, preformed inside and outside corner sheet flashings, in-seam sealants, and other accessories compatible with roofing membrane and recommended by roofing system manufacturer for specified system, fire resistance, and warranty.

C. Elastomeric membrane roof flashing

1. Flexible flashing material: Same material as membrane.
   a. Thickness: 60 mil
   b. Color: Match membrane

PART 3 - EXECUTION

3.1 ABOVE GROUND PENETRATION INSTALLATION

A. Where insulated ducts or pipes which pass through sleeves, the sleeves shall be of sufficient size to permit the full specified thickness of insulation to pass through sleeves.

B. The contractor shall not drill holes through, cut or otherwise damage any beam or column of the building's structural frame.

3.2 FLASHING

A. Built-up bituminous roof flashing

1. Flashing shall be installed at junctures in the roofing system; in the angles formed where the roof deck abuts curbs, ventilators, pipes, and other vertical surfaces; and where necessary to make the work watertight; and in accordance with the membrane manufacturer's requirements and recommendations.

2. Outlets: Properly seal drains, outlets, and penetrations in accordance with roofing manufacturer's specifications and as indicated.

3. Pipes, vents, gravel stops, and flashings: Install flanges of such items on top of last roofing ply in full bed of plastic cement ¼" thick. Flanges shall then be covered with two additional plies of felt, 4" and 6" inches respectively, in full bed of plastic cement, feathered onto roofing.

4. Flashing systems shall consist of an approved system of the roofing materials, manufacturer and shall be applied over flat portion of roof perimeters and extended up over cant strips and up sloping and vertical surfaces fully height to under metal counter-flashings. Roof flashings shall be left in watertight condition by applying plastic cement to any and all areas not yet covered by metal flashings or counter-flashings.

5. Apply fabric reinforcement in hot asphalt or plastic cement at transitions, over joints, cracks, and other surfaces where fabric reinforcement is required or recommended.

B. Modified bituminous membrane roof flashing

1. Sheet flashing: Apply modified bitumen sheet flashing matching the roofing system in the angles formed where the roof deck abuts curbs, ventilators, pipes, and other vertical surfaces, and where necessary to make the work watertight, and in accordance with the membrane manufacturer's requirements and recommendations. Install using hot asphalt. Seal flashings and flanges of items penetrating the roof membrane with two plies of sheet flashing.

C. Elastomeric membrane roof flashing

1. Use roofing manufacturers pre-molded flashings to the greatest extent possible. Where not possible, obtain manufacturers recommended flashing detail requirements in writing.

3.3 CLEANING

A. Clean sleeves with fire, smoke and fume stopping materials as follows.

1. Remove damming materials where necessary after material has cured.

2. Clean up adjacent surfaces with Xylene or other approved cleaning agent.

END OF SECTION

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SECTION 20 0529
HANGERS AND SUPPORTS FOR MECHANICAL, PLUMBING AND FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Hangers and supports specifically applicable to Divisions 20, 22, and 23, including:

1. Duct hangers
2. Upper attachments
3. Roof supports
4. Miscellaneous materials

1.2 CODES AND STANDARDS

A. American Society of Mechanical Engineers (ASME)

1. ASME B31.1: Power Piping
2. ASME B31.9: Building Services Piping

B. American Society for Testing and Materials (ASTM)

1. ASTM A1011: Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability *(Formerly ASTM A570)*
2. ASTM A123: Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
3. ASTM A36: Steel Plates, Shapes and Bars
4. ASTM A653: Specification for Steel Sheet, Zinc-Coated by the Hot-Dip Process
5. ASTM B633: Specification for Electrodeposited Coatings of Zinc on Iron and Steel
6. ASTM C404: Uniformly Graded Natural Sand
7. ASTM E-814: Fire Tests of Through-Penetration Fire Stops

C. American Welding Society (AWS)

1. Specifications for Qualification of Welding Procedures and Welders

D. American Water Works Association (AWWA)

E. International Conference of Building Officials (ICBO)

1. ICBO: Uniform Building Code

F. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)

1. MSS SP 58: Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation
2. MSS SP 89: Pipe Hangers and Supports - Fabrication and Installation Practices

G. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1. SMACNA: HVAC Duct Construction Standards, Metal and Flexible

H. Underwriters Laboratories, Inc. (UL)

1. UL 1479: Fire Tests of Through Penetration Firestops and Building Joint Systems

I. Factory Mutual (FM)

1.3 QUALITY ASSURANCE

A. Supports for mechanical and plumbing piping: Provide products in compliance with MSS Standards:

1. Provide pipe hangers and supports of which materials, design and manufacture comply with MSS SP-58.

2. Select and apply pipe hangers and supports, complying with MSS SP-58.

3. Fabricate and install pipe hangers and supports, complying with MSS SP-89.

4. Terminology used in this section is defined in MSS SP-90.

B. Structural steel welding qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe welding qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.4 SUBMITTALS

A. Preconstruction – Prior to construction provide the following in accordance with Division 01 and Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Product data: Submit product data on all hanger and support devices, including shields and attachment methods. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.

B. Contract Closeout – At contract closeout provide the following in accordance with Division 01 and Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Warranties

1.5 DELIVERY, STORAGE AND HANDLING

A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.

B. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

PART 2 - PRODUCTS

MSS Types are shown in diagrams at end of document for reference.

2.1 DUCT HANGERS

A. Cable type

1. Approved manufacturers

a. Gripple

b. Duro Dyne

2. Cable type duct hangers shall be an engineered manufactured product supplied as a complete duct hanging system by the manufacturer.

3. Cable type duct hangers shall be provided and installed according to the manufacturer's recommendations.
4. Cable lock
    a. Cable locks shall have an ultimate breaking strength of at least 5 times the published working load limit.
    b. Cable locks shall be constructed of zinc alloy for interior use and stainless steel for exterior use.
    c. Cable locks shall be suitable for use up to 300°F.
5. Cable
    a. Wire rope shall be galvanized steel of $^{3}/_{16}$" or ⅛" diameter.
    b. All wire rope shall have an ultimate breaking strength of at least 5 times the published working load limit.
6. Duct trapeze
    a. Duct trapeze bracket shall include a cable lock which fastens to the duct utilizing sheet metal screws.
    b. Duct trapeze bracket shall have an ultimate breaking strength of at least 5 times the published working load limit.
7. Upper attachments
    a. Stud
        (1) Zinc coated steel threaded rod stud for connection of cable to building structure.
        (2) Stud shall be connected to structure by screwing into a drop-in anchor set in concrete structure or by screwing into a C-clamp (MSS Type 19 or 23) or beam clamp (MSS Types 20, 21, 25, 27, 28, 29, or 30) attached to steel structure.
        (3) Stud shall have an ultimate breaking strength of at least 5 times the published working load limit.
    b. Loop
        (1) Loop cable around building structure and lock utilizing cable lock.

2.2 UPPER ATTACHMENTS

A. Concrete and masonry drilled in anchors
1. Wedge anchor
    a. Approved manufacturers
        (1) ITW Red Head
        (2) Hilti
        (3) Powers
    b. Wedge type, torque-controlled, with impact section to prevent thread damage complete with required nuts and washers. Provide anchors with length identification markings conforming to ICC ES AC01 or ICC ES AC193.
    c. Anchor shall be listed with ICC-ES.
    d. Interior use: Carbon steel anchors with zinc plating
    e. Exterior use: Stainless steel anchors of AISI Type 304 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or

greater than the specified minimum full-size tensile strength of the externally threaded fastener. Stainless steel nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.

f. Basis of Design: Hilti Kwik Bolt 3

2. Screw anchors

a. Approved manufacturers

(1) ITW Red Head

(2) Hilti

(3) Powers

b. Screw type: Pre-drilling of the hole requires a standard ANSI drill bit with the same diameter as the anchor and installing the anchor will be done with an impact wrench. Provide anchors with a diameter and anchor length marking on the head.

c. Anchor shall be listed with ICC-ES.

d. Interior use: Carbon steel anchors with zinc plating

e. Basis of Design: Hilti Kwik-Hus

B. Metal deck

1. Metal deck with concrete topping on structural steel: Support hangers from 1½" x 1½" x ⅛" x 12" long angles set on deck over holes drilled in deck and across corrugations, before pouring of concrete topping or from beam clamps fastened to structural steel

2. Metal deck on bar joist: Support hangers from MSS type 21 center beam clamps fastened at the plates along the top or bottom chord or to auxiliary steel between bar joists

2.3 ROOF SUPPORTS

A. Equipment rail support

1. Acceptable manufacturers:

a. Pate

b. Thybar

2. Factory fabricated 18-gauge galvanized sheet steel structural members with internal bulkheads spaced to provide high load-bearing capacity of roof mounted equipment

3. Support shall incorporate a continuous 2x4 treated wood nailer covered by a removable counter flashing to allow for watertight roofing installation.

4. Support shall be designed to be compatible with roofing system and roofing pitch.

B. Multiple pipe penetration curb

1. Acceptable manufacturers:

a. Pate

b. Thybar

2. Factory fabricated 18-gauge galvanized sheet steel curb with full mitered corners, fully welded seams, continuous 2x2 pressure treated wood nailer, and factory installed 1½" thick, 3 pounds per cubic foot density rigid insulation.

3. Support shall be designed to be compatible with roofing system and roofing pitch.

4. EPDM compression molded rubber cap for single or multiple pipes as required.
5. Stainless steel draw-band clamps.

C. Permanent pipe support

1. Acceptable manufacturers:
   a. Pate PRS/MPRS
2. Factory fabricated 18-gauge galvanized sheet steel support curb with fully welded corner seams, 2x4 pressure treated wood nailer, and 18-gauge galvanized steel counterflashing with galvanized steel channel track attached.
3. Vertical and horizontal adjustable roller assembly of galvanized steel channel track, galvanized steel fittings, washers and nuts and a painted cast iron roller.
4. Support shall be designed to be compatible with roofing system and roofing pitch.

2.4 MISCELLANEOUS MATERIALS

A. Metal framing: Provide products complying with NEMA STD ML 1.

B. Steel plates, shapes and bars: Provide products complying with ASTM A 36.

C. Cement grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.1 DUCT HANGERS

A. Duct hanging system shall be at contractor's option. Comply with SMACNA - HVAC Duct Construction Standards, Metal and Flexible and meet with approval of Engineer.

B. Vertical ducts through floor slabs: Are to be supported on two sides by galvanized steel angles bolted to duct and resting on floor slab. Supporting angles are to be bolted to floor, ceiling or wall to prevent vibration.

C. Vertical ducts in open shafts: Provide additional galvanized structural steel members to span openings for support of ducts and angles at each floor.

D. Ducts along walls: Are to have supports spaced not more than 8 feet apart.

E. Provide hangers at the center of every ell or change in direction of horizontal ductwork.

F. Wire strap or perforated hangers will not be permitted.

3.2 UPPER ATTACHMENTS

A. In remodeled areas, provide expanding concrete anchors. Holes for expanding fasteners to be drilled either by carbide bit or by teeth on fastener itself. Expansion shield to be "set" by driving it into hole and expanding it with conical plug.

3.3 ROOF SUPPORTS

A. Verify that roofing system is complete and roof surfaces are smooth, flat, and ready to receive work of this section.

B. Clean surfaces of roof in areas to received supports.

C. Install in accordance with manufacturer's instructions. Provide flexible sheet flash and counterflash with sheet metal and caulk as necessary to make installation watertight. Weld, bolt, or screw roof curbs as instructed by manufacturer.

D. Equipment supports

1. Locate bases and support framing as required by equipment manufacturer. Provide complete and adequate support of equipment whether or not all required devices are shown.

E. Pipe and duct supports

1. Locate bases and support framing as indicated on drawings and as specified herein. Provide complete and adequate support of all piping and ducts whether or not all required devices are shown.

2. The use of wood for supporting piping is not permitted.

3. Provide supports spaced so deflection of piping does not exceed L/240 of span.

4. Install framing at spacing indicated, but in no case at greater than 10 feet (3 m) on center.

3.4 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 Section 20 9100 Painting for Mechanical, Plumbing, and Fire Suppression

C. Galvanized surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

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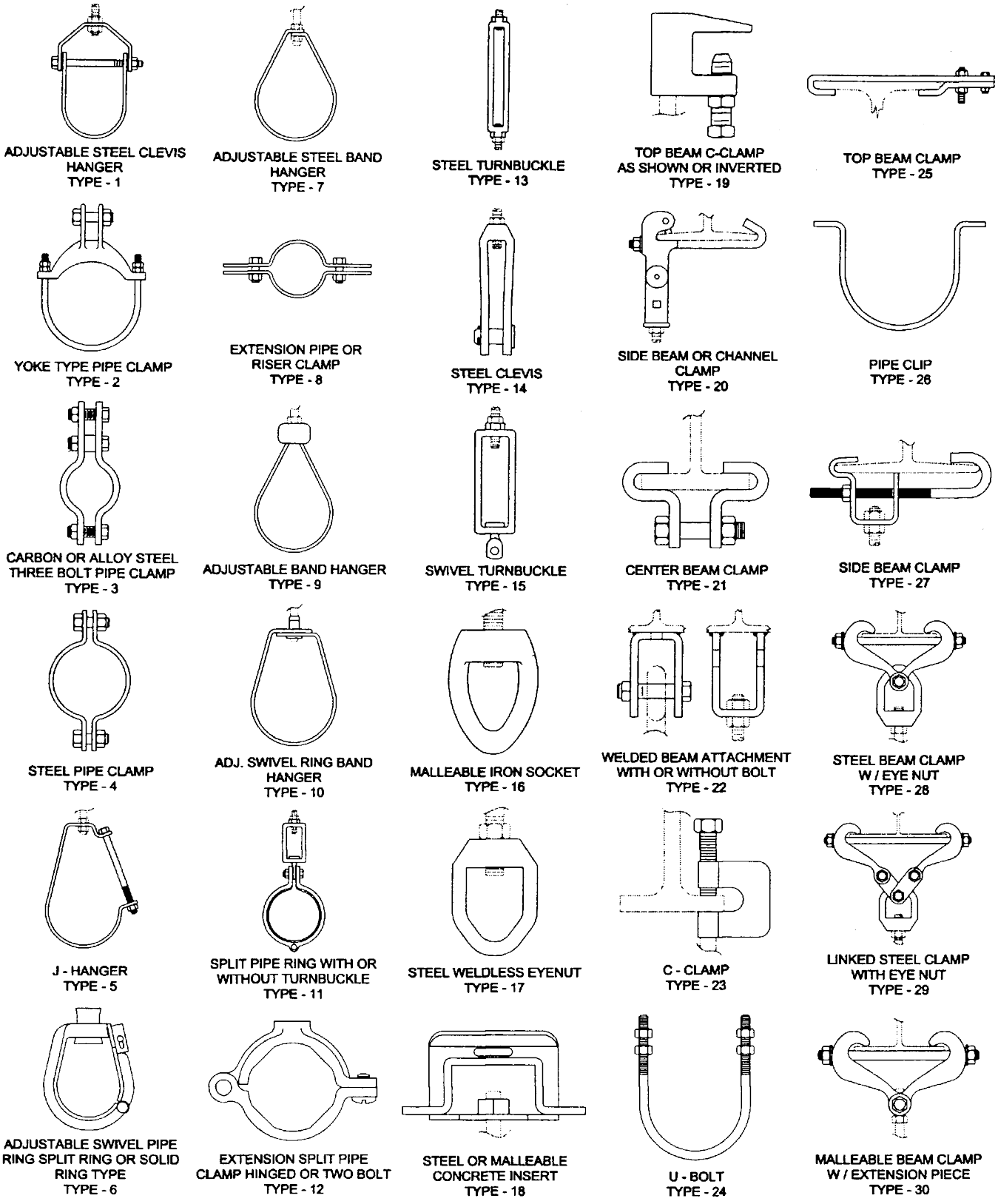

FIGURE 1. TYPE CHART

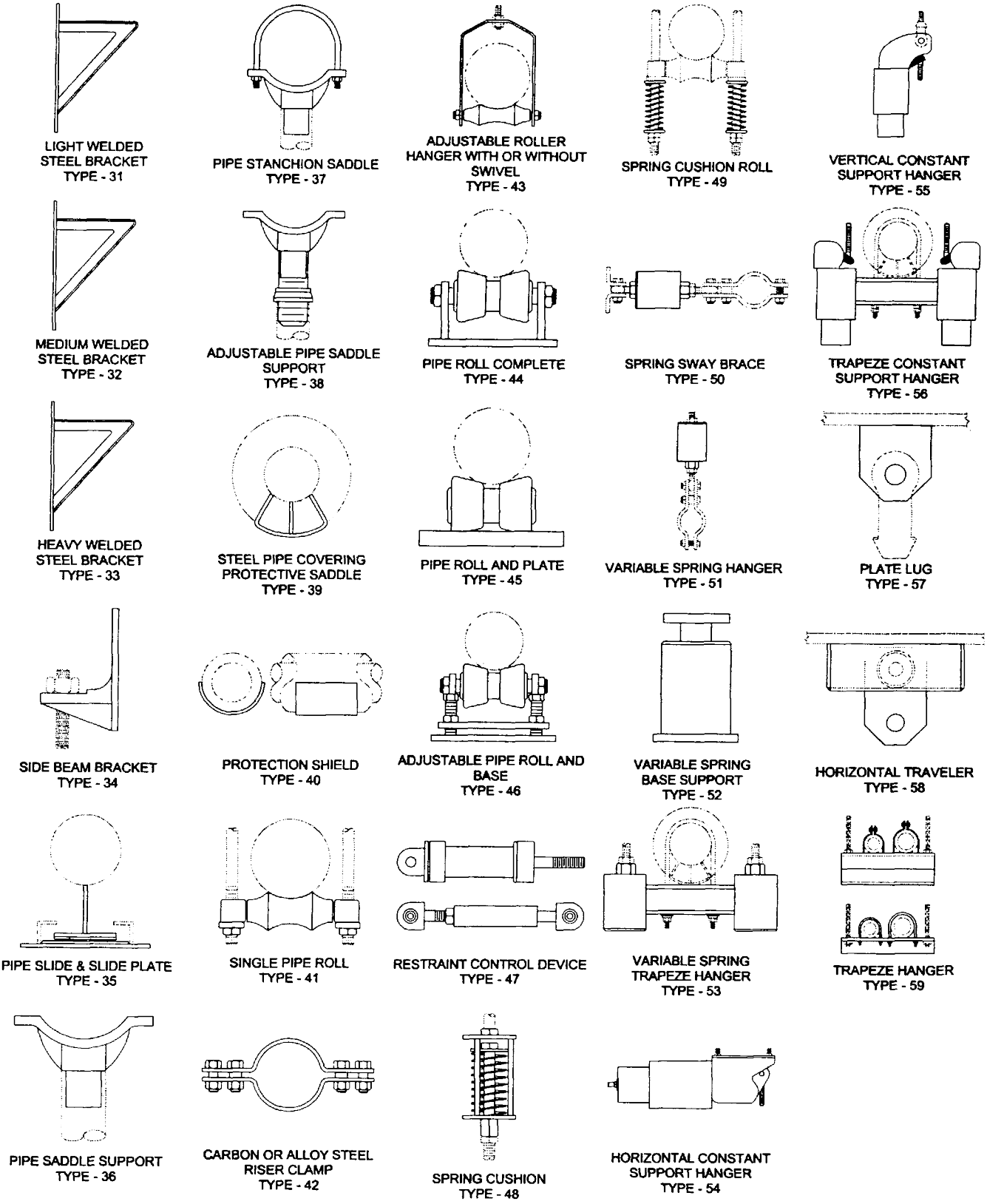

FIGURE 1. TYPE CHART

IDENTIFICATION FOR MECHANICAL, PLUMBING, AND FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Identification of mechanical products installed under Divisions 20, 21, 22, and 23 as defined below:

1. Equipment labels
2. Labels for miscellaneous electrical for temperature controls

1.2 DEFINITIONS

A. AHU: Air-handling unit

B. DI: Deionized

C. OD: Outer diameter based on pipe outside diameter; for the purpose of this specification section, the outer diameter of pipe with insulation includes the insulation.

D. RO: Reverse osmosis

E. TC: Temperature controls

1.3 CODES AND STANDARDS (USE LATEST EDITION)

A. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)

1. ANSI/ASME A13.1: Scheme for the Identification of Piping Systems.

B. American Public Works Association (APWA)

1. APWA Uniform Color Code for marking underground utility lines.

C. ASTM International (ASTM)

1. ASTM D882: Standard Test Method for Tensile Properties of Thin Plastic Sheeting
2. ASTM D2103: Standard Specification for Polyethylene Film and Sheeting
3. ASTM D2578: Standard Test Method for Wetting Tension of Polyethylene and Polypropylene Films

D. International Codes

1. International Mechanical Code (IMC)

E. Underwriters Laboratories Inc. (UL)

1. UL E-84-03: Standard Test Method for Surface Burning Characteristics of Building Materials.

1.4 QUALITY ASSURANCE

A. For hydronic piping, conform to ANSI/ASME A13.1 requirements for color, length of color field and letter height.

B. Label fire dampers, smoke dampers and combination fire/smoke dampers per IMC.

C. Stencils shall not be used.

D. Labels/markers listed by the manufacturer as “economy” or “value” shall not be used.

1.5 SUBMITTALS

A. Preconstruction – Prior to construction provide the following in accordance with Division 01 and Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Product Data: For each type of product indicated provide:
    a. Manufacturer's data including colors, materials, wording, symbols, letter size, methods of attachment and color coding for mechanical and electrical identification of piping, ductwork and equipment.
    b. Submit manufacturer's installation instructions.
    c. Valve Schedule: Submit proposed valve identification for approval prior to installing valve tags. Include valve tag number, location, system served, and function.

B. Contract Closeout – At contract closeout provide the following in accordance with Division 01 and Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Valve Schedule: Provide "as-installed" valve tag schedule indicating valve tag number, location, system served, and function for Owner at completion of project.
2. Warranties

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Brimar Identification and Safety Products

B. Kolbi Pipe Marker Co.

C. Marking Services Inc. (MSI)

D. Seton Identification and Safety

2.2 EQUIPMENT LABELS

A. General requirements for equipment labels

1. Label content: Include equipment's Drawing designation or unique equipment number.
2. Equipment label schedule: For each item of equipment to be labeled provide am equipment label schedule on 8½" x 11" bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.
3. Label size: Length and width may vary for required label content shall not be less than 2" x 4".
4. Lettering size: A minimum letter size of 1½" high. If label must be viewed from greater than 72" away, the minimum text size is 1½". Secondary lettering shall be two-thirds to three-fourths the size of principal lettering.

B. Indoor equipment labels

1. Multilayer, multicolor, three-ply plastic labels for mechanical engraving and having predrilled holes for attachment hardware. Able to withstand temperatures up to 160°F. Minimum plastic label thickness shall be as follows:

a. 1/16" for labels up to and including either a maximum area of 18 square inches or 6" in lengths.

b. ⅛" for labels larger than either 18 square inches in area or 6" in length.

2. Contact-type permanent adhesive, compatible with label and with substrate shall be utilized.

3. Basis of Design MSI Engraved Plastic Equipment Tags & Signs

C. Outdoor equipment labels

1. Label shall be constructed of printed legends sealed between two layers of chemically resistant plastic and should be designed for outdoor duty and exposure to sun light. Labels shall have predrilled holes with stainless steel grommets for attachment hardware.

2. Service temperature range of -40°F to 200°F

3. Fasteners: Self-tapping stainless-steel screws.

a. Adhesive backing is acceptable only where screws cannot or should not penetrate the surface to which is attached. Contact-type permanent adhesive, compatible with label and with substrate shall be utilized.

4. Basis of Design: MS-215 MAX-TEK Equipment Tags & Signs

2.3 LABELS FOR MISCELLANEOUS ELECTRICAL FOR TEMPERATURE CONTROLS

A. Self-adhesive pipe labels

1. Printed plastic with contact-type, permanent-adhesive backing

2. Black text on orange labels

3. Basis of Design: MSI-900 Conduit and Electrical ID

PART 3 - EXECUTION

3.1 INSTALLATION

A. General installation requirements

1. 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.

2. Install marking in accordance with manufacturer's installation instructions.

3. Install identification prior to installation of acoustic ceiling and similar removable concealment.

4. Provide custom pipe and duct labels when standard labels meeting the requirements of this specification are not available.

B. Additional requirements for equipment labels

1. Provide labeling for all mechanical and plumbing equipment including but not limited to the equipment defined below. Equipment label text shall provide the name and number of the identified equipment, as well as the system or location which the equipment serves. Indicate when equipment is stand-by. Examples of the required text is given below:

a. AHUs: (e.g. AHU-1, air handling unit serving 1st floor west)

b. Temperature control panels and other major control equipment

2. Confirm equipment numbering scheme with Owner; provide different numbering scheme than that shown on drawings if required by Owner. If Owner has no preference, number as shown on drawings.

C. Additional requirements for labels for miscellaneous electrical for temperature controls

1. Identify temperature control conduit and electrical conduit installed as part of the temperature control work.

END OF SECTION

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SECTION 20 0700
THERMAL INSULATION FOR MECHANICAL, PLUMBING AND FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Products furnished and installed under this section:

1. Duct and equipment insulation
2. Insulation accessories

B. Repairs to all existing insulation cut or damaged by work performed under this Contract.

1.2 DEFINITIONS

A. ASJ: All Service Jacket (no outer film)

B. ASJ+: All Service Jacket with an outer film layer leaving no paper exposed.

C. Concealed applications: Insulation on ductwork, piping or equipment that is located in a concealed area not visible to the building occupants such as behind walls and above ceilings.

D. Ductwork insulation: Thermal insulation applied to limit or reduce heat transmission to or from a duct system.

E. EPA: Environmental Protection Agency.

F. Equipment insulation: Thermal insulation applied to limit or reduce heat transmission to or from a piece of equipment that is part of a plumbing, heating or cooling system.

G. Exposed applications: Insulation on ductwork, piping or equipment that is located in an area such that is visible by the building occupants such as within a mechanical room or located in a space where there is no ceiling and all ductwork and piping is exposed.

H. FSK: Foil Scrim Kraft; jacketing

I. Insert: Spacer placed between the equipment support system and the equipment to allow for the space required for insulation.

J. Insulation shield: Buffer material placed between the equipment support system and the insulation to prevent the insulation material from being crushed.

K. Jacket: Protective covering over insulation; may be factory-applied or field-applied to provide additional protection; of such materials as canvas, polyvinyl chloride (PVC), aluminum or stainless steel.

L. Piping insulation: Thermal insulation applied to limit or reduce heat transmission to or from a piping system.

M. PSK: Poly Scrim Kraft; jacketing

N. PVC: PolyVinyl Chloride

O. SSL: Self-Sealing Lap

P. SSL+: Self-Sealing Lap with Advanced Closure System

Q. Thermal conductivity (K value): Units of Btu-inch/hour per square foot per °F.

R. Vapor retarder jacket: Insulation jacket material which impedes the transmission of water vapor.

S. WHO: World Health Organization

1.3 CODES AND STANDARDS (USE LATEST EDITION)

A. ASTM International (ASTM)

1. ASTM A167: Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. ASTM A240: Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
3. ASTM B209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate).
4. ASTM C165: Test Method for Measuring Compressive Properties of Thermal Insulation
5. ASTM C177: Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.
6. ASTM C195: Standard Specification for Mineral Fiber Thermal Insulating Cement.
7. ASTM C335: Standard Test Method for Steady-State Heat Transfer Properties of Pipe Insulation
8. ASTM C449: Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
9. ASTM C450: Practice for Fabrication of Thermal Insulation Fitting Covers for NPS Piping, and Vessel Lagging
10. ASTM C518: Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
11. ASTM C547: Standard Specification for Mineral Fiber Preformed Pipe Insulation.
12. ASTM C552: Specification for Cellular Glass Thermal Insulation.
13. ASTM C553: Mineral Fiber Blanket and Felt Insulation (Industrial Type).
14. ASTM C585: Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
15. ASTM C612: Mineral Fiber Block and Board Thermal Insulation.
16. ASTM C795: Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
17. ASTM C871: Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions.
18. ASTM C921: Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
19. ASTM C1136: Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
20. ASTM C1290: Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
21. ASTM C1393: Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks.

22. ASTM C1617: Standard Practice for Quantitative Accelerated Laboratory Evaluation of Extraction Solutions Containing Ions Leached from Thermal Insulation on Aqueous Corrosion of Metals"
23. ASTM D1644: Test Methods for Nonvolatile Content of Varnishes.
24. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials.
25. ASTM E96: Standard Test Methods for Water Vapor Transmission of Materials.
26. ASTM E136: Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C
27. ASTM F249: Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.

B. ASHRAE

1. ASHRAE Standard 90.1: Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. Code of Federal Regulations

1. 40 CFR - Protection of Environment, Chapter I - Environmental Protection Agency, Part 59 - "National Volatile Organic Compound Emission Standards for Consumer and Commercial Products," Subpart D - "National Volatile Organic Compound Emission Standards for Architectural Coatings."

D. Midwest Insulation Contractors Association (MICA)

1. MICA: Commercial and Industrial Insulation Standards.

E. Military Specifications

1. MIL-A-24179A: Adhesive, Flexible Unicellular-Plastic Thermal Insulation
2. MIL-A-3316C: Adhesives, Fire-Resistant, Thermal Insulation
3. MIL-C-20079H: Cloth, Glass; Tape, Textile Glass and Thread, Glass and Wire-Reinforced Glass
4. MIL-PRF-19565C: Coating Compounds, Thermal Insulation, Fire- and Water-Resistant, Vapor Barrier
5. MIL+PRF-22344E (except pH requirements): Military Specification: insulation, Pipe, Thermal
6. MIL+24244D: Insulation Material with Special Corrosion, Chloride and Fluoride Requirements

F. National Fire Protection Association (NFPA)

1. NFPA-90A: Installation of Air Conditioning and Ventilation Systems.
2. NFPA-90B: Warm Air Heating and Air-Conditioning Systems.
3. NFPA 255: Standard Method of Test of Surface Burning Characteristics of Building Materials.

G. North American Insulation Manufacturers Association (NAIMA)

1. NAIMA: National Insulation Standards.

H. Underwriters Laboratories Inc. (UL)

1. UL 723: Standard for Test for Surface Burning Characteristics of Building Materials.
2. Underwriter's Laboratories Environmental (UL Environment)

1.4 QUALITY ASSURANCE

A. Installer qualifications: Company specializing in performing the work of this section with minimum five years documented experience utilizing 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, UL/ULC Classified per UL 723 as determined by UL testing. 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 and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

C. Manufacturer's qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

D. Insulation thickness shall be per Part 3 of this specification or as required by the latest edition of ASHRAE Standard 90.1 and the applicable energy code(s), whichever is greater.

E. Low-emitting materials: For all thermal and acoustical applications of glass wool insulation products, provide materials complying with the testing and products requirements of UL GREENGUARD Gold Certification.

F. Products shall not contain asbestos, lead, mercury, or mercury compounds.

G. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.

H. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

I. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

J. No insulation product shall support or promote mold or fungus growth.

1.5 SUBMITTALS

A. Preconstruction – Prior to construction provide the following in accordance with Division 01 and Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

   1. Product data: Provide a schedule, listing each type of insulation, thickness, density, type of protective covering, etc., and the work and service to which each type of insulation is to be applied. The schedule shall be submitted in quantities consistent with that required in the Conditions of the Contract. No insulation shall be purchased or installed until the schedule is reviewed by the Engineer.

   2. Manufacturer's installation instructions: Indicate specific installation instructions per the manufacturers of the various products and indicate how the system (combination of products) will be assembled. Highlight critical environmental factors such as drying time, etc., as well as any variations between the manufacturer's installation instructions and the specified installation instructions along with a reason for the difference.

   3. Manufacturer's certificate: Certify that products meet or exceed specified requirements.

B. Contract Closeout – At contract closeout provide the following in accordance with Division 01 and Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

   1. Test Reports

a. Insulation Inspection Test

2. Warranties

1.6 DELIVERY, STORAGE AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

B. Protect products against dirt, water, chemical and mechanical damage before, during and after installation. Do not install damaged or wet insulation; remove from project site. Damage to products prior to final acceptance of the Work shall be repaired or replaced at no additional cost to Owner.

C. Maintain ambient conditions required by the manufacturer of each product.

PART 2 - PRODUCTS

2.1 DUCT AND EQUIPMENT INSULATION

A. **Type MF-FB**: Mineral or glass fiber flexible blanket insulation

1. Acceptable manufacturers and products
   a. Basis of Design: Knauf Insulation; Atmosphere Duct Wrap
   b. Johns Manville; Microlite EQ
   c. Owens Corning; SoftR Duct Wrap
2. Mineral or glass fibers bonded with a sustainable bio-based thermosetting resin. Comply with ASTM C553, Types I, II and III and ASTM C 1290 Types I, II and III; for use to 250F. Density: ¾ lb/ft^3 minimum. Increase density if required to meet specified 'k' value.
3. Thermal conductivity (k-value) of 0.29 Btu in/ hr ft^2 F or less at 75°F mean temperature per ASTM C518.
4. Jacket: Factory applied type FSK.

2.2 DUCT AND EQUIPMENT INSULATION JACKETS

A. Factory-applied insulation jackets

1. **Type FSK**: Foil-scrim kraft jacket
   a. Factory applied aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing. Comply with ASTM C1136, Type I. Vapor permeability shall not exceed .02 perms.

2.3 INSULATION ACCESSORIES

A. Adhesives and insulating cements

1. Acceptable manufacturers:
   a. Foster
   b. Minnesota Mining
   c. Chicago Mastic
2. Adhesives and insulating cements shall meet the following requirements:
   a. Mineral-fiber insulating cement: Comply with ASTM C195;
   b. Mineral-fiber, hydraulic-setting insulating and finishing cement: Comply with ASTM C449

c. Mineral-fiber adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

d. Cellular-glass adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100F - 200F

e. Flexible elastomeric and polyolefin adhesive: Comply with MIL-A-24179A, Type II, Class I.

f. ASJ adhesive jacket adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

g. PVC jacket adhesive: Compatible with PVC jacket.

3. For indoor applications, adhesive and insulating cement shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24). Exception: Mineral-Fiber Adhesive shall have a VOC content of 80 g/L or less.

4. Adhesives and insulating cements 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. Sealants

1. For indoor applications, sealants shall 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. Joint sealants:

a. Fire and water resistant permanently flexible, elastomeric sealant.

b. Service temperature range: Minus 100°F - 300°F

c. Color: White or gray.

d. Elastomeric: Permanently flexible.

e. Cellular glass: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100°F - 200°F. Materials in first paragraph below are for sealing metal jacket seams and joints.

4. FSK and metal jacket flashing sealants:

a. Fire- and water-resistant, flexible, elastomeric sealant.

b. Service temperature range: Minus 40°F - 250°F.

c. Color: Aluminum.

C. Mastics

1. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

2. 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).

3. Vapor-barrier mastic, indoor: Water based; suitable for indoor use on below-ambient services.

a. Water-vapor permeance: ASTM F 1249, 0.08 perm at 37-mil dry film thickness.

b. Service temperature range: Minus 20°F - 180°F.

c. Solids content: ASTM D1644, 58% by volume and 70% by weight.

d. Color: White.

4. Vapor-barrier mastic, outdoor: Water based; suitable for outdoor use on below-ambient services.
    a. Water-vapor permeance: ASTM F1249, 1.8 perm at 30-mil dry film thickness.
    b. Service temperature range: Minus 20°F - 180°F.
    c. Solids content: ASTM D1644, 60% by volume and 66% by weight.
    d. Color: White.

D. Tapes

1. FSK tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
    a. Width: 3 inches.
    b. Thickness: 6.5 mils.
    c. Adhesion: 90 ounces force/inch in width.
    d. Elongation: 2%.
    e. Tensile strength: 40 lbf/inch in width.
2. Aluminum-foil tape: Foil face vapor-retarder tape with acrylic adhesive.
    a. Width: 2 inches
    b. Thickness: 3.7 mils.
    c. Adhesion: 100 ounces force/inch in width.
    d. Elongation: 5%.
    e. Tensile strength: 34 lbf/inch in width.

E. Securements

1. Stainless steel bands: ASTM A167 or ASTM A240, Type 304; 0.015 inch thick, ½-inch wide with wing seal. Provide closed seal when strapping on tanks or vessels with diameter greater than or equal to 8 feet.
2. Aluminum bands: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch thick, ½-inch wide with wing seal. Provide closed seal when strapping on tanks or vessels with diameter greater than or equal to 8 feet.
3. Band springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
4. Staples: Outward-clinching insulation staples, nominal ¾-inch wide, stainless steel or Monel.
5. Wire: 16-gauge annealed galvanized steel.
6. Insulation pins and hangers:
    a. Capacitor-discharge-weld pins: Zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106” diameter shank, length to suit depth of insulation indicated.
    b. Cupped-head, capacitor-discharge-weld pins: Zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106” diameter shank, length to suit depth of insulation indicated with integral 1½” galvanized carbon-steel washer.
    c. 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:

(1) Baseplate: Perforated, galvanized carbon-steel sheet, 0.030" thick by 2" square.

(2) Spindle: Zinc-coated, low-carbon steel or Aluminum, fully annealed, 0.106" diameter shank, length to suit depth of insulation indicated.

(3) Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

d. Insulation-retaining washers: Self-locking washers formed from 0.016" thick, galvanized-steel or aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1½" in diameter.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine for possible asbestos-containing insulation and notify Owner. Do not remove insulation thought to contain asbestos.

B. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

C. Verify that systems to be insulated have been tested and are free of defects.

D. Verify that surfaces to be insulated are clean and dry.

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

F. Install products only after piping, ductwork and equipment have been pressure testing and the pressure testing approved by the Engineer.

G. Provide drop cloths or other means of protecting all equipment from drops, spattering, etc. which may be caused by the application of insulating products.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Insulate all cold surfaces that can condense and all warm surfaces 105°F or higher. This includes, but is not limited to, surfaces supplied as part of a manufacturer's packaged equipment assembly.

B. Install products in accordance with manufacturer's and NAIMA instructions.

C. Surface preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

D. 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.

E. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

F. 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.

G. Install insulation with longitudinal seams at top and bottom of horizontal runs.

H. Install multiple layers of insulation with longitudinal and end seams staggered.

I. Keep insulation materials dry during application and finishing.

J. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

K. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

L. Install insulation with least number of joints practical.

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. 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.

5. Duct mounted sensors and other devices to be installed on the outside of the insulation. Seal and provide complete vapor barrier at any penetrations of the insulation.

N. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

O. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

P. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3” wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4” o.c.

3. Overlap jacket longitudinal seams at least 1½”. 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” o.c.

4. For below-ambient services, apply vapor-barrier mastic over staples.

5. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

6. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

Q. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.

R. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

S. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4” beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

T. Where existing insulation has been removed or disturbed, due to new connections and/or alterations, repair and replace existing insulation per the requirements of this specification.

U. Penetrations:

1. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
    a. Seal penetrations with flashing sealant.
    b. 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. Seal joint with joint sealant.
    c. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
    d. Seal jacket to roof flashing with flashing sealant.
2. Insulation installation at interior wall and partition penetrations (that are not fire-rated): Install insulation continuously through walls and partitions.
3. Insulation installation at fire-rated wall and partition penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Comply with requirements in Division 20 Section 20 0517: Penetrations for Mechanical, Plumbing, And Fire Suppression Systems for firestopping and fire-resistive joint sealers.
4. Insulation installation at floor penetrations:
    a. Duct: For penetration 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.
    b. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 20 0517: Penetrations for Mechanical, Plumbing, And Fire Suppression Systems.

3.3 INSTALLATION – DUCT AND EQUIPMENT INSULATION

A. General

1. Install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2” from one edge and one end of insulation segment. Secure laps to adjacent insulation section with ½” outward-clinching staples, 1” 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 50F 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“.
    c. Install vapor stops at all insulation terminations on either side of pumps and equipment.
2. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6“ wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6” o.c.
3. Where insulated ductwork is supported by trapeze hangers, the insulation shall be installed continuous through the hangers. Drop the supporting channels required to facilitate the

installation of the insulation. Where rigid board or flexible insulation is specified, install high density inserts to prevent the weight of the ductwork from crushing the insulation.

4. Where insulated ductwork is supported by steel metal straps or wire ropes that are secured directly to the duct, the straps or ropes shall be completely covered with insulation and sealed to provide a complete vapor barrier.
5. Where insulated duct risers are supported by steel channels secured directly to the duct, extend the insulation and vapor barrier jacketing to encapsulate the support channels.
6. Duct mounted sensors and other devices to be installed on the outside of the insulation. Seal and provide complete vapor barrier at any penetrations of the insulation.

B. Installation of **Type MF-FB** duct insulation

1. Install duct wrap using manufacturer's stretch-out tables to obtain specified R-value using a maximum compression of 25%.
2. Secure blanket insulation with weld pins.
3. Install either 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" and smaller, place pins along longitudinal centerline of duct. Space 3" maximum from insulation end joints, and 16" o.c.
   b. On duct sides with dimensions larger than 18", place pins 16" o.c. each way, and 3" 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 over-compress 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. Overlap unfaced blankets a minimum of 2" on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18" o.c.
5. 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.

3.4 APPLICATION – DUCTWORK

A. Provide insulation on new ductwork and modified portions of existing ductwork per the following schedule:

SERVICE	INSULATION TYPE	INSULATION THICKNESS	JACKET
Transfer air ducts: Indoor	None	N/A	N/A
Return air ducts located in unconditioned spaces and attics	MF-FB	2 3/16" (R-6 at installed thickness)	FSK
Supply air ducts located in unconditioned spaces and attics	MF-FB	2 3/16" (R-6 at installed thickness)	FSK

END OF SECTION

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SECTION 20 9100
PAINTING FOR MECHANICAL, PLUMBING, AND FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Painting requirements specifically applicable to Divisions 20, 21, 22, and 23, including:

1. Ferrous metal surfaces (does not include stainless steel).
    a. Exterior cast iron handhole and manhole covers and similar units are excluded from work to be painted.
    b. Zinc coated (galvanized ferrous metal surfaces).
    c. Concealed work is excluded from painting, except for exterior work and work in “high humidity” areas.
2. Aluminum which is not specifically anodized as final finish, and so indicated.
    a. Concealed work is excluded from painting, except for exterior work and work in “high humidity” areas.
3. Color-coded work indicated for continuous painting (not including banding, stripping, or stenciling).
4. Major items of mechanical equipment, including units delivered to project with factory applied finish, regardless of whether indicated as prime coat or finish coat.
5. Major items of mechanical equipment, excluding equipment delivered to project site with factory applied “final finish,” not only “prime coat.”

1.2 CODES AND STANDARDS (USE LATEST EDITION)

A. ANSI/ASME A13.1: Scheme for the Identification of Piping Systems.

1.3 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of products for mechanical related work of sizes, types, ratings, and materials required, whose products have been in satisfactory use in similar service for not less than three years.

B. Installer’s qualifications: Firm with at least three years of successful installation experience on projects with mechanical related work similar to that required for this project.

C. Federal specifications, painting work: In general, and where applicable, comply with indicated Federal Specifications for paint quality, and use only paint from original containers which bear manufacturer’s labels indicating compliance with required Federal Specifications.

D. Single source responsibility, painting work: Provide primers and other undercoat paints produced by same manufacturer as finish coats. Use only thinners approved by paint manufacturer and use only within recommended limits.

E. Coordination of painting work: Review other sections of these specifications in which prime paints are to be provided to ensure compatibility of total coatings system for various substrates. From other trades, obtain information or characteristics of finish materials provided for use, to ensure compatible prime coatings are used.

F. Environmental conditions, painting work: Comply with governing regulations concerning use of and conditions for application of paint. Comply with manufacturer's recommendations and instructions. Do not apply paint in unfavorable conditions of temperature, moisture (including humidity) or ambient contamination (dust and other pollutants).

1.4 SUBMITTALS

A. Preconstruction – Prior to construction provide the following in accordance with Division 01 and Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Product data:
    a. Submit manufacturer's technical information, including analysis of ingredients and application instructions for products used in painting work.
    b. Submit 12" x 12" color samples of each required finish paint color (except black and white); prepared on smooth face where application is for smooth surfaces and on texture face for textured surface applications. Use actual paint materials to be applied and label each sample to show materials and coats applied.
    c. Color schedule: Submit proposed schedule of paint colors and colors for coding of piping system for approval prior to painting. Include manufacturer, manufacturer's paint stock number, and piping system or equipment.

B. Contract Closeout – At contract closeout provide the following in accordance with Division 01 and Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Color schedule: Provide "as-installed" schedule of colors including manufacturer, manufacturer's paint stock number, and piping system or equipment.
2. Warranties

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver painting materials to job site in original, new and unopened packages and containers bearing manufacturer's name and label showing the following information:

1. Name and title of material
2. Fed. Spec. number, if applicable
3. Manufacturer's name
4. Manufacturer's stock number and date of manufacture
5. Contents by volume, for major pigments and vehicles
6. Thinning instructions
7. Application instructions
8. Color name and number

B. Store materials not in actual use in tightly covered containers. Maintain containers used in storage of paint in clean condition, free of foreign materials and residue.

C. Protect from freezing when necessary. Keep storage area neat and orderly. Remove oily rags and waste daily. Take all precautions to ensure that workmen and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing, and application of paints.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - PAINTING PRODUCTS

A. Devoe and Reynolds Company (Devoe)

B. Glidden Coatings and Resins (Glidden)

C. Benjamin Moore and Company (Moore)

D. Pratt and Lambert (P & L)

2.2 PAINTING PRODUCT

A. Color pigments: Pure, non-fading, applicable types to suit substrates and service indicated.

B. Lead content in pigment, if any, is limited to contain not more than 0.05% lead, as lead metal based on total non-volatile (dry film) of paint by weight.

C. This limitation is extended to interior surfaces and those exterior surfaces, such as stairs, decks, porches, railings, windows, and doors.

D. Vehicles and thinners: Comply with governing regulations and recognized safe practices in handling, use and drying of paint vehicles and thinners. Compatibility of paint products is Contractor's exclusive responsibility. Select paint products to ensure freedom from problems relating to vehicles and thinners of type and within limits recommended by paint manufacturer.

E. Undercoat paints: Use paint produced by same manufacturer as paint to be used for finish coats.

F. Colors: Provide colors as indicated or established by Engineer, by color schedule or by other indication or, where not otherwise indicated, as selected by Engineer from manufacturer's standard (non-premium cost) colors available for type of paint to be provided in each case. Match existing throughout building.

G. Color-coded finishes: For finishes indicated to be color coded for identification, provide paint complying with color requirements of ANSI A13.1 "Scheme for the Identification of Piping Systems", except where another specific color requirement is indicated. Match existing throughout building.

H. "Paint" as used herein means coating system materials, including primers, emulsions, enamels, sealers, fillers and other applied materials whether used as prime, intermediate or finish coats.

I. Standards: In the following designated paint systems the descriptions similar to FS TT P 55, Type II refers to Federal Specifications of that number, and indicates required compliance with performance standards of that publication as minimum standard of performance quality for paint product as named. Products of recognized higher performance quality can be used, provided either label indicates compliance with required standard, or manufacturer submits proof and certification that product meets or exceeds standard in every significant measure of performance.

2.3 EXTERIOR PAINT SYSTEMS

A. Ferrous metal

1. Full gloss alkyd enamel: Two finish coats over primer.
    a. Prime coat: Pigmented primer (FS TTC 530B). Primer is not required on items delivered shop primed.
        (1) Devoe: 13101 Mirrolac USDA approved lead-free primer.
        (2) Glidden: Rustmaster 590 Metal Primer.

(3) Moore: Ironclad Retardo 163 Rust Inhibitive Paint.

(4) P & L: P & L Techguard Rust Inhibitor Primer.

b. First and second finish coats: High gloss alkyd enamel (FS TTP 59E).

(1) Devoe: 70XX Mirrolac Alkyd Gloss Enamel.

(2) Glidden: Y 4500 Line Glid Guard Industrial Enamel.

(3) Moore: Impervo High Gloss Enamel Exterior/Interior.

(4) P & L: Effecto Enamel.

2. Semi-gloss alkyd enamel: Two finish coats over primer.

a. Prime coat: Pigmented primer (FS TTC 530B). Primer is not required on items delivered shop primed.

(1) Devoe: 13101 Mirrolac USDA approved lead-free primer.

(2) Glidden: Rustmaster 590 Metal Primer.

(3) P & L: P & L Techguard Rust Inhibitor Primer.

b. First and second finish coats: Semi-gloss alkyd enamel (FS TTP 81E, Class A).

(1) Devoe: 1XX All Weather Exterior Alkyd Gloss House and Trim Paint.

(2) Glidden: Spread Gel-flo 19XX

(3) P & L: Permalize H.P.

B. Zinc-coated metal

1. High-gloss alkyd enamel: Two finish coats over primer.

a. Prime coat: Zinc dust zinc oxide primer (FS TT P 641).

(1) Devoe: 13201 Galvanized Metal Primer.

(2) Glidden: Y 5229 Glid Guard All Purpose Metal Primer.

b. First and second finish coats: High gloss alkyd enamel (FS T E 489).

(1) Devoe: 70XX Mirrolac Interior/Exterior Alkyd Gloss Enamel.

(2) Glidden: Rustmaster 500.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION FOR PAINTING

A. Refer to Division 01 and Division 20 Section 20 0500, “Basic Requirements for Mechanical, Plumbing, and Fire Suppression.”

B. No piping systems shall be painted until their field tests have been approved by Owner representatives.

C. General: Clean surfaces before applying paint products. Remove oil and grease prior to mechanical cleaning. Comply with paint products manufacturer’s instructions for surface cleaning and preparation. Remove surface applied accessories which are not to be painted and reinstall after completion of painting. Protect non removable items not to be painted, by covering with paper or plastic film. Do not paint nameplates.

D. Cementitious surfaces: Remove efflorescence, chalk, dust and glaze to ensure good bond of paint products. Clean concrete with muriatic acid (one part diluted with six to eight parts water) and flush with water, where necessary to ensure good paint bond. Perform appropriate tests to determine that

both alkalinity and moisture content of concrete surfaces are below maximum allowable levels for painting, as recommended by paint manufacturer.

E. Ferrous metal surfaces: Remove mill scale and loose rust on surfaces which are not zinc coated or shop/factory prime coated.

F. Clean shop applied prime coats on metal surfaces, and repair (touch up) prime coats wherever abraded, or otherwise damaged prior to application of paint system.

G. Zinc-coated surfaces: Clean with non-petroleum-based solvent. Wash with copper sulfate solution and flush with water, unless surface has been pretreated, or unless treatment is not recommended by manufacturer of prime coat.

3.2 PAINT SYSTEM APPLICATION

A. Mixing: Comply with manufacturer's recommendations for mixing or stirring paint products immediately before application.

B. Application limitations: Except as otherwise indicated, paint every accessible surface of each unit of work indicated to be painted, regardless of whether in location recognized as "concealed" or "exposed."

C. Omit painting on surfaces located in service shafts and tunnels and above non removable ceilings and in similar place where space is too limited, or services are too congested to allow access for painting.

D. Omit painting of ductwork and insulated piping above removable ceilings, but apply paint system to uninsulated steel piping, exposed threads of galvanized piping, pipe hangers, duct hangers, and similar work.

E. Omit painting on machined sliding surfaces and rotating shafts of equipment, and on nonferrous finished metals including chrome plate, stainless steel, special anodized aluminum, brass/bronze and copper, and on plastics and similar finished materials, except where specifically indicated to be color coded by painting.

F. Omit painting on required name plates, labels, identification tags, signs, markers, printed instructions, performance ratings, flow diagrams and similar text and graphics, located within the scope of work indicated to receive paint application.

G. Omit specified prime coat of paint system for metal surfaces where surface has shop applied prime coat of equivalent quality. Apply prime coat on other surfaces to be painted; comply with paint manufacturer's instructions for prime coating where not otherwise indicated. Apply additional prime coats where suction spots or unsealed areas appear.

H. General application requirements: Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate, for type of material being applied, and for ambient conditions. Apply additional coats when undercoats, stains or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Apply paint at edges, corners, joints, welds and exposed fasteners in manner which will ensure dry film thickness equal to that of flat surfaces. Allow sufficient time between successive coats for proper drying (comply with manufacturer's drying instructions).

1. Number of coats: Number indicated is minimum number; apply as many coats as are necessary to comply with dry-film thickness requirements.

2. Coating thickness: Apply uniform coats to produce dry-film thickness indicated or, if not otherwise indicated, apply paint without thinning in application thickness recommended by manufacturer for each coat.

3. Smooth finishes: Except as otherwise indicated, apply paint in smooth finish without noticeable texture, cloudiness, spotting, holidays, laps, brush marks, runs, sags, ripples, ropiness and other surface imperfections.

I. Application by spraying, whether airless or air-bearing, is strictly prohibited. Use roller or brush.

3.3 MECHANICAL IDENTIFICATION

A. Refer to Division 20 Section 20 0553, "Identification for Mechanical, Plumbing, and Fire Suppression Systems."

B. Identification of piping shall comply with ANSI/ASME A13.1.

C. Identification of piping systems by color:

1. Color Scheme

CLASS	COLOR
F - Fire-protection	Red
D - Dangerous materials	Yellow or Orange
S - Safe materials	Green (or the achromatic colors, white, black, gray or aluminum)
P - Protective materials	Bright blue
V - Extra valuable materials	Deep purple

3.4 CLEAN-UP AND PROTECTION

A. General painting clean-up: During progress of work, remove from site discarded paint materials, rubbish, cans and rags at end of each workday.

1. Spattered surfaces: Upon completion of painting work, clean paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

2. Protection: Protect work of other trades, whether to be painted or not, against damage by painting work. Correct damage by cleaning, repairing or replacing and repainting as directed. Provide "Wet Paint" signs as required to protect newly-painted finishes. Remove temporary protective wrappings installed for protection of work not to be painted, after completion of painting operations. At completion of work by other trades, touch-up and restore damaged or defaced painted surfaces.

B. General concrete clean-up: Upon completion of concrete work, clean excess concrete from adjacent areas and surfaces. Remove excess concrete by proper methods of washing or scraping, using care not to scratch or otherwise damage finished surfaces.

END OF SECTION

SECTION 23 0100
COMMON WORK REQUIREMENTS FOR MECHANICAL

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic requirements applicable to all Division 23 work.

1.2 RELATED SECTIONS

A. All specification sections in Division 20 are applicable to Division 23. It is the responsibility of the Division 23 Contractor to obtain all Division 20 specifications and conform to all applicable requirements. Division 20 Sections included are:

1. Section 20 0500: Basic Requirements for Mechanical, Plumbing, and Fire Suppression
2. Section 20 0501: Minor Mechanical, Plumbing, and Fire Suppression Demolition
3. Section 20 0517: Penetrations for Mechanical, Plumbing, and Fire Suppression
4. Section 20 0529: Hangers and Supports for Mechanical, Plumbing and Fire Suppression Systems
5. Section 20 0553: Identification for Mechanical, Plumbing, and Fire Suppression Systems
6. Section 20 9100: Painting for Mechanical, Plumbing, and Fire Suppression

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 SCOPE

A. Work included under Divisions 20 and 23 shall include all labor, services, materials, and equipment and performance of all work required for installation of mechanical systems as shown on Drawings and as specified.

END OF SECTION

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SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section includes testing, adjusting, and balancing to produce design objectives for the following:

1. Air systems

1.2 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report forms: Test data sheets for recording test data in logical order.

I. System effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

J. System effect factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

K. TAB: Testing, adjusting, and balancing.

L. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

M. Test: A procedure to determine quantitative performance of systems or equipment.

N. Testing, adjusting, and balancing firm: The entity responsible for performing and reporting TAB procedures.

1.3 CODES AND STANDARDS (USE LATEST EDITIONS)

A. ASHRAE 111: Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.

B. Associated Air Balance Council (AABC): National Standards for Total System Balance.

C. ANSI S12.1: Physical Measurement of Sound

D. National Environmental Balancing Bureau (NEBB): Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

E. National Environmental Balancing Bureau (NEBB): Procedural Standard for Fume Hood Performance Testing.

F. National Environmental Balancing Bureau (NEBB): Procedural Standards for Certified Testing of Cleanrooms.

G. National Environmental Balancing Bureau (NEBB): Procedural Standards for Measurement of Sound and Vibration.

H. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): TAB Procedural Guide.

I. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): HVAC Sound and Vibration Manual

1.4 QUALITY ASSURANCE

A. Qualifications

1. Testing agency shall be a certified member of AABC, NEBB, and/or TABB.

2. Testing and Balancing shall be performed by a testing agency who specializes in testing, adjusting, and balancing of heating, ventilating, air-moving equipment, air-conditioning systems and hydronic systems and has a minimum of one year experience.

3. Testing agency shall have successfully completed a minimum of five projects, similar in size and scope.

B. Certifications - TAB Technician shall be certified by a nationally recognized certifying agency.

C. TAB conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda items: Include at least the following:
    a. Submittal distribution requirements
    b. The Contract Documents examination report
    c. TAB plan
    d. Work schedule and Project-site access requirements
    e. Coordination and cooperation of trades and subcontractors
    f. Coordination of documentation and communication flow

D. Instrumentation type, quantity, and accuracy: As described in AABC's "National Standards for Total System Balance," NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification," or the TABB Instrument List.

E. Instrumentation calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.5 SUBMITTALS

A. Preconstruction – Prior to construction provide the following in accordance with Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Qualification data: Within 30 days from Contractor's Notice to Proceed, submit evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

2. TAB contract document examination report: Within 30 days from Contractor's Notice to Proceed.

3. Strategies and procedures plan: Within 60 days from Contractor's Notice to Proceed.

B. During Construction – During construction provide and maintain the following in accordance with Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Deficiency report

2. Preliminary TAB reports

C. Contract Closeout – At contract closeout provide the following in accordance with Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Certified TAB reports

2. Warranties

1.6 PROJECT CONDITIONS

A. Full owner occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

D. Coordinate the following with the Temperature Control Contractor to verify calibration of installed equipment and devices:

1. Field coordinate with the Temperature Control Contractor to establish supply duct static pressure set point for the air-handling unit.

2. Field coordinate with the Temperature Control Contractor to establish minimum outside air damper position for the air-handling unit.

3. Field coordinate with the Temperature Control Contractor to develop exhaust fan tracking curve based on offset pressurization set point.

4. Field coordinate with the Temperature Control Contractor to validate airflow readings as measured by each airflow measuring station.
5. Field coordinate with the Temperature Control Contractor to establish airflow rate as measured by each air terminal unit inlet flow sensor.

E. Include a summary of the above results in the test and balance report.

1.8 WARRANTY

A. Provide one of the following performance guarantees:
1. AABC National Project Performance Guarantee
2. NEBB Certificate of Conformance Certification
3. TABB Quality Assurance Program Guarantee

B. Guarantee shall include the following provisions:
1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS

2.1 ACCEPTABLE FIRMS

A. Aero Building Solutions., Franklin Park, IL

B. International Test & Balance, Northbrook, IL

C. Mechanical Test & Balance, Crown Point, IN

D. Superior Test & Balance, Inc., Algonquin, IL

2.2 TESTING SCOPE

A. The following systems shall be tested in accordance with the procedures defined in Part 3 of this specification:
1. Air systems
2. Sound and vibration

PART 3 - EXECUTION

3.1 GENERAL

A. Provide sufficient time before completion date to complete balancing operations.

B. Note changes made to the system during construction.

C. Install required test holes complete with removable and replaceable plugs.

D. Make and document revisions to controls, dampers, fan and pump drives, and consult with equipment manufacturers as required to achieve the specified system's performance.

E. Take and report testing and balancing measurements in inch-pound (IP) units.

F. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close

probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

G. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.2 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to review system designs for deficiencies that may prevent proper TAB.

B. Examine approved submittal data of HVAC systems and equipment.

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. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems,"; or in SMACNA's "HVAC Systems – Duct Design,". Compare this data with the design data and installed conditions.

3.3 PREPARATION

A. Prepare a Strategies and Procedures Plan that includes TAB strategies and step-by-step procedures as specified in Part 3 of these specifications.

B. Prior to commencing the TAB verify the following conditions. If deficiencies are evident, submit Deficiency Report to Owner. Do not begin TAB until deficiencies have been remedied.

1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed, complete, and operable.
3. Startup air filters are removed.
4. Final filters are clean and properly installed.
5. Duct and fan systems are clean.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.

3.4 TOLERANCES

A. Air systems

1. Air handling systems: Adjust to within +10% of outlet total plus allowable leakage rate.

3.5 AIR SYSTEMS PROCEDURE

A. Perform testing and balancing procedures on each system according to any of the following:

1. AABC National Standards for Total System Balance
2. NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems

3. SMACNA TAB Procedural Guide

4. ASHRAE 111 Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems

B. Minimum air procedures shall include the following:

1. Test and adjust fan RPM to design requirements.

2. Test and record motor full load nameplate rating and actual ampere draw.

3. Test and record system static pressures, fan suction, and discharge.

4. Test and record outside air, mixed air, and discharge temperatures (D.B. for heating cycle, D.B. and W.B. for cooling cycle).

5. In coordination with the ATC contractor, set adjustments of automatically operated dampers to operate as specified, indicated and/or noted.

6. Test and adjust air handling and distribution systems to provide required supply, return, outside, and exhaust air quantities within design tolerance.

7. Make air velocity measurements in ducts by Pitot tube traverse across entire cross-sectional area of duct in accordance with SMACNA equal area method or Log Linear method.

8. Use volume control devices to regulate air quantities only to the extent that adjustments do not create objectionable air motion or sound levels.

9. Vary total system air quantities by adjustment of fan speeds. Provide drive changes recommendations. Vary branch air quantities by damper regulation.

10. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for loading of filters and coils.

11. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions within specified tolerances.

12. Where modulating dampers or economizers are provided, take measurement at full return air, minimum outside air, and 100% outside air mode of operation.

3.6 REPORTING

A. TAB contract document examination 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.

B. Deficiency report: Following examination of installed system, prior to balancing, submit report indicating system deficiencies that would prevent proper testing, adjusting, and balancing of systems and equipment to meet specified performance.

C. Preliminary TAB reports: Submit one copy of the preliminary testing, adjusting and balancing report without field data, including any drawings indicating air outlets, thermostats, and equipment identified to correspond with data sheets.

D. Certified TAB reports

1. Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

2. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

3. TAB report forms: Use standard forms from AABC, NEBB or TABB/SMACNA.

4. Minimum certified TAB reports shall include the following:

    a. Certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

    b. List of instruments used for procedures, along with proof of calibration.

    c. Certified TAB field data reports. This certification includes the following:

        (1) Review field data reports to validate accuracy of data and to prepare certified TAB reports.

        (2) Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

    d. Fan curves

    e. Manufacturers' test data

    f. Field test reports prepared by system and equipment installers

    g. Other information relative to equipment performance, but do not include shop drawings and product data

    h. Where specified, vibration and/or sound measurement report in accordance with the requirements of the current edition of the NEBB Procedural Standards for Measurement of Sound and Vibration.

3.7 INSPECTIONS

A. Initial inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.

2. Randomly check the following for each system:

    a. Measure airflow of at least 10% of air outlets.

    b. Measure water flow of at least 5% of terminals.

    c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.

    d. Measure sound levels at two locations.

    e. Measure space pressure of at least 10% of locations.

    f. Verify that balancing devices are marked with final balance position.

    g. Note deviations to the Contract Documents in the Final Report.

B. Final inspection:

1. The Owner reserves the option to request at no extra charge a final inspection of the final TAB report.

2. TAB firm test and balance engineer shall conduct the inspection in the presence of Engineer.

3. Owner shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10% of the total measurements recorded, or the extent of measurements that can be accomplished in a normal eight-hour business day.
4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10% of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

END OF SECTION

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SECTION 23 0900
BASIC TEMPERATURE CONTROL REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Scope

B. Quality assurance

C. Specifications

D. Project/site conditions

E. Work by subcontractors

F. Coordinated work

G. Project phasing

H. Hazardous materials

I. Design submittals

J. Start-up and testing

K. Guarantee

L. Substantial completion submittals

M. Closeout submittals

N. Record documents

O. Operating and maintenance (O&M) manuals

P. Training

1.2 SCOPE

A. The purpose of this project is to update equipment on the existing energy management.

B. The work includes the complete installation of an electronic building automation, energy management and temperature control system as identified below:

1. Control for the following systems:
    a. Base Bid 1
        (1) Rooftop packaged air handling units RTU-1 and RTU-2, miscellaneous points.
        (2) Related software.

C. Contractor must take special precautions at all times to prevent any damage to Owner's equipment or premises. This Contractor shall be liable for any damage.

D. Contractor shall obtain and pay for all necessary construction permits and licenses.

1.3 QUALITY ASSURANCE

A. The system shall be designed, installed, commissioned and serviced by manufacturer employed, factory trained personnel. Manufacturer shall have in-place a support facility within 100 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment.

Distributors or licensed installing contractors are not acceptable. Contractor must be an authorized representative of the controller manufacturer and shall be fully backed by same.

B. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be the manufacturer's latest standard design that complies with the specification requirements.

C. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, "Governing Radio Frequency Electromagnetic Interference" and be so labeled.

D. This system shall have a documented history of compatibility by design for a minimum of 10 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing controllers and field panels and extend new controllers and field panels on a previously installed network.

E. The Contractor shall employ specialists in the field of Building Automation Systems including: Programming, Engineering, Field Supervision and Installation. Specialists shall have a minimum of 5 years of experience with Building Automation Systems.

F. The Contractor shall be responsible for all work fitting into place in a satisfactory, neat, workmanlike manner acceptable to the Owner and Engineer.

1.4 SPECIFICATIONS

A. The Contract Documents are to be considered scope in coverage only and do not necessarily show the exact location and details of the work to be installed. It shall be the responsibility of the Contractor to furnish and install the work in conformity with the requirements of these Specifications, the applicable codes, regulations and standards, the best trade practices and to meet with the approval of Owner. If any departures from the Contract Drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted immediately to Engineer for approval.

B. If the drawings and/or specifications are in conflict with governing codes, the Contractor shall submit proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, this specification shall govern.

C. If the drawings and specifications are in conflict with each other, the more stringent shall apply.

1.5 PROJECT/SITE CONDITIONS

A. Before submitting proposal, the Contractor shall visit and carefully examine the individual sites so as to familiarize himself with existing conditions, the amount of work required, the working hours and special auxiliary restrictions of the project requirements including storage and delivery of materials.

B. The Contractor shall verify all conditions on the job which may affect the installation of the work, and shall familiarize himself with applicable local and state regulations. Any discrepancies or interferences shall be reported immediately to Engineer. Additions to the contract price will not be allowed when they are due to the failure of the Contractor to carefully inspect existing condition.

C. The submission of a proposal will be construed as evidence that such examination has been made. Later claims for labor, equipment or material required for difficulties encountered, which could have been foreseen had such examination and evaluation have been, will not be recognized.

1.6 WORK BY SUBCONTRACTORS

A. All Subcontractors to the Contractor shall be approved by Owner.

B. The Contractor shall be totally responsible for his work and all work by his Subcontractors.

1.7 COORDINATED WORK

A. This Contractor shall cooperate with other contractors performing work on this project, or other projects at the site, as necessary to achieve a complete, neatly fitting installation for each condition. To that end, each Contractor shall consult the drawings and specifications, for all trades to determine nature and extent of other work.

1.8 HAZARDOUS MATERIALS

A. If hazardous materials including, but not limited to, asbestos, pollutants, or PCB are in any way suspected, inform Owner immediately and suspend work on that portion of the project.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 DESIGN SUBMITTALS

A. Submit all design submittals within 30 days after award of contract.

1. Submit electronic copies of all drawings and product data every time a submission is made until final approval.
2. Separate submittals may be made: hardware and software.

B. Engineer shall review and comment on copies submitted.

C. If design does not conform to the design intent, Contractor shall resubmit to Engineer.

D. No construction may begin until the design is approved for conformity with specification's intent by Engineer.

E. Submittals and drawings shall be sufficient to:

1. Show that the intent of the specification has been met.
2. Provide a document for use by Owner showing all equipment incorporated into the system including both new and existing.
3. Provide a document for use by Owner showing all equipment pneumatic and wiring connections of the system for both new and existing equipment.

F. Items to be included in hardware drawings at minimum are:

1. Include a complete bill of material of equipment used indicating quantity, manufacturer and model number and other relevant technical data.
2. Include manufacturer's description and technical data, such as performance curves, product specification sheets and installation/maintenance instructions for the items listed in Division 23 Section 23 0901, "Temperature Control Hardware."
3. Provide each electrically operated device with completely coded interconnection wiring diagrams. Show all termination and wiring numbers.
4. Provide schematic wiring diagrams for each control panel. Show all terminations and wiring numbers.

5. Provide schematic wiring diagrams for all field sensors and controllers.
6. Provide each pneumatic operated device with complete piping diagram.
7. All schematic diagrams shall show both new and existing equipment for a complete control system schematic.
8. Provide system schematic diagrams for air handling units, heating plant, exhaust/ventilation systems, and all other miscellaneous points. Schematics to indicate every monitored/controlled point associated with that system.
9. Provide system riser diagrams showing all controllers, workstations, network wiring, etc.

G. Items to be included in software drawings at minimum are:
   1. Personal computer/operator workstation
      a. SE shall inspect and update, as necessary the existing operator workstation.
         (1) For those programs which are activated, provide schedules, lists or other documentation of all data which will be entered to customize base programs to this facility.
         (2) Include a complete description of the operation of each software program. This description shall directly reference the line-by-line program.
         (3) Provide schedules, lists or other documentation of all operation parameters.
   2. The Contractor shall provide (4) four hours of labor at Engineer's office for the principle program writer to meet with Engineer to interpret/review line by line programming.

H. No work may begin on any segment (hardware or software) of this project until the design for the respective segment has been reviewed by Engineer for conformity with the specification design intent.

I. Quantities of items submitted will not be reviewed by Engineer and are the responsibility of the Contractor.

J. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Clearly note exact models, options and accessories being provided. General catalogs will not be accepted as cut sheets to fulfill submittal requirements.

K. Drawings and product data not bearing the approval stamp of the Contractor, showing Contractor has reviewed and approved, or containing deviations from the contract documents, will be returned to the Contractor for resubmittal for compliance with above requirements.

L. Equipment furnished and installed which is not reviewed by Engineer and not conforming to the design concept of the project will have to be removed and replaced with acceptable equipment all at the cost of the Contractor.

M. Corrections or changes indicated on drawings and product data shall not be considered as extra work order.

N. Engineer's checking and reviewing of drawings is a gratuitous assistance and in no way relieves the Contractor from responsibility for errors or omissions which may exist on the drawings. Whenever such error or omissions are discovered, they must be made good by the Contractor, without any additional cost to Owner, irrespective of any review by Engineer.

O. Provide to Engineer any additional information or data which they deem necessary to determine compliance with these specifications or which they deem valuable in documenting the equipment to be installed.

3.2 START-UP AND TESTING

A. Where new digital controls are being installed, they shall be installed to the greatest extent possible before switch over from the existing temperature control system.

1. Prior to switch over, the controllers shall be completely installed, checked and tested.

2. Controller software and hardware shall be verified prior to switch over.

B. Prior to testing and verifying proper system operation, Contractor shall furnish Engineer, for acceptance, electronic copies of the start-up/testing procedure proposed. Engineer must approve the check-out procedure prior to start up/testing.

C. Check out procedure must include provisions for technicians to specifically check off procedures or tests performed.

D. At minimum, the following shall be included in the checkout procedure:

1. The Contractor shall test and verify proper operation for each control loop.

2. Each control loop check will verify that the controller, manual override, fail safe control and electric interlocks are operating as intended to accomplish the control strategy.

a. Provide to Engineer trend logs of a minimum of thirty minutes in length, sampling no less frequently than every one minute, registering analog values of controlled variables showing that control loops respond adequately during system start up as well as steady state conditions. Logs must show the loop response to a step input of at least 5°F change in setpoint or 10% relative humidity change in setpoint.

3. Contractor shall test and verify that correct terminations/designations of I/O are in place for each input and output.

4. Contractor shall test and verify that sensors are properly calibrated, operational, and are within the performance parameters established in this specification.

a. Contractor shall have onsite instrumentation to calibrate/verify all analog input sensing. Instruments shall themselves be properly calibrated and be of greater accuracy than the sensors installed.

5. Contractor shall test and verify onsite that operator interface menus and help screens are properly displayed, and that point names and designations are correct.

6. Contractor shall test and verify communications between controllers.

E. Start-up of the new digital control system must be phased with the phases of construction on this project. Start-up of an individual digital controller shall be planned such that the entire switch-over and checkout of a system can occur in less than one day. Incomplete or unverified controller systems shall not be left in operation overnight without permission of Owner.

1. Contractor will not be allowed to switch over additional systems until the present controller being worked on is 100% complete.

F. After the procedure is approved and after portions of the system are complete (phasing of system installation/commissioning to be approved by Owner) and ready to be placed into regular service, Contractor shall inform Owner of this fact in writing.

G. Contractor shall agree on start-up dates with Owner.

H. On each start-up date for completed portions of the system, Contractor shall have on-site qualified vendor field technicians to place the system in operation, making such tests, adjustments and changes as may be found necessary to insure successful operation of the installed equipment and systems.

I. Contractor shall notify Owner 24 hours in advance when equipment needs to be shut-down during start-up/testing.

J. All tests shall be documented by the Contractor and certified, verifying that the tests have been performed and that all deficiencies have been corrected.

1. Contractor shall demonstrate on site to Engineer that each input and output operates as specified, control loops are tuned, alarms report as specified, failsafe modes are as specified, and other verification as requested by Engineer and/or Owner to demonstrate that the system has been checked by the Contractor.

2. All testing must be performed, and all deficiencies corrected to Engineer's and Owner's satisfaction.

K. At the end of each phase of start-up/testing, if equipment and systems are operating in a manner satisfactory to Engineer and Owner, Owner will sign a certificate affirming that the systems operation has been tested and accepted in accordance with the terms of his specification. The date of Owner's final acceptance of the entire system (not phased portions) will be the start of the guarantee period.

3.3 GUARANTEE

A. Workmanship and material for work specified shall be guaranteed free from defects for a period of twelve (12) months after final completion and acceptance by Owner of the entire system, not portions of the system. Note that warrantees for individual controllers placed in service will not commence until the entire system is complete and accepted by Owner. Any equipment herein described that is shown to be defective during the guarantee period shall be adjusted, repaired, or replaced at no charge to Owner.

B. After the final inspection and demonstration, a punchlist of incomplete or unsatisfactory items will be developed by Engineer.

C. The Contractor shall respond to the punchlist with a date by which all items will be completed/corrected.

D. Upon completion of all punchlist items, the Contractor shall inform Engineer in writing of this fact. This date will serve as the tentative guarantee start date.

E. Upon verification that all punchlist items are complete by the Engineer, the tentative guarantee start date will become the actual guarantee start date.

F. Items which unreasonably delay the start of the guarantee and are beyond the Contractor's control such as change orders late in the project will not be considered in establishing the guarantee start date.

G. During the guarantee period, software updates/controller improvements (i.e., microprocessor chip changes) shall be provided to Owner at no charge. Coordinate with Owner prior to the installation of such changes.

Note: The intent of G. is to insure that Owner receives any product updates which are directed toward correcting a product problem which may or may not be apparent. It is not intended to

automatically extend to Owner new product features or enhancements which did not exist at the time of Contract Award.

H. At Owner's request, the Contractor shall visit the building to clarify for the operating personnel any questions as to the proper operation and maintenance of the system during the first year after final acceptance of system.

3.4 SUBSTANTIAL COMPLETION SUBMITTALS

A. Contractor shall provide the following documents at the time requesting Certification of Substantial Completion:

1. Documents as described in General Conditions.
2. Listing of all changes in sequence of operation from those specified by Owner's direction. Listing shall be signed and dated by Owner.
3. Print-out of each color graphic design.

3.5 CLOSEOUT SUBMITTALS

A. Contractor shall provide closeout submittals required by the Contract Documents including, but not limited to, the following prior to requesting Final Acceptance of the Work:

1. Record Documents as described in Paragraph 3.6 herein;
2. Operating and Maintenance Manuals for items so required by the various Specification Sections and other items as so requested by Owner and as described in Paragraph 3.7 herein;
3. Warranties, guarantees, and bonds as outlined in Paragraph 3.3 of this section;
4. Keys and keying schedule;
5. Tools, spare parts, maintenance stock of materials, etc.;
6. Certificates of Insurance for products and completed operations;
7. List of subcontractors, service organizations, and principal vendors, including names, addresses, and telephone numbers where they can be reached for emergency service at all times including nights, weekends, and holidays;
8. Verification that all training has been reviewed with Owner personnel as described in Paragraph 3.8 herein;
9. Certified copy of final punchlist of itemized work to be completed or corrected (including equipment requiring final connection), stating that each item has been completed or otherwise resolved for acceptance, endorsed and dated by Owner;
10. Revised evidence of final, continuing insurance coverage complying with the insurance requirements;
11. Final Application for Payment in accordance with the provisions of the Contract Documents;

B. Contractor and all Subcontractors and major material suppliers who have furnished material or labor for the Work under contract with the Contractor or Subcontractor shall submit final lien waivers. The lien waivers shall be for the full amount of the Contract involved.

3.6 RECORD DOCUMENTS

A. General

1. When conflict occurs between various technical specification sections and this Section 23 0900, “Basic Temperature Control Requirements,” the more stringent requirements shall govern.
2. Each Contractor shall maintain at the site for Owner one record copy of all drawings, specifications, addenda, approved shop drawings, change orders, and other modifications, in good order and marked to record all changes applicable to the work made during construction. All changes made during construction shall be recorded by the Contractor. Contractors shall be responsible for accuracy of all changes made.
3. The daily record of changes shall be the responsibility of Contractor’s field superintendent. No arbitrary mark-ups will be permitted.
4. Failure to keep accurate records of equipment installed will require the Contractor to site verify the installation as required, all at Contractor’s expense.

B. Recording

1. Legibly mark and record at each Product section of the Project Manual a description of actual Products installed, including the following:
    a. Manufacturer’s name and product model and number.
    b. Product substitutions or alternates utilized.
    c. Changes made by Addenda and Modifications.
2. Record drawings: Legibly mark to record actual construction:
    a. Location of devices (sensors, actuators, controllers, etc.) internal utilities (including conduit routing), and appurtenances, concealed in construction or not readily observable from floor level, referenced to visible and accessible features of structure.
    b. Changes of dimension and detail.
    c. Details not on original Contract Drawings.
    d. Modifications/additions to original electrical and pneumatic interface schematics.

C. Submittal

1. During the first week of each month, Contractor shall present, at the project site, the job copy showing variations and changes to date to Owner for review.
2. At completion of Project, submit electronic copies on disk of Project Record Documents to Owner. Project Documents shall contain Project Documents indicating all changes made during construction. Accompany submittal with transmittal letter, in duplicate containing:
    a. Date
    b. Project title and address
    c. Contractor’s name and address
    d. Title and number of each record document
    e. Certification that each document as submitted is complete and accurate.
    f. Signature of Contractor or his authorized representative.

3.7 OPERATING AND MAINTENANCE (O & M) MANUALS

A. Contractor shall provide electronic set of Operating and Maintenance (O&M) manuals to Owner.

B. The format and information contained in the new O & M manuals will be as follows:

1. Format

a. Tab Dividers: Provide tabbed fly leaf for each separate product, system or subject with typed description.

b. Table of Contents: Provide table of contents for each volume.

c. Project Record Drawings: Reduce AutoCAD drawings to 11" x 17" format, provide with reinforced punched binder tab. Bind in with text; fold drawings to size of text pages. (Larger drawing will be allowed if 11" x 17" format is unreadable.)

2. Volume 1 Hardware

a. Section 1:

(1) Include all submittals and drawings updated to as built conditions.

(2) Include manufacturer's operation and installation instructions for items such as modems, printers, CRTs, computers, keyboards, etc.

b. Section 2:

(1) Field hardware, product literature.

c. Section 3:

(1) Controller product catalogs, controller panels, electronic cards, components, etc.

C. Provide electronic copies of all job software on disks which can be directly loaded by Owner.

D. All drawings, applications software and other job documentation will become the property of Owner.

E. Distribution of O&M manuals will be by Owner.

3.8 TRAINING

A. Contractor shall provide a minimum of (1) one training sessions during the Contract period. Training shall be made available to Owner during all three working shifts.

1. Session 1: Covering DDC and ASC Controllers and Operator Interfaces. At owners' on-site location, classroom environment. Two separate classes shall be held covering same material. Each class shall handle up to five Owner designated personnel. Each session to occur during project construction and at minimum one month prior to start-up of first controller.

B. One month prior to the first session, the Contractor shall provide an outline of all topics to be covered in all sessions for approval by Owner.

C. The instructor(s) shall be competent and have full knowledge of the system installed and shall provide training specifically oriented to Owner's installed system.

D. The instructor(s) shall utilize the operating and maintenance manual provided for the system as a reference manual during the training session. Each person attending the training session shall be provided with an O&M manual. At minimum, these sessions shall include the following:

1. Description of the overall control system configuration and physical layout, indicating location of all sensors and controlled devices.

2. Description of all programs and program features (software).

3. Description of the control strategies being utilized at the installation.

4. Description of all key hardware components utilized in the system.

5. Demonstration of how to communicate with (command and monitor) the DDC and ASC Controller(s).

6. Demonstration of the programming instructions required to use the system.
7. Demonstration of how to retrieve alarms and logs.
8. Demonstration of diagnostic trouble shooting techniques for the system.
9. Description of any changes made to existing electric and pneumatic controls which remain.
10. Provide quick reference card for operator ease of operation.

END OF SECTION

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SECTION 23 0901
TEMPERATURE CONTROL HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including General Conditions of the Construction Contract and Supplementary Conditions and Division 01 of the specifications apply to the work in this section.

B. This section is hereby made part of all other sections of Division 23 as fully as if repeated in each.

1.2 SECTION INCLUDES

A. Network communications

B. Direct digital control controllers

C. Application specific controllers

D. Operator workstation

E. DDC system field hardware

F. Miscellaneous hardware

1.3 SCOPE

A. This Section establishes a minimum quality of hardware and installation and establishes standard equipment or equipment configurations.

B. The digital control/building automation system shall utilize systems as herein specified and manufactured by Schneider Electric (Alpha Controls).

C. Work installed by the Contractor shall be done in a neat and workmanlike manner, as determined by Owner and in keeping with acceptable standards for this type of work.

D. Unless indicated in this specification, all materials used shall be new. Where items have been indicated to be reused, it is the Contractor's responsibility to insure that the reused items are operating properly and are in good condition. Contractor must make Owner aware of defective items designated for reuse. Owner will be responsible for repairs.

E. Submit data, at minimum, on the following:

1. Network communications
2. Field interface panels
3. DDC field hardware
    a. Sensors, including supporting documentation
    b. Transmitters
    c. Utility Interfaces
    d. Switches
    e. Relays
    f. Solenoid air valves
    g. Transducers
    h. Power supplies

4. Miscellaneous hardware
    a. Electrical surge suppressor
    b. Air pressure safety switches
    c. Electric HOA switches
5. Existing Operator workstation
    a. Modify or upgrade existing as necessary to accommodate this project.

PART 2 - PRODUCTS

2.1 NETWORKING COMMUNICATIONS

A. Connect to existing Schneider Electric building automation system.

B. Access to either network shall be totally transparent to the user when accessing data or developing control programs.

2.2 EXISTING OPERATOR WORKSTATION

A. Inspect, test modify and upgrade as necessary for this project.

2.3 DDC SYSTEM FIELD HARDWARE

A. Field interface panel

1. All field interface devices, where practical shall be mounted in field interface panels. All other field interface devices shall be mounted at the point of field interface in a separate enclosure suitable for the location. When the manufacturer provides an enclosure/packaging of the device or sensor suitable for the location that protects the device from dust and moisture, conceals integral wiring and moving parts, this enclosure shall be acceptable.
2. Mounted within the field interface panel shall be power supplies for sensors, interfacing relays and contactors, pneumatic to electric and electric to pneumatic transducers, output status indication, manual override switches, etc.
3. Provide an enclosure meeting the same requirements as DDC controllers and application specific controllers.
4. No power line carrier type interfacing equipment will be allowed in the field interface panel.
5. Terminations
    a. Wiring to and from the field interface panel shall be to terminal strips with screw type terminals. Analog or communications wiring may use the field interface panel as a raceway without terminating. The use of wire nuts or crimped connections within the field interface panel shall be minimized and will only be allowed if the device has fixed length leads pre-¬attached by the manufacturer. Wire nuts are applicable only to line voltage circuits. Crimped connectors are applicable to non-analog low voltage circuits.
    b. All wiring within the field interface panel shall be run in plastic wiring duct to give a neat and workmanlike appearance.
    c. Every field interface device and every field termination shall be labeled using words, letters or numbers with permanent, mechanically fabricated or printed, laminated tags exactly corresponding to as built drawings.

B. Analog input devices

1. Contractor shall provide equipment for analog inputs as indicated in the point lists and shown on the drawings. This shall include the sensor and transmitter.
2. Sensors and transmitter provided shall be of the type that is universally accepted in the industry, can easily be second sourced and could be utilized with the majority of digital controller manufacturer's equipment.
3. All sensors and transmitters utilized in a similar application shall be of the same manufacturer.
4. Sensing ranges and accuracies given are for the normal values anticipated. The actual sensor range will be dictated by the maximum and minimum sensed values anticipated and standard sensor ranges.
5. All sensors shall be calibrated at the midpoint of the expected sensed values.
6. Sensor/transmitter shall be appropriately packaged for the location, as follows:
    a. Architectural housing for space wall mounting.
    b. Weatherproof and sun shield housing for outside mounting.
    c. Thermal well housing for water applications.
    d. Dust and physical protective housing for duct mounting.
7. Sensor/transmitter shall be appropriately selected to withstand ambient conditions, such as:
    a. Moisture or condensation, where it is a factor.
    b. Vibration from ductwork, equipment, etc.
    c. Reasonably expected transient conditions such as temperatures, pressures, humidity, etc., outside the normal sensing range.
8. Sensor/transmitter shall be appropriately selected to most closely match the expected sensing range.
9. Sensor/transmitter shall be appropriately selected for an accurate, responsive, and noise free signal.
10. The system shall maintain the specified end to end accuracy, indicated below for the noted range, throughout the guarantee period from sensor to controller read out.
    a. Sensing accuracy shall be determined by the square root of the sum of the errors squared. All sensing errors introduced, including but not limited to, sensor accuracy as manufactured, repeatability, self-heating, linearity, thermal drift, lead length, analog to digital conversion, annual sensor drift, etc., shall be taken into account.
    b. Contractor must submit all accuracy information required to prove that sensing accuracy provided will not exceed that specified.
        (1) Supporting documentation that solely indicates a percentage, without indicating what it is a percentage of (i.e., span, reading, etc.) will not be acceptable.
11. Sensor power supplies shall be located in controller panels or field interface panels.
12. Current measurement (amps)
    a. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal which will be converted to a 4-20 mA DDC compatible signal for use by the system.
    b. Current transformer. Provide a split core current transformer to monitor motor amps.

(1) Operating frequency - 10 - 80 Hz

(2) UL recognized

(3) Five amp secondary

(4) Select current ratio as appropriate for application.

c. Current transducer. Provide a matching current to voltage or current to mA transducer and power supply. Current transducer shall include:

(1) 6X input over amp rating for AC inrushes of up to 120 amps.

(2) Manufactured to UL 1244.

(3) Accuracy: ±0.5% of full scale, Ripple ±1%.

d. When used for pump or fan status, differentiate signal between off, on with no load, and on with load (high and low speeds).

e. Manufacturers: Veris Industries or approved equal.

13. VFD speed feedback

a. Provide signal indicating actual variable frequency drive speed.

b. Provide all interface devices as required.

14. Highest zone thermostat pressure

a. Obtain pneumatic control signal from existing pneumatic signal selector.

b. Verify calibration and setpoint for each existing thermostat connected to the signal selector.

C. Analog output devices

1. Contractor shall provide equipment for analog outputs as indicated in the point list and shown on the drawings. This shall include digital to analog conversion and wiring or pneumatic tubing to the controlled device. When necessary, the analog output signal must be fed back and used in the control algorithm.

2. All controlled devices which are to be modulated are to receive analog signals of one of the following forms: 0 20 psi, 3 15 psi, 4-20 MA, 0-5 VDC or 0-10 VDC.

3. Analog output signal for variable frequency drives shall be 0-10 VDC.

4. Coordinate with chiller manufacturer for proper signal to control chiller capacity.

D. Binary input devices

1. Contractor shall provide equipment for binary inputs as indicated in the point lists and shown on the drawings.

2. All binary shall be electrically isolated from the digital controller either by optical isolation or relays. Provide filtering to eliminate false signals resulting from input “bouncing.”

3. All binary inputs shall be provided by double or single pole double throw dry contacts wired Normally Open (NO) or Normally Closed (NC) as required. All binary inputs will be wired to alarm on “out of normal” conditions.

4. Status relay. Relays shall be located in the field interface panel or in the monitored equipment’s control panel. These relays shall be of the sealed, multiple pole type with socket mount. These relays shall have silver cadmium contacts with a minimum life of 1 million operations. Contact rating shall be 5 amps at 110 volts resistive. Provide Potter Brumfield, Allen Bradley or approved equal.

5. Current status switch
    a. Self-powered current sensing consisting of a current transformer, solid state current sensing circuit, adjustable trip point, solid state switch, dry contact SPDT relay and separate LEDs indicating the power and sensor trip status.
    b. Unit shall be capable of detecting belt loss, belt failure, motor failure and other mechanical failures.
    c. Unit will be accurate to within ± 1% of range.
    d. Unit shall be suitable for variable frequency drive applications.
    e. A conductor of the load shall pass through the window of the device. Device shall be able to accept up to twice its trip point range.
    f. Shall be used for all fan and pump status points, unless otherwise noted on the drawings.
    g. Manufacturers: Veris Industries or approved equal.
6. VFD fault status
    a. Provide status indication of the variable frequency drive being in a fault condition.
    b. Obtain contact closure from variable frequency drive.
7. VFD manual/bypass status
    a. Provide status indication of the variable frequency drive placed into manual control mode or in bypass mode.
    b. Obtain contact closure from variable frequency drive.

E. Binary outputs
1. Contractor shall provide equipment for binary outputs as indicated in the point list.
2. For all binary outputs to inductive loads such as relay, solenoid, or motor coils, transient voltage suppression shall be placed across the binary output relay contacts.
3. Binary outputs shall be wired/piped normally open or normally closed for proper operation and failsafe operation.
4. Control relays shall be located in the field interface panel. These relays shall be of the sealed, multiple pole type with socket mount. These relays shall have silver cadmium contacts with a minimum life of one million operations. Contact rating shall be 5 amps at 110 volts resistive. Provide Potter Brumfield, Allen Bradley or approved equal.
    NOTE: No inductive or switching loads shall be mounted in the same enclosure as digital controllers.

2.4 MISCELLANEOUS HARDWARE

A. Air pressure safety switches
1. Air pressure safety switches shall be of the manual reset type with DPDT contacts rated for 2 amps at 120 VAC.
2. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.

B. Electric H.O.A. switches
1. Provide control panel and MCC mounted electric Hand/Off/Auto switches as required.
2. Contact rating: 5 amps at 110 volts resistive.

3. Manufacturers: Square D 9001-D4G3S, Allen Bradley or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Every device comprising this temperature control system, whether new or revised, shall have a bar code label affixed to it. Bar coding shall meet Owner's standards.

B. Items to be so labeled include, but are not limited to:

1. Controllers and field interface panels.

   Note: Labeling of modules and devices within controllers and panels (such as point modules, E/P switches, etc.) is **not** included.

2. Sensors, transmitters and transducers including DDC, pneumatic and electric.

3. Operator interface workstation. Label each separate piece of equipment.

3.2 OPERATOR WORKSTATION

A. The operator workstation shall be turned over to Owner in complete operating order. All hardware shall be checked, and adjusted for immediate use. All software required shall be loaded and turned over to Owner ready for use, including menus, alarms, graphic screens, etc.

3.3 DDC SYSTEM FIELD HARDWARE

A. Field interface panel

1. The panel shall be firmly attached to a permanent wall or it shall be free standing from unistrut type supports. It shall be mounted directly adjacent to the controller panel.

2. Provide individual 120V power circuits to each panel. A separate third wire (independent grounding wire) shall be furnished as part of the field interface panel power circuit. Power source shall be the same as the controller.

3. Provide a fused disconnect at each panel. Non-control loads are not to be on this circuit.

B. Sensors

1. Space sensors on exterior walls shall be mounted on an insulated backplate and the hole into the wall completely sealed. If conduit is used up to the device, the conduit shall be plugged with insulation to prevent cold air from entering the device.

2. Space sensors shall be mounted 4'0" above the finished floor line or in line with existing devices.

3. When installing space sensors, the Contractor shall examine the actual locations of air distribution diffuser. Obtain Owner's approval as to the location of all space sensors.

4. All water temperature sensors shall be installed in wells.

5. Outside air temperature sensors shall be mounted on the exterior wall in a weather and sun shield and shall be located to provide accurate outside air temperature sensing. Outside air sensors are to be installed such that they point up to prevent the sensor housing from filling with water.

6. Outdoor air humidity sensor shall be located next to the outdoor air temperature sensor as indicated on plans.

7. Duct sensors in large ducts will be arranged in a four-sensor array to average the duct temperature. These arrays will be indicated in the point schedule.

3.4 MISCELLANEOUS HARDWARE

A. Miscellaneous hardware shall be installed as per manufacturer's recommendations.

B. Thermostat and switch set points shall be set by the contractor to an appropriate level for the application.

END OF SECTION

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SECTION 23 0903
TEMPERATURE CONTROL CONDUIT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Conduit

B. Connectors

C. Junction Boxes

1.2 SCOPE

A. This section includes conduit requirements for use with wire, cable and pneumatic polyethylene tubing.

1.3 SUBMITTALS

Not Applicable

PART 2 - PRODUCTS

2.1 CONDUIT

A. All wiring shall be installed in a complete conduit raceway system of a minimum trade size of ½". Conduit shall be installed continuous from terminal to terminal and shall be mechanically and electrically connected. The entire system shall be grounded.

1. Exception: With permission of Owner, metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors. Receive authorization from Owner before using surface raceway.

2. Exception: The conduit system shall be complete except that up to 12" of exposed Class 2, 3, or communications wiring may be used from the conduit system to an actuator. Wiring extending beyond the conduit system shall be protected by a plastic bushing at the end of the conduit.

B. Conduit installed outside or exposed to moisture shall be rigid aluminum. Conduit in other areas shall be electric metallic tubing (EMT).

C. Conduits installed in dry locations requiring flexible connections for adjustment or vibration isolation shall be provided with a 14" maximum length of flexible galvanized steel (Greenfield) conduit. Flexible conduit installed in wet locations and exterior locations shall be liquid-tight type.

2.2 CONNECTORS

A. Couplings and connectors for use with rigid aluminum shall be the threaded type. Terminations shall be with double locknut and insulated bushings. Fittings installed outdoors shall be watertight.

B. Couplings and connectors for electrical metallic tubing (EMT) shall be gland compression.

2.3 JUNCTION BOXES AND PULL BOXES

A. Provide junction boxes and pull boxes of the proper size and shape.

B. Junction and pull boxes shall be supported independently of the conduit system.

C. Junction and pull boxes shall be of galvanized steel construction.

D. Paint each junction box cover per specification Division 26 Section 26 0505, “Basic Electrical Materials and Methods.” Mark cover using permanent marker to indicate that wiring enclosed is associated with the controls system.

PART 3 - EXECUTION

3.1 CONDUIT INSTALLATION

A. Conduit shall not be smaller than the sizes indicated or specified, and where no size is indicated, the Contractor shall size the conduit in accordance with the requirements of the local/state Electrical Code for the number, size and type of wires indicated and specified for application, except that no conduit shall be less than ½” trade size.

B. Where conduit enters panel boxes, pull boxes, outlet boxes or wireways, it shall be secured in place by galvanized locknut on the outside and galvanized locknut and bushing on the inside. Bushing shall be insulated throat type with ground lug. Care shall be taken to see that all conduit runs from a permanent and continuous ground return back to the panel ground connection point. All bushings shall be bonded to the junction box, outlet box, cabinet, etc. Where required, bonding jumpers shall be installed between conduit and boxes.

C. Conduits for branch circuits shall be installed continuous between connections to outlets, boxes and cabinets and shall have a minimum possible number of bends or fittings. Bends shall be made with an approved hickey or conduit-bending machine and shall be smooth and even without flattening or flaking.

D. Exposed conduit runs shall be run neatly and shall be parallel to the walls of the building.

E. The actual installation of conduit shall be made in the field to clear all piping, ductwork, equipment fixtures, ceiling inserts, access doors, etc. Bends, turns, and pull boxes, as required, shall be provided in accordance with field conditions.

F. Conduit ends shall be reamed and shall be thoroughly cleaned before installation. Conduit openings and boxes shall be plugged or covered as required to keep conduit clean during construction. All conduit shall be swabbed clear of obstructions before the pulling of wires.

G. All threaded joints in rigid aluminum conduit shall be sealed with Thomas & Betts “Alum-Shield” compound on the male thread only.

H. Conduit runs shall be securely fastened in place with approved straps, and hangers and supports from inserts set in the construction above. Vertical conduit shall be securely clamped to steel members and unistruts, and attached to the structure.

I. Conduit shall not pierce or interfere with waterproofing, vapor barriers, damp-proofing, etc.

J. Raceways run through foundation walls, basement slabs, or through any walls for floors that have vapor barriers, waterproofing, or any type of damp-proofing, shall be sealed by use of special wall and floor entrance seals designed for the purpose. Drawings of the proposed seals and clamping arrangements shall be submitted for approval.

K. Conduits passing from the building exterior to interior or passing between conditioned and non-conditioned spaces shall be sealed to prevent condensation in the conduit.

L. Conduits crossing building expansion joints shall be provided with expansion fittings and flexible grounded bonds bypassing the fittings to insure ground continuity.

M. All conduit shall be supported with fasteners designed for the application and must be attached to the building structure and shall not be supported from other conduit, pipes, ductwork, ceiling suspension members or equipment. Existing pipe hangers for multiple conduits with spare capacity may be used.

1. Exception: When conduit is required to terminate at a sensor or control point on ductwork, the conduit may be fastened to the ductwork. This is the only condition in which conduit is allowed to be fastened to ductwork.

2. Note: Perforated metal strap and tie wire are prohibited.

N. Existing conduit which is in place and has additional wire carrying capacity due to existing wiring being removed or due to original spare capacity may be used for new wiring if the conduit installation meets this Temperature Control conduit specification.

O. All openings for conduit passing through masonry walls or floor shall be core drilled by this Contractor. Core holes shall be sealed as follows:

1. For the conduits penetrating floor or fire walls, the Contractor shall provide fire stopping equivalent to the construction penetrated.

2. Where conduit passes through floor or exterior walls, caulk at both sides to insure waterproofing around conduit.

3. Where conduit penetrates walls separating quiet areas such as offices from noisy areas such as equipment rooms, the opening around the conduit shall be filled with fiberglass insulation and sealed.

3.2 JUNCTION BOX INSTALLATION

A. All outlets shall be installed in accessible locations and none shall be installed above ducts, behind furring or in other similar locations. Any outlet designated as providing power for particular piece of equipment shall be accessible for disconnection with said unit in place.

END OF SECTION

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SECTION 23 0904
TEMPERATURE CONTROL WIRING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Wire

B. Cable

1.2 SCOPE

A. Power wiring, Class 1, 2, or 3 wiring, and communications wiring required for satisfactory installation and operation of all equipment specified under temperature control shall be furnished and installed by this contractor.

B. Wiring shall be installed in accordance to wiring specification found in this section.

C. All wiring shall be UL listed and installed in accordance with applicable electrical codes and shall comply with equipment manufacturer's recommendations.

Note: When specified materials or installation methods exceed applicable electrical codes and equipment manufacturer's recommendations, this specification shall govern.

1.3 SUBMITTALS

A. Submit data and samples of the following:

1. Analog Cable
2. Other low voltage signal cable

PART 2 - PRODUCTS

2.1 WIRE AND CABLE

A. All wires shall be copper and shall meet the minimum wire size and insulation class listed.

WIRE CLASS	MINIMUM WIRE SIZE	MINIMUM INSULATION CLASS
Power	12 Gauge	600 Volt
Class 1	14 Gauge Stranded	600 Volt
Class 2	18 Gauge Stranded	300 Volt
Class 3	18 Gauge Stranded	300 Volt
Communications	Per Manufacturer	Per Manufacturer

B. 120V power circuit wiring shall be #12 AWG. Home runs longer than 100 feet shall be #10 AWG.

C. 24V control power circuit wiring and all wiring to flow switches and relays shall be #14 AWG. Runs greater than 200 feet in length shall be #12 AWG.

D. Use twisted shielded pair, insulated and jacketed cable, #18 AWG minimum, for wiring to sensors (temperature, humidity, etc.). All sensor wiring shall have a 100% grounded shield.

E. Network communications wiring shall be in accordance with manufacturer's specifications.

F. Use THHN wires for power circuit wiring and all control wiring in dry locations; use THWN wires for wet locations.

G. Conductors shall be continuous from outlet to outlet and no splices or connections shall be made, except within outlet boxes, junction boxes or cabinets.

H. Permanent wiring shall not be pulled into conduits or raceways until permission is granted by Owner.

I. Where the space above a ceiling is a supply or return air plenum, the wiring therein shall be plenum rated.

PART 3 - EXECUTION

3.1 WIRING

A. All sensor wiring shall use crimped or soldered connections; wire nuts are not allowed.

B. Sensor wiring shall be continuous containing no splices between the digital controller and the field sensor.

C. Identify all control/signal wires with labeling tape using either words, letters or numbers that can be exactly cross-referenced with as-built drawings.

3.2 INSTALLATION

A. Wires shall be kept a minimum of 3” from hot water piping, steam piping, condensate piping or any other hot surfaces.

B. The Contractor shall provide a separate insulated green ground wire inside each power branch circuit conduit. Connect one end of the ground wire to the ground bus or ground terminal in the panel board. Connect the other end of the ground wire to the grounding lug in equipment being served. Provide and install a grounding lug in equipment being served if no grounding lug exists.

C. Identify all temperature control raceways with labels stating “Control System Wiring.” Typed (not handwritten) labels shall be affixed to the covers of all junction boxes and pull boxes.

3.3 RACEWAY SYSTEM

A. Power and Class 1 wiring may be run in the same conduit. Class 2 and 3 wiring and communications wiring may be run in the same conduit. Power and Class 1 may not be run together with Class 2, Class 3, or communications wiring.

B. No sensor wiring shall be run in the same conduit with power or Class 1 wiring.

C. Where different wiring classes terminate within the same enclosures, maintain clearances and install barriers per National Electric Code.

D. Pneumatic tubing may not be run in wiring conduit.

E. Wiring within air handling units shall be in a complete conduit system.

END OF SECTION

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SECTION 23 0906
TEMPERATURE CONTROL DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Miscellaneous Existing Controls

B. Demolition of Controls

1.2 SCOPE

A. Demolition of DDC and pneumatic control panels, devices and associated wiring, tubing and conduit for mechanical systems specified in this section.

1.3 SUBMITTALS

Not Applicable

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 MISCELLANEOUS EXISTING CONTROLS

A. Existing control equipment that is to remain is to be calibrated/adjusted for proper operation.

B. Any equipment found to be defective and requiring replacement shall be brought to the attention of Owner. Owner will be responsible for repairs to same.

C. Existing control equipment that is to remain shall be relocated to a new enclosure.

D. The following devices and sensors may be reused provided they meet the requirements of Division 23 Section 23 0901, “Temperature Control Hardware”:

1. Mixed air temperature sensors
2. Supply air temperature sensors

3.2 DEMOLITION

A. Demolition of the existing control systems shall be limited to those systems in which the temperature controls are to be replaced by this Project.

B. Demolition shall include removal of all existing direct digital controls and electric controls not specifically identified to remain. This includes but is not limited to:

1. Field control panels
2. Temperature control panels
3. Pneumatic/electric controls associated with mechanical systems equipment
4. Pneumatic tubing
5. Electric devices, wiring and conduit

a. **Note**: Abandoned tubing and wiring, including conduit, shall be removed completely except where tubing or conduit are installed in inaccessible locations, such as within walls or floors. All tubing ends shall be capped. Above drop ceilings is considered to be inaccessible except that wiring and pneumatic tubing within or outside conduit is to be pulled out. Conduit is to remain in place.

C. Demolition of temperature control panels includes removal of all associated wiring.

D. Owner will inform the Contractor of any equipment to be removed that will remain the property of Owner. All other equipment removed shall be disposed of by the Contractor.

E. The Contractor shall insure that removed controls do not compromise the operation of the existing controls which remain.

F. The Contractor shall be required to make minor modifications to the existing control system such that when a portion of a control system is removed, the remaining system is left in a neat and orderly condition similar to the original installation.

1. It is the intent of this project to eliminate existing DDC and electronic control panels where much of the internal equipment is no longer needed. Consolidate equipment that is to remain into one new field panel.

2. Caution is necessary in this consolidation/clean-up mode, since there is potential for existing wiring which passes through these panels and does not terminate at the panel.

a. Where control panels, once so demolished of controls, devices, etc., render the remaining function of the panel to be a junction box or pull box, Contractor shall so remove the control panel and install a junction box and necessary conduit, where allowed by code.

b. Contractor shall maintain all fire and smoke control system interlocks on units where such exists.

G. Patch and seal any holes left in ductwork, walls, etc. after the existing controls have been removed. A stainless or Owner-approved equal cover plate may be used in finished spaces.

H. Temporary work necessary to maintain air flow, space temperature and relative humidity during demolition of existing controls shall be provided by this Contractor.

END OF SECTION

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SECTION 23 0919
MOISTURE INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Outside air relative humidity and temperature sensor/transmitter

B. Duct relative humidity and temperature sensor/transmitter

1.2 DEFINITIONS

A. NIST: National Institute of Standards and Technology

B. RTD: Resistance temperature detector

1.3 CODES AND STANDARDS (UTILIZE LATEST EDITION)

A. National Fire Protection Association (NFPA)

1. NFPA 90A: Installation of Air Conditioning and Ventilating Systems

B. National Electrical Manufacturers Association (NEMA)

1. NEMA 250: Enclosures for Electrical Equipment (1,000 volts maximum)

C. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1. SMACNA: HVAC Duct Construction Standards-Metal and Flexible

1.4 QUALITY ASSURANCE

A. This Section establishes a minimum quality of hardware and installation and establishes standard equipment or equipment configurations.

B. Work installed by the Contractor shall be done in a neat and workmanlike manner, as determined by Owner and in keeping with acceptable standards for this type of work.

C. Unless indicated in this specification, all materials used shall be new. Where items have been indicated to be reused, it is the Contractor's responsibility to insure that the reused items are operating properly and are in good condition. Contractor must make Owner aware of defective items designated for reuse. Owner will be responsible for repairs.

1.5 SUBMITTALS

A. Preconstruction – Prior to construction provide the following in accordance with Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Product data: For each type of product, including the following:

a. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.

b. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.

c. Product description with complete technical data, performance curves, and product specification sheets.

d. Installation instructions, including factors affecting performance.

2. Manufacturer's installation and operating manuals.

B. Contract closeout – At contract closeout provide the following in accordance with Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Operating and maintenance data including:

a. Product data

b. Installation instructions

c. Assembly drawings

d. Replacement parts list

e. Maintenance and operation instructions

2. NIST Calibration Certificates

3. Test Reports

a. Manufacturer Installation Inspection Report

4. Warranties

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site under provisions of Division 1.

B. Deliver products to site in containers with manufacturer's stamp affixed.

C. Protect products against dirt, water, chemical and mechanical damage before, during and after installation. Damage to products prior to final acceptance of the Work shall be repaired or replaced at no additional cost to the Owner.

1.7 SPARE PARTS

Not Applicable

1.8 WARRANTY

A. One year warranty on products and complete installation commencing at the time of Substantial Completion

1.9 MAINTENANCE

Not Applicable

PART 2 - PRODUCTS

2.1 OUTSIDE AIR RELATIVE HUMIDITY AND TEMPERATURE SENSOR/TRANSMITTER

A. Acceptable manufacturer

1. Vaisala

B. Performance

1. Humidity

a. Range: 0% - 100% RH, non-condensing
b. Accuracy: ±2% RH at 77°F from 10%-90% RH
c. Operating temperatures: -40°F - 140°F
d. Hysteresis: ≤1%
e. Drift: ≤0.5% per year
f. Output resolution: 0.1% RH
g. Three-point NIST traceable calibration with certificate

2. Temperature
a. Dry bulb temperature accuracy: ±0.5°F at 68°F
b. Dew point accuracy: ±1.2°F
c. Wet bulb temperature accuracy: ±0.9°F
d. Enthalpy accuracy: ±0.7 BTU/lb
e. Operating temperatures: -40°F - 140°F
f. Temperature dependence: ±0.01°C/°C
g. Output resolution: 0.1°F
h. Linearity: <0.1°C
i. Three-point NIST traceable calibration with certificate

C. Construction
1. Humidity sensing element: Capacitive polymer integrated circuit.
2. Temperature sensing element: 1000Ω platinum RTD.
3. Probe: Stainless steel or plastic probe with replaceable sensor tip and filter.
4. Enclosure: IP65 class polycarbonate with glass fiber enclosure, UL-V0 approved, with radiation shield.

D. Output signal
1. 4-20 mA or 0-10 VDC output humidity and dry bulb temperature signals
2. 4-20 mA or 0-10 VDC output dew point temperature signal
3. 4-20 mA or 0-10 VDC output wet bulb temperature signal
4. 4-20 mA or 0-10 VDC output enthalpy signal
5. Non-interacting zero and span adjustments.

E. Accessories
1. Calibration tool

F. Basis of Design: Vaisala Model HMS110

2.2 HIGH ACCURACY DUCT RELATIVE HUMIDITY AND TEMPERATURE SENSOR/TRANSMITTER

A. Acceptable Manufacturer
1. Vaisala

B. Performance

1. Humidity
    a. Range: 0% - 100% RH, non-condensing
    b. Accuracy: ±2% RH at 77°F from 10% - 90% RH
    c. Operating temperatures: -40°F - 140°F
    d. Hysteresis: ≤1%
    e. Drift: ≤0.5% per year
    f. Output resolution: 0.1% RH
    g. Three-point NIST traceable calibration with certificate
2. Temperature
    a. Dry bulb temperature accuracy: ±0.5°F at 68°F
    b. Dew point accuracy: ±1.2°F
    c. Wet bulb temperature accuracy: ±0.9°F
    d. Enthalpy accuracy: ±0.7 BTU/lb
    e. Operating temperatures: -40°F - 140°F
    f. Temperature dependence: ±0.01°C/°C
    g. Output resolution: 0.1°F
    h. Linearity: <0.1°C
    i. Three-point NIST traceable calibration with certificate

C. Construction
1. Humidity sensing element: Capacitive polymer integrated circuit.
2. Temperature sensing element: 1000Ω platinum RTD.
3. Probe: Stainless steel or plastic probe with replaceable sensor tip and filter.
4. Enclosure: IP65 class polycarbonate with glass fiber enclosure, UL-V0 approved.

D. Output Signal
1. 4-20 mA or 0-10 VDC output humidity and dry bulb temperature signals
2. 4-20 mA or 0-10 VDC output dew point temperature signal
3. 4-20 mA or 0-10 VDC output wet bulb temperature signal
4. 4-20 mA or 0-10 VDC output enthalpy signal
5. Non-interacting zero and span adjustments.

E. Accessories
1. Calibration tool

F. Basis of Design: Vaisala Model HMD110

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the required temperature and humidity and furnish instruments that are compatible with installed process condition.

B. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations and connections before installation.

D. Prepare a written report listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Properly support instruments, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment.

C. Provide ceiling, floor, roof, wall openings, and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

D. Fastening hardware

1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.

2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.

3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

E. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for access, confirm unrestricted ladder placement is possible under occupied condition.

F. Corrosive environments

1. Use products that are suitable for environment to which they are subjected.

2. If possible, avoid or limit use of materials in corrosive environments.

3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.

4. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

G. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 20 0553 “Identification for Mechanical, Plumbing, and Fire Suppression Systems."

B. Install engraved phenolic nameplate identification at instrument.

3.4 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install raceways. Comply with requirements in Section 26 0533 "Raceways and Boxes for Electrical Systems."

C. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 26 0526 "Grounding and Bonding for Electrical Systems."

3.5 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

B. Wash and shine glazing.

C. Polish glossy surfaces to a clean shine.

3.6 CHECKOUT PROCEDURES

A. Inspection

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check instruments for proper location and accessibility.
3. Check flow instruments for proper installation for direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.
5. Check that instrument attachment is properly secured and sealed.

B. Validation

1. Verify that instrument wiring is complete, enclosed, and connected to correct power source.
2. Verify sensing element type and proper material.
3. Verify instrument tag against approved submittal.

3.7 CALIBRATION

A. General

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration shall meet instrument manufacturer’s written instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.

6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated.

7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.

8. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.

9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements and to supplement requirements indicated.

B. Calibration of analog signals

1. Check analog voltage signals using a precision voltage meter at zero, 50%, and 100%.

2. Check analog current signals using a precision current meter at zero, 50%, and 100%.

C. Calibration of digital signals

1. Check digital signals using a jumper wire.

2. Check digital signals using an ohmmeter to test for contact.

D. Calibration of sensors: Check sensors at zero, 50%, and 100% of the design values.

E. Calibration of switches: Calibrate switches to make or break contact at set points indicated.

F. Calibration of transmitters

1. Check and calibrate transmitters at zero, 50%, and 100% of Project design values.

2. Calibrate resistance temperature transmitters at zero, 50%, and 100% of span using a precision-resistance source.

3.8 ADJUSTING

A. Occupancy adjustments: When requested with 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions.

3.9 TESTING

A. Manufacturer Installation Inspection Report - Provide report prepared by manufacturer's representative, stating that systems installed and services provided under this Section are in accordance with manufacturer's recommendations and are properly operating.

END OF SECTION

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SECTION 23 0923
PRESSURE INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Air pressure sensor/transmitters

B. Air pressure switch

1.2 DEFINITIONS

Not Applicable

1.3 CODES AND STANDARDS (UTILIZE LATEST EDITION)

A. National Fire Protection Association (NFPA)

1. NFPA 90A: Installation of Air Conditioning and Ventilating Systems

B. National Electrical Manufacturers Association (NEMA)

1. NEMA 250: Enclosures for Electrical Equipment (1,000 volts maximum)

C. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1. SMACNA: HVAC Duct Construction Standards-Metal and Flexible

D. IEC Publication 60529: Classification of Degrees of Protection Provided by Enclosures

E. NEMA 250-2014: Enclosures for Electrical Equipment

F. UL® 94: Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.4 QUALITY ASSURANCE

A. This Section establishes a minimum quality of hardware and installation and establishes standard equipment or equipment configurations.

B. Work installed by the Contractor shall be done in a neat and workmanlike manner, as determined by Owner and in keeping with acceptable standards for this type of work.

C. Unless indicated in this specification, all materials used shall be new. Where items have been indicated to be reused, it is the Contractor's responsibility to insure that the reused items are operating properly and are in good condition. Contractor must make Owner aware of defective items designated for reuse. Owner will be responsible for repairs.

D. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

E. Device ratings and enclosures shall be as required by ambient conditions where product is to be installed.

F. Factory tests: Test and inspect assembled pressure instruments, as indicated by instrument requirements. Affix standards organization's certification and label.

1.5 SUBMITTALS

A. Preconstruction – Prior to construction provide the following in accordance with Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Product data: For each type of product, including the following:
    a. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
    b. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
    c. Product description with complete technical data, performance curves, and product specification sheets.
    d. Installation instructions, including factors affecting performance.
2. Manufacturer's installation and operating manuals.

B. Contract closeout – At contract closeout provide the following in accordance with Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Operating and maintenance data including:
    a. Product data
    b. Installation instructions
    c. Assembly drawings
    d. Replacement parts list
    e. Maintenance and operation instructions
2. NIST Calibration Certificates
3. Test Reports
    a. Manufacturer Installation Inspection Report
4. Warranties

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site under provisions of Division 1.

B. Deliver products to site in containers with manufacturer's stamp affixed.

C. Protect products against dirt, water, chemical and mechanical damage before, during and after installation. Damage to products prior to final acceptance of the Work shall be repaired or replaced at no additional cost to the Owner.

1.7 SPARE PARTS

Not Applicable

1.8 WARRANTY

A. Two-year warranty on products and complete installation commencing at the time of Substantial Completion.

1.9 MAINTENANCE

Not Applicable

PART 2 - PRODUCTS

2.1 AIR PRESSURE SENSOR/TRANSMITTERS

A. The assembly shall consist of a pressure transducer with a solid state, two wire, 4-20 MA transmitter mounted in one housing.

B. The transmitter shall be matched to the respective sensing element.

C. The transmitter shall have non-interactive zero and span adjustments, adjustable from the outside cover.

D. Multi-range duct mounted static pressure sensor/transmitter

1. Acceptable manufacturers
    a. Dwyer
    b. Setra
2. Description
    a. Multi-range duct mounted pressure sensor/transmitter with duct probe.
3. Construction
    a. IP66/NEMA 4 plastic glass-filled polycarbonate UL94V-0 case.
    b. LCD display of reading.
    c. Zero and span adjustment.
    d. Provided with static duct probe.
    e. Multi-range capability with field selectable ranges via switches.
4. Performance
    a. Range: unidirectional, selectable from:
        (1) 0.0 – 0.5 in. W.C.
        (2) 0.0 – 1.0 in. W.C.
        (3) 0.0 – 2.5 in. W.C.
        (4) 0.0 – 5.0 in. W.C.
    b. Accuracy: ±1.0% of full scale with calibration certificate
    c. Maximum overpressure: 1.0 psi operation, 10 psi burst
    d. Linearity: ±0.98% of full scale
    e. Hysteresis: ±0.10% of full scale
    f. Repeatability: ±0.05% of full scale
    g. Operating temperature: 32°F - 122°F
5. Remote signal interface: The output signal shall be field selectable from the following output options:
    a. 4 – 20 mA
    b. 0 – 5 VDC
    c. 0 – 10 VDC

6. Basis of Design: Setra Model MRG

E. Space static pressure sensor/transmitter

1. Acceptable manufacturers
    a. Dwyer
    b. Setra
2. Description
    a. Ceiling mounted pressure pickup port with single range low pressure transmitter.
3. Pressure pickup port
    a. Wall mounted: Single gang electrical box mounted concealed pressure pickup port with 1/8" tubing connection, 60-micron filter, and white wall plate.
    b. Ceiling mounted: Concealed pressure pickup designed to rest on ceiling with 1/8" tubing connection and 60-micron filter.
    c. Provide with silicone rubber tubing with surge damper.
4. Transmitter
    a. Construction
        (1) IP65/NEMA 4 plastic glass-filled polycarbonate UL94V-0 case.
        (2) Zero and span adjustment.
    b. Performance
        (1) Range: bidirectional, -0.10 to 0.10 in. W.C.
        (2) Accuracy: ±0.25% of range with calibration certificate
        (3) Maximum overpressure: 1.0 psi operation, 10 psi burst
        (4) Linearity: ±0.22% of full scale
        (5) Hysteresis: ±0.10% of full scale
        (6) Repeatability: ±0.05% of full scale
        (7) Operating temperature: 0°F - 175°F
5. Remote signal interface: The transmitter shall output a 4-20mA analog signal.
6. Basis of Design: Setra Model 264

2.2 AIR PRESSURE SWITCHES

A. Air pressure differential switch with manual reset

1. Acceptable Manufacturers
    a. Automation Components
    b. Cleveland Controls
    c. Dwyer
    d. Penn
    e. Siemens
2. Field adjustable differential pressure switch with manual reset switch that detects excessively high positive pressures or low negative pressures and turns off a fan before damage occurs.
3. Construction

a. Diaphragm operated to actuate a SPDT snap switch with manual reset.
b. User Interface: Screw-type set-point adjustment located inside removable enclosure cover.
c. Enclosure
(1) Dry indoor installations: NEMA 250, Type 1.
(2) Outdoor and wet indoor installations: NEMA 250, Type 4.
(3) Hazardous environments: Explosion proof.
d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

4. Performance
a. Electrical rating: 15A at 120 - 480VAC.
b. Maximum overpressure: 0.5 psi
c. Temperature limits: -30°F - 180°F.
d. Operating range: Approximately 2 times set point.
e. Repeatability: Within 3%.

5. Provide complete installation kit including: static pressure tips, tubing, fittings and air filters.

6. Basis of Design: Dwyer Model 1831

B. Air pressure differential switch with automatic reset

1. Acceptable manufacturers
a. Automation Components
b. Cleveland Controls
c. Dwyer
d. Penn
e. Siemens

2. Field adjustable differential pressure switches with automatic reset used to monitor air filter status.

3. Construction
a. Diaphragm operated to actuate a SPDT snap switch with automatic reset.
b. User Interface: Screw-type set-point adjustment with enclosed set-point indicator and scale.
c. Enclosure
(1) Dry indoor installations: NEMA 250, Type 1.
(2) Outdoor and wet indoor installations: NEMA 250, Type 4.
(3) Hazardous environments: Explosion proof.
d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

4. Performance
a. Electrical rating: 15A at 120 - 480VAC.
b. Maximum overpressure: 0.5 psi
c. Temperature limits: -30°F - 110°F.

d. Operating range: Approximately 2 times set point.

e. Repeatability: Within 1%.

5. Provide complete installation kit including: static pressure tips, tubing, fittings and air filters.

6. Basis of Design: Dwyer Model EDPS

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

B. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

C. Examine roughing-in for instruments installed in piping to verify actual locations and connections before installation.

D. Examine roughing-in for instruments installed in duct systems to verify actual locations and connections before installation.

E. Prepare a written report listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Install products in accordance with manufacturer's instructions.

C. Do not mount switches on rotating equipment.

D. Do not mount sensor/transmitters on equipment.

E. Install products in a location free from vibration, heat, moistures, or adverse effects which damage the products and hinder accurate operation.

F. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment.

G. Provide ceiling, floor, roof, wall openings, and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

H. Fastening hardware

1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.

2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.

3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

I. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for access, confirm unrestricted ladder placement is possible under occupied condition.

J. Corrosive environments

1. Use products that are suitable for environment to which they are subjected.
2. If possible, avoid or limit use of materials in corrosive environments.
3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
4. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

K. Mounting location

1. Rough-in: Outline instrument-mounting locations before setting instruments and routing, cable, wiring, tubing, and conduit to final location.
2. Install switches and sensor/transmitters for air and liquid pressure associated with individual air-handling units and associated connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
3. Install liquid pressure switches and sensor/transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on drawings.
4. Install air pressure switches and sensor/transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on drawings.
5. Mount switches and sensor/transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
6. Install instruments (except pressure gages) in liquid and liquid-sealed piped services below their process connection point. Slope tubing down to instrument with a slope of 2%.

L. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

M. Unless indicated on drawings, locate duct pressure sensor/transmitters approximately 75% of the distance of the longest hydraulic run. Location of sensors shall be submitted and approved before installation.

N. System process tubing connections for liquid pressure switches and sensor/transmitters shall be full size of device connection, but not less than 1/2 inch. Install stainless-steel bushing if required to mate device to system connection.

O. Install isolation valves in process tubing for liquid pressure switches and sensor/transmitters as close to system connection as practical.

P. Install dirt leg and drain valve at each liquid pressure switch and sensor/transmitter connection.

Q. Provide shielded static pressure probe at each end of building differential pressure sensors. Probe shall have multiple sensing ports, impulse suppression chamber and airflow shielding. Provide suitable probes for indoor and outdoor locations.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 20 0553 “Identification for Mechanical, Plumbing, and Fire Suppression Systems."

B. Install engraved phenolic nameplate identification at instrument.

3.4 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install raceways. Comply with requirements in Section 26 0533 "Raceways and Boxes for Electrical Systems."

C. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.5 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

B. Wash and shine glazing.

C. Polish glossy surfaces to a clean shine.

3.6 CHECK-OUT PROCEDURES

A. Inspection

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check instruments for proper location and accessibility.
3. Check flow instruments for proper installation for direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.
5. Check that instrument attachment is properly secured and sealed.

B. Validation

1. Verify that instrument wiring is complete, enclosed, and connected to correct power source.
2. Verify sensing element type and proper material.
3. Verify instrument tag against approved submittal.

3.7 CALIBRATION

A. General

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration shall meet instrument manufacturer's written instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements and to supplement requirements indicated.

B. Calibration of analog signals
   1. Check analog voltage signals using a precision voltage meter at zero, 50%, and 100%.
   2. Check analog current signals using a precision current meter at zero, 50%, and 100%.

C. Calibration of digital signals
   1. Check digital signals using a jumper wire.
   2. Check digital signals using an ohmmeter to test for contact.

D. Calibration of sensor/transmitters: Check sensor/transmitters at zero, 50%, and 100% of the design values.

E. Calibration of switches: Calibrate switches to make or break contact at set points indicated.

3.8 ADJUSTING

A. Occupancy adjustments: When requested with 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions.

3.9 TESTING

A. Manufacturer Installation Inspection Report - Provide report prepared by manufacturer's representative, stating that systems installed and services provided under this Section are in accordance with manufacturer's recommendations and are properly operating.

END OF SECTION

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SECTION 23 1113
FUEL GAS PIPING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Pipe and pipe fittings

B. Valves and gas cocks

C. Pressure regulators

D. Natural gas piping system

1.2 CODES AND STANDARDS (USE LATEST EDITIONS)

A. American National Standards Institute (ANSI)

1. ANSI A21.52: Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds for Gas
2. ANSI Z21.69: Connectors for Movable Gas Appliances
3. ANSI Z21.18: Gas appliance pressure regulators

B. American Society of Mechanical Engineers (ASME)

1. ASME B16.3: Malleable Iron Threaded Fittings Class 150 NS 300
2. ASME B16.23: Cast Copper Alloy Solder Joint Drainage Fittings DWV
3. ASME B16.29: Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings DWV
4. ASME Sec. 9: Welding and Brazing Qualifications
5. ASME: Boiler and Pressure Vessel Code

C. American Society for Testing and Materials (ASTM)

1. ASTM A234: Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
2. ASTM A377-79: Gray Iron and Ductile Iron Pressure Pipe
3. ASTM A53: Pipe, Steel, Black and Hot Dipped Zinc Coated, Welded and Seamless
4. ASTM B32: Solder Metal
5. ASTM B88: Seamless Copper Water Tube
6. ASTM D1785: Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120
7. ASTM D2241: Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR PR)
8. ASTM D2466: Poly (Vinyl Chloride) (PVC) Plastic Piping Fittings. Schedule 40.
9. ASTM D2513: Thermoplastic Gas Pressure Pipe, Tubing and Fittings
10. ASTM D2517: Reinforced Epoxy Resin Gas Pressure Pipe and Fittings
11. ASTM D2683: Socket Type Polyethylene Fillings for Outside Diameter Controlled Polyethylene Pipe
12. ASTM D2855: Making Solvent Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings

D. American Welding Society (AWS)

1. AWS A5.8: Brazing Filler Metal
2. AWS D1.1: Structural Welding Code

E. American Water Works Association (AWWA)

1. AWWA C105: Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids
2. AWWA C110: Ductile Iron and Gray Iron Fittings 3 in. through 48 in., for Water and Other Liquids
3. AWWA C111: Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings
4. AWWA C151: Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand Lined Molds, for Water or Other Liquids

F. American Gas Association Laboratories (AGA)

G. Environmental Protection Agency (EPA)

H. Underwriters Laboratories Inc. (UL)

1.3 QUALITY ASSURANCE

A. Pipe: Each length of pipe shall be legibly identified at mill by paint, stenciling or raised symbols identifying manufacturer and class type or schedule of pipe.

B. Fittings: To be identified by the manufacturer by permanently attached tags, imprints or other approved means, indicating the class of wall thickness and material.

C. Valves and gas cocks: All valves shall be listed and labeled for natural gas service by UL, CSA or a Nationally Recognized Testing Laboratory acceptable to the authority having jurisdiction and the local gas utility company. Manufacturer's name and pressure rating shall be marked on valve body.

D. Welding materials and procedures: Conform to ASME Code and applicable state labor regulations.

E. Welders certification: In accordance with ASME Sec 9.

1.4 SUBMITTALS

A. Preconstruction – Prior to construction provide the following in accordance with Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Product data: Submit product data for each type of the products listed in Part 2 including:
    a. Product description
    b. Model
    c. Dimensions
    d. Rough in requirements
    e. Service sizes
    f. Finishes
2. Welding certificates.

B. During construction – During construction provide and maintain the following in accordance with Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Site record drawings - Maintain a set of drawings on site during construction showing the exact routing and location of piping systems being installed. The drawing shall be updated neatly by hand on a daily basis and account for routing modifications made in the field. Contractor shall use these drawing as a basis for generating the project as-built drawings.

C. Contract closeout – At contract closeout provide the following in accordance with Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Operation and maintenance data including:
    a. Product data
    b. Installation instructions
    c. Assembly views
    d. Replacement parts list
    e. Maintenance and operation instructions
2. Warranties

1.5 DELIVERY, STORAGE AND HANDLING

A. Protect new pipe interiors from moisture, construction debris and dust, and other foreign materials with the use of plastic end caps/plugs on each end of pipe. Maintain end-caps/plugs in place until piping is installed. Open end of pipes should be capped/plugged throughout construction.

B. Store materials indoors, protected from the weather. Where exterior storage is necessary, elevate piping above grade and enclose with waterproof wrapping or cover.

C. Deliver and store valves in shipping containers with labeling in place.

D. Replace any piping or devices which are damaged during shipping or storage.

1.6 SPARE PARTS

Not Applicable

1.7 WARRANTY

A. One year warranty on products and complete installation commencing at the time of Substantial Completion

1.8 MAINTENANCE

Not Applicable

PART 2 - PRODUCTS

2.1 NATURAL GAS PIPING, ABOVE GRADE

A. Steel pipe: ASTM A53, Schedule 40 black. Fittings: ASME B16.3, malleable iron, or ASTM A234, forged steel welding type. Joints: Screwed for pipe 2” and under; AWS D1.1, welded, for pipe over 2”.

2.2 FLANGES, UNIONS AND COUPLINGS

A. Pipe size 2” and under: ASME B16.3 150 psig malleable iron unions for threaded ferrous piping; ASME B16.15 bronze unions for copper pipe, soldered joints.

B. Unions above 150 psig: 300 psig malleable iron, brass to iron seat ground joint air tested unions.

C. Flanges to match those on valves and equipment.

D. Flange bolts: ASTM A-193.

E. Dielectric connections

1. Flanged or union type: Gaskets to conform to manufacturer's recommendations for the intended service, rated at minimum temperature of 200°F (or higher as dictated by service) for continuous duty.

2. Union type: Galvanized or plated steel-threaded end; copper -- solder end; water impervious isolation barrier.

3. Fittings provided shall meet ANSI B16.8 and be capable of isolating stray electrical currents up to 600 volts minimum.

4. Acceptable manufacturers: B&K Industries, Inc., Eclipse, Inc., EPCO Sales Inc., Capital Manufacturing Company; Division of Harsco Corporation, Watts Regulator Company.

2.3 BALL VALVES

A. Acceptable manufacturers

1. Apollo

2. Crane

3. A.Y. McDonald

4. Nibco

5. Watts Regulator

B. Up to 2½": 250 psi LP gas rated, ANSI B16.33 – 2012, UL 842 Listed for natural gas service, manufactured in accordance with MSS-SP-110. Two-piece bronze body, chrome plated full port ball for sizes up to 1", conventional port ball for sizes 1¼" to 3", PTFE or TFE seats, lever handle and threaded ends. Model T-585-70-UL sizes up to 1" and model T-580-70-UL for sizes 1¼" to 3", manufactured by Nibco.

2.4 PRESSURE REGULATORS

A. Acceptable manufacturers

1. Maxitrol Company

2. Eaton Corporation; Controls Div.

3. Emerson Electric Co.

4. Norgas Controls

5. Or Equal

B. General Requirements:

1. Single stage and suitable for natural gas.

2. Steel jacket and corrosion-resistant components.

3. Elevation compensator.

4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2½" and larger.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18. Die-cast aluminum body and diaphragm case; interchangeable zinc-plated steel springs; zinc-plated steel diaphragm plate; nitrile rubber seat disc; ultraviolet-stabilized, mineral-filled nylon seal plug; minimum three-layer polyester and polyurethane factory-applied paint finish.

1. Maximum Inlet Pressure: 5 psig

D. Basis of Design: Maxitrol Series 325

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Field test all piping before start-up of equipment.

E. Provide non conducting dielectric connections wherever jointing dissimilar metals.

F. Route piping in orderly manner, plumb and parallel to building and maintain gradient.

G. Install piping to conserve building space and not interfere with use of space and other work.

H. Provide clearance for access to valves and fittings.

I. Where pipe support members are welded to structural building framing, scrape, brush clean and apply one coat of zinc rich primer to welding.

J. Prepare pipe, fittings, supports and accessories not prefinished, ready for finish painting. Refer to Division 20 Section 20 9100, “Painting for Mechanical, Plumbing, and Fire Protection.”

1. Paint all gas piping safety yellow.

K. Install valves or cocks with stems upright or horizontal, not inverted.

L. Install all gas piping in compliance with all local codes.

3.2 APPLICATION

A. Install unions downstream of valves and cocks.

B. Install minimum shutoff cock 6” long dirt leg and union at gas fired equipment or apparatus connection.

3.3 WELDING

A. All welding shall be performed by experienced welders in a neat and workmanlike manner. Welding done on piping, pressure vessels and structural steel under this section shall be performed only by persons who are currently qualified in accordance with ANSI Standard Code for Pressure Piping, Section I, Power Piping, Bulletin ANSI B31.1.0-1980; applicable portions of ASME Boiler and Pressure Vessel Code, Section I, Power Boilers,; and Section IX, Welding Qualifications. Submit for approval and record certified copies of Procedure Specification for Welding, Welding Procedure Qualification Tests and Welder Performance Qualification Tests. Welding specifications and qualification tests shall be recorded on Forms Q-1, as recommended in Appendix II of Section IX of the ASME Boiler and

Pressure Vessel Code. Records shall be certified by Contractor and shall be accessible to authorized inspector.

B. Bevel piping on both ends before welding as required and defined in Code.

C. Use following weld spacing on all butt-welds:

Nominal Pipe Wall Thickness	Space
¼" or less	⅛"
Over ¼" or less than ¾"	3/16"
¾" and over	3/16"

D. Use backing rings on welds in all piping 3" and larger.

E. Before start of any welding, remove all corrosion and other foreign material from surface to be welded.

F. Welding shall be performed by either manual shielded metallic arc process or automatic submerged arc process. Use direct current exclusively.

G. Electrodes to be used with manual shielded metallic arc method shall conform to ASTM A-233, Classification E-6010.

H. Size of electrodes, voltages, current, thickness and number of passes or beads shall be in accordance with provisions of previous paragraph.

I. After deposition, clean each layer of weld metal to remove all slab and scale by wire brushing or grinding, then chip where necessary to prepare for proper deposition of next layer.

J. Weld reinforcement shall be not less than 1/16" nor more than ⅛" above normal surface of joined sections. Reinforcement shall be crowned at center and shall taper on each side to surface being joined. Exposed surface of weld shall present workmanlike appearance and shall be free of depressions below surface of joined members.

K. No welding of any kind shall be done when temperature of base metal is lower than 0°F. Material to be welded during freezing temperatures shall be made warm and dry before welding is started. Temperature of metal shall be "warm to hand" – or approximately 60°F.

L. All welders engaged in work performed under this Section shall have been qualified in accordance with test requirements of Section IX of the ASME Boiler and Pressure Vessel Code. Each operator shall identify his production welds by marking his regularly assigned identification number or mark within 1" of weld. Contractor shall submit to Engineer complete list of individual numbers of identifying marks and operator's name. Copy of each operator's certificate shall be filed with Engineer.

M. Welds will be inspected visually by representatives of Engineer and Contractor. Any weld judged defective by Engineer from visual inspection shall be cut out and tested in presence of or his representative. In event any welder consistently produces high percentage of unsatisfactory production welds, he shall be discharged at request of Owner even though he is able to produce satisfactory welds when test expected in advance. Removal and replacement of test coupons and samplings shall be done at expense of Contractor.

3.4 TESTING

A. Pipe Testing

1. Furnish all labor, material, instruments, supplies and services and bear all costs for the accomplishment of tests herein specified. Correct all defects appearing under test and repeat the tests until no defects are disclosed; leave the equipment clean and ready for use.
2. Field test all piping before start-up of systems. Tests of piping systems shall be conducted before connections to equipment are made and before piping is covered, buried or otherwise concealed.
3. Perform all tests other than herein specified which may be required by legal authorities or by agencies to whose requirements this work is to conform.
4. Furnish all necessary testing apparatus, make all temporary connections and perform all testing operations required, at no additional cost to Owner.
5. Systems found to have leaks shall be subjected to further tests when faulty joints have been repaired or replaced.
6. Welded joints shall be subjected to a hammer test while under pressure. For additional test requirements see welding specification.
7. Contractor shall be responsible for any corrective action required due to a failed pipe pressure test.

END OF SECTION

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SECTION 23 2113
HYDRONIC PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Hydronic pipe and fitting materials, joining methods, valves, and specialties in this section include:

1. Cooling coil condensate drain piping

1.2 DEFINITIONS

A. CWP: Cold working pressure

B. EPDM: Ethylene propylene copolymer rubber

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

D. NRS: Non-rising stem

E. OS&Y: Outside screw and yoke

F. PTFE: Polytetrafluoroethylene

G. RS: Rising stem

H. SWP: Steam working pressure

1.3 CODES AND STANDARDS (USE LATEST EDITIONS)

A. American Society of Mechanical Engineers (ASME)

1. ASME B1.20.1: Pipe Threads, General Purpose, Inch

B. American Society for Testing Materials (ASTM)

1. ASTM D 1785: Specification for PolyVinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120
2. ASTM D 2466: Specification for PolyVinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40
3. ASTM D 2564: Specification for Solvent Cements for PolyVinyl Chloride (PVC) Plastic Piping Systems
4. ASTM D 2672: Specification for Joints for IPS PVC Pipe Using Solvent Cement
5. ASTM D 2855: Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
6. ASTM F 402: Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermostatic Pipe and Fittings
7. ASTM F 656: Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings

C. Manufacturers Standardization Society (MSS)

1. MSS SP-45: Bypass and Drain Connections
2. MSS SP-107: Transition Union Fittings for Joining Metal and Plastic Products

1.4 QUALITY ASSURANCE

A. Pipe: Each length of pipe shall be legibly identified at mill by paint, stenciling, or raised symbols identifying manufacturer and class type or schedule of pipe. Copper pipe shall be identified at 3 foot intervals.

B. Fittings: To be identified by the manufacturer by permanently attached tags, imprints, or other approved means, indicating the class of wall thickness and material.

C. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

1.5 SUBMITTALS

A. Preconstruction – Prior to construction provide the following in accordance with Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Product data: Submit product data for each type of the products listed in Part 2 including:
    a. Product description
    b. Model
    c. Dimensions
    d. Rough in requirements
    e. Service sizes
    f. Finishes

1.6 DELIVERY, STORAGE AND HANDLING

A. Protect new pipe interiors from moisture, construction debris and dust, and other foreign materials with the use of plastic end caps/plugs on each end of pipe. Maintain end-caps/plugs in place until piping is installed. Open end of pipes should be capped/plugged throughout construction.

B. Store materials indoors, protected from the weather. Where exterior storage is necessary, elevate piping above grade and enclose with waterproof wrapping or cover.

C. Deliver and store valves in shipping containers with labeling in place.

D. Replace any piping or devices which are damaged during shipping or storage.

1.7 SPARE PARTS

Not Applicable

1.8 WARRANTY

A. One year warranty on products and complete installation commencing at the time of Substantial Completion

1.9 MAINTENANCE

Not Applicable

PART 2 - PRODUCTS

1.10 COOLING COIL CONDENSATE DRAIN PIPING

A. PVC pipe: ASTM D1785, Schedule 40, plain ends

1. Fittings: Socket fittings, ASTM D2466 for Schedule 40 pipe
2. Joints: ASTM D2855, solvent weld, with cement conforming to ASTM D2564

1.11 FLANGES, UNIONS AND COUPLINGS

A. Steel pipe

1. Unions 2" and smaller: ANSI/ASME B16.39 malleable iron unions for threaded pipe, ground joint, screwed bronze or brass to iron. Pressure class and joint type of union shall be equal to that specified for fittings of respective piping service.

EXECUTION

2.1 INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated piping 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 on coordination drawings.

B. Protect new pipe interiors from moisture, construction debris and dust, and other foreign materials with the use of plastic end caps/plugs on each end of pipe. Maintain end-caps/plugs in place until piping is installed. Open end of pipes should be capped/plugged throughout construction.

C. Install piping at indicated slopes. Install condensate piping at a uniform grade of 1% downward in direction of flow when no other slope is indicated on the drawings. Piping shall be installed to permit system drainage.

D. Install piping free of sags and bends.

E. Install fittings for changes in direction and branch connections.

F. Pipe joint construction

1. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. 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:
    a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    b. 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.
4. Plastic piping solvent-cemented joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    b. PVC non-pressure piping: Join according to ASTM D 2855.
    c. Paint exterior piping with UV protecting paint compatible with material.

G. Coordination of mechanical work installation and access requirements:

1. Mechanical Work installed before coordinating with other work so as to cause interference with other work to be changed to correct such condition without additional cost to Owner.

2.2 APPLICATIONS

A. Piping to equipment shall be installed full size as indicated on the plans. If equipment connections differ from piping shown on the drawings, provide reducers/increasers at all valves, devices, and equipment as required.

END OF SECTION

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SECTION 23 3113
METAL AND FLEXIBLE DUCT

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Duct and duct-associated materials and procedures in this section include:

1. Sheet metal materials
2. Single-wall rectangular ducts and fittings
3. Duct liners (transfer duct only)
4. Sealants and gaskets

1.2 DEFINITIONS

A. Duct size: Duct sizes indicated herein or on associated drawings shall be the inside clear dimensions of actual air path for both unlined and lined ducts.

B. Pressure class: A "SMACNA - HVAC Duct Construction Standards, Metal and Flexible" pressure classification system designating static pressure values (in inches w.g.) equal to the maximum operating pressure to which the ductwork can safely be subjected.

1.3 CODES AND STANDARDS (USE LATEST EDITIONS)

A. American Society for Testing Materials (ASTM)

1. ASTM A 36/A 36M: Specification for Carbon Structural Steel
2. ASTM A 366/A 366M: Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality
3. ASTM A 480/A 480M: Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
4. ASTM A 653/A 653M: Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
5. ASTM B 209: Specification for Aluminum and Aluminum-Alloy Sheet and Plate
6. ASTM C 203: Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation
7. ASTM C209: Standard Test Methods for Cellulosic Fiber Insulating Board
8. ASTM C 411: Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation
9. ASTM C 534: Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
10. ASTM C 916: Specification for Adhesives for Duct Thermal Insulation
11. ASTM C 920: Specification for Elastomeric Joint Sealants
12. ASTM C 1071: Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material)
13. ASTM D 256: Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

14. ASTM D 638: Standard Test Method for Tensile Properties of Plastics
15. ASTM D 790: Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
16. ASTM D 1621: Standard Test Method for Compressive Properties of Rigid Cellular Plastics
17. ASTM E 84: Test Method for Surface Burning Characteristics of Building Materials

B. National Fire Protection Association (NFPA)

1. NFPA 90A: Installation of Air Conditioning and Ventilating Systems
2. NFPA 90B: Installation of Warm Air Heating and Air Conditioning Systems
3. NFPA 96: Ventilation Control and Fire Protection of Commercial Cooking Operations
4. NFPA 255: Standard Method of Test of Surface Burning Characteristics of Building Materials

C. North American Insulation Manufacturers Association (NAIMA)

1. NAIMA AH124: Fibrous Glass Duct Liner Standard

D. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1. SMACNA: Duct Cleanliness for New Construction
2. SMACNA: HVAC Air Duct Leakage Test Manual
3. SMACNA: HVAC Duct Construction Standards - Metal and Flexible (excluding all amendments and proposed revisions)
4. SMACNA: IAQ Guidelines for Occupied Buildings Under Construction

E. Underwriters Laboratory

1. UL® 94: Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
2. UL® 181: Factory-Made Air Ducts and Air Connectors
3. UL® 723: Test for Surface Burning Characteristics of Building Materials

1.4 QUALITY ASSURANCE

A. Construct ductwork to NFPA 90A standards.

B. Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall, at a minimum, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," excluding all amendments and proposed revisions, and performance requirements and design criteria indicated.

1. All further references to conformance with the requirements of SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" shall always mean with the exclusion of all amendments and proposed revisions.
2. Where the requirements of this specification exceed the requirements of the SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," the specifications shall govern.

C. Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1.5 SUBMITTALS

A. Preconstruction – Prior to construction provide the following in accordance with Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Product data: Submit for each type of the following products:
    a. Sealants and gaskets: submit manufacturer's data sheets including performance data, pressure ratings, surface burning characteristic and installation instruction.
2. Shop drawings: For all new duct systems submit layout drawings at ¼" = 1'-0" scale in both hard-copy and AutoCAD compatible format. Shop drawings shall include, but not be limited to:
    a. Metal and flexible ductwork and fittings including both factory- and shop-fabricated
    b. Fittings
    c. Seam and joint construction
    d. Penetrations through fire-rated and other partitions
    e. Equipment installation based on equipment being used on Project
    f. Hangers and supports, including methods for duct and building attachment, and vibration isolation
    g. Provide detail or schedule of:
        (1) Sheet metal thicknesses
        (2) Joint and seam construction and sealing
        (3) Reinforcement details and spacing
        (4) Materials, fabrication, assembly, and spacing of hangers and supports
3. Warranties

1.6 DELIVERY, STORAGE AND HANDLING

A. Protect new duct interiors from moisture, construction debris and dust, and other foreign materials. If inside of new duct becomes dirty, Contractor shall clean duct per Duct Cleaning specifications.

B. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Intermediate Level.

1.7 WARRANTY

A. One-year warranty on products and complete installation commencing at the time of Substantial Completion.

PART 2 - PRODUCTS

2.1 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.

1. Galvanized sheet steel: Comply with ASTM A 653. Lock forming quality with G-90 galvanized coating designation (not less than 1.25 oz. of zinc on each side of each square foot of sheet).

2. Minimum ducts gauges shall be in accordance with the following tables. This table shall be used in conjunction with SMACNA table for application of appropriate reinforcement in accordance with proper pressure class.

MINIMUM GALVANIZED AND STAINLESS STEEL RECTANGULAR DUCT GAUGE WITHOUT REINFORCEMENT					
DUCT DIMENSION (IN.)	**1" W.G.**	**2" W.G.**	**3" W.G.**	**4" W.G.**	**6" W.G.**
8 and under	26	26	24	24	24
9 – 10	26	26	24	22	24
11 – 12	26	26	24	22	20
13 – 14	26	24	22	20	20
15 – 16	26	24	22	20	18
17 – 18	24	22	20	18	18
19 – 20	24	20	18	18	16
21 – 22	22	18	18	18	16
23 – 24	22	18	18	18	16
25 – 26	20	18	18	16	
27 – 28	18	18	18	16	
29 – 30	18	18	18	16	
31 – 36	18	16	16		
37 – 42	16				
43 – 48	16				
49 – 54	REINFORCEMENT REQUIRED REFER TO SMACNA HVAC DUCT CONSTRUCTION STANDARDS - METAL AND FLEXIBLE				
55 – 60					
61 – 72					
73 – 84					
85 – 96					
97 – 108					
109 – 120					

2.2 SINGLE WALL RECTANGULAR DUCTS AND FITTINGS (SHOP AND FACTORY FABRICATED)

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

1. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Inc.
4. Sheet Metal Connectors, Inc.
5. Shop fabricated duct is acceptable for ducts with a pressures class rating of 6" w.g. or less provided compliance with the requirements herein are met.

B. General fabrication requirements

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
2. Comply with SMACNA's "Industrial Duct Construction Standards" where indicated.

C. Transverse joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" except as otherwise noted.

1. No duct shall be constructed to less than 2" w.g.

D. Longitudinal seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," except as otherwise noted:

1. Button punch snap lock is not acceptable.

E. Elbows, transitions, offsets, branch connections, and other duct construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," except as otherwise noted.

2.3 DUCT LINER - FIBERGLASS

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

1. CertainTeed Corporation; Insulation Group.
2. Johns Manville.
3. Knauf Insulation.
4. Owens Corning.

B. Fibrous-glass duct liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

C. Surface-burning characteristics: For insulation and related materials, as determined by UL testing identical products according to ASTM E84. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency. Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

D. Maximum thermal conductivity

1. Type I, Flexible: 0.27 Btu x in./h x ft^2 x °F 75°F mean temperature.

E. 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.

F. Water-based liner adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

G. Insulation pins and washers

1. Cupped-head, capacitor-discharge-weld pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135" diameter shank, length to suit depth of insulation indicated with integral 1½" galvanized carbon-steel washer.

2. Insulation-retaining washers: Self-locking washers formed from 0.016" thick galvanized steel, aluminum, or stainless steel to match duct material; with beveled edge sized as required to hold insulation securely in place but not less than 1½" in diameter.

2.4 SEALANT AND GASKETS

A. Acceptable manufacturers for duct sealant

1. Hardcast
2. United McGill
3. Ductmate

B. 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.

C. Duct sealant

1. Water-based non hardening, water resistant, mold and mildew resistant sealant classified compounded specifically for sealing joints and seams in ductwork.
   a. Maximum Static-Pressure Class: 10" w.g., positive and negative.
   b. Service: Indoor or outdoor.
   c. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets for specific applications.
2. Duct tapes are not allowed.

D. Flanged joint sealant: Comply with ASTM C 920. General: Single-component, acid-curing, silicone, electrometric. Type S, Grade NS, Class 25, Use O.

E. Flange gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

1. Gaskets used in chemical, laboratory, or process exhaust duct systems shall be suitable for exposure to substances in the air stream. Contractor shall verify the compatibility with Engineer prior to installation.

PART 3 - EXECUTION

3.1 APPLICATION

A. Install duct with duct material for pressure class as per the following table:

DUCT SYSTEM AND LOCATION	MATERIAL	PRESSURE CLASS
VAV supply system: duct from AHU discharge to inlet of air terminal units	Galvanized steel (G90)	+4"
Return system with no air terminal units: all duct	Galvanized steel (G90)	-2"
Air relief and transfer	Galvanized steel (G90)	+2"

3.2 INSTALLATION

A. General

1. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Where interferences develop in field, offset or reroute ductwork as required for clearing such interference.

2. Contractor shall modify specified duct sizes as required to fit. Modified duct size shall have cross-sectional area and pressure drop equivalent to that of the specified duct size.
3. All ducts shall be airtight and free from pulsation and vibration at normal operating conditions.
4. Contractor shall submit sheet metal shop drawings to the Test and Balance Contractor for review, and provide any additional volume dampers that the Test and Balancing Contractor needs to perform final balancing.
5. Install ducts with fewest possible joints.
6. Install ducts with a minimum clearance of 1", plus allowance for insulation thickness.
7. Where ducts of different metals meet, joint shall use a gasket, seal or compound to prevent the two different metals from coming in contact.
8. Galvanized surfaces altered or damaged (including the damage due to welding) shall be painted with a galvanized paint.
9. Gaskets shall not protrude into airstream.
10. Offsets and transitions: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-7, "Offsets and Transitions."
    a. Transitions
        (1) Increase duct sizes gradually, not exceeding 15° on each side for a concentric transition or 30° on one each side for an eccentric transition.
        (2) Decrease duct sized not exceeding 22.5° on each side for a concentric transition or 45° on one side for an eccentric transition.
    b. Offsets
        (1) Provide smooth radius offset with the radius equal to the duct dimension.
        (2) Mitered offset Type 2 is acceptable provided the offset angle no greater than 15°.
11. Easements for obstructions
    a. Provide easements where ductwork conflicts with piping and structure.
    b. Where easements exceed 10% duct area, split into two ducts maintaining original duct area.
12. Seam and joint sealing
    a. For **all new ducts**, all transverse joints, longitudinal seams and connections shall be sealed in conformance with SMACNA Class A sealing requirements as defined in the 2005 SMACNA HVAC Duct Construction Standards - Metal and Flexible, Second Edition.

B. Fiberglass duct liner – shop application: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90% adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

5. 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.
6. Secure liner with mechanical fasteners 4" from corners and at intervals not exceeding 12" transversely; at 3" from transverse joints and at intervals not exceeding 18" longitudinally.
7. Secure transversely oriented liner edges facing the air stream 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.
    c. Upstream edges of transverse joints in ducts.
8. Terminate inner ducts with build-outs attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated build-outs (metal hat sections) or other build-out means are optional; when used; secure build-outs to duct walls with bolts, screws, rivets, or welds.
9. Intermediate reinforcement
    a. Galvanized Steel Ducts: Galvanized steel.
10. Schedule
    a. Transfer ducts: Type I, 1" thick.

END OF SECTION

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SECTION 23 3713
AIR INLETS AND OUTLETS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Products covered in this section include:

1. General use diffusers, registers and grilles
    a. Return and exhaust grille or register

1.2 DEFINITIONS

A. Grilles: Louvered or perforated coverings for openings in air passages, which can be located in sidewalls, ceilings, or floors.

B. Registers: Combination grille and damper assemblies over air openings.

1.3 CODES AND STANDARDS (USE LATEST EDITIONS)

A. American Architectural Manufacturers Association (AAMA)

1. AAMA 605.2: High Performance Organic Coatings on Architectural Extrusions and Panels

B. Air Movement & Control Association International, Inc. (AMCA)

1. AMCA 511: Certified Ratings Program for Air Control Devices

C. American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE)

1. ASHRAE 70: Method of Testing for Rating the Performance of Air Outlets and Inlets

D. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1. SMACNA: HVAC Duct Construction Standards-Metal and Flexible

E. Underwriters Laboratory (UL®)

1. UL 94: Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.4 QUALITY ASSURANCE

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."

B. Louver ratings shall be based on tests and procedures performed in accordance with AMCA 511. Louvers shall be provided with an AMCA Certified Rating Seal for air performance and water penetration.

1.5 SUBMITTALS

A. Preconstruction – Prior to construction provide the following in accordance with Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Diffusers, registers, and grilles
    a. Product data: For each type of product provide the following product data:
        (1) Materials of construction

(2) Finish

(3) Mounting details

(4) Performance data including throw and drop, static-pressure drop, and noise ratings.

b. Schedule: Provide a diffuser, register, and grille schedule indicating drawing designation, room location, quantity, model number, size, material and color, accessories furnished.

B. Contract closeout – At contract closeout provide the following in accordance with Specification 20 0500 – Basic Requirements for Mechanical, Plumbing, and Fire Suppression:

1. Operating and maintenance data including:
   a. Product data
   b. Installation instructions
   c. Assembly drawings
   d. Replacement parts list
   e. Maintenance and operation instructions
2. Warranties

PART 2 - PRODUCTS

2.1 GENERAL USE DIFFUSERS, REGISTERS AND GRILLES

A. Acceptable manufacturers

1. Nailor Industries, Inc.
2. Price Industries
3. Titus

B. General

1. Diffuser color shall be standard white unless indicated otherwise.
2. Unless otherwise noted diffusers, registers and grilles shall be fabricated of heavy gauge steel except in locations defined below:
   a. Devices used in areas subject to moisture (locker and shower rooms) shall be heavy gauge extruded aluminum.
   b. Devices located in stainless steel duct shall be stainless steel.
3. Contractor to provide type of frame compatible with the ceiling type including but not limited to T-bar, spline, or plaster ceiling.
4. Refer to drawing schedule for opposed blade damper requirements in supply diffusers. If damper is required by the drawing schedule, provide radial opposed blade damper operable from diffuser face.

C. Square perforated face, star pattern diffuser

1. Flush perforated face shall have $^{3}/_{16}$" diameter holes on ¼" staggered centers.
2. The diffuser shall have an 22" x 22" neck.
3. Basis of Design: Titus PAR for return

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install items level and plumb.

B. Clean/repair damaged surfaces in accordance with manufacturer's instructions.

C. Additional requirements for all diffusers, registers and grilles including critical environment diffuser:

1. Check location of ceiling mounted diffusers, registers and grilles and make necessary adjustments in position to conform to architectural reflected ceiling plans. Where architectural features or other items conflict with installation, notify Architect/Engineer for a determination of final location.

END OF SECTION

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SECTION 23 7414
INSTALLATION OF PRE-PURCHASED PACKAGED ROOFTOP AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pre-purchased Packaged 60-ton rooftop unit

B. Pre-purchased transition curb

C. Maintenance service

1.2 REFERENCES

A. Air Conditioning, Heating, and Refrigeration Institute (AHRI)

1. AHRI 210: Unitary Air Conditioning Equipment
2. AHRI 240: Air Source Unitary Heat Pump Equipment
3. AHRI 270: Sound Rating of Outdoor Unitary Equipment

B. National Fire Protection Association (NFPA)

1. NFPA 90A: Installation of Air Conditioning and Ventilation Systems

1.3 ASSIGNMENT

A. Equipment pre-purchased by Owner will be assigned to the successful contractor so that, once selected, that contractor becomes (1) responsible for coordination of the installation and (2) the single construction and warranty period contact for the project thereafter. Bidder agrees to accept, honor and acknowledge Owner's assignment of its obligations under the prepurchase agreement.

B. Pre-purchased packaged rooftop unit and transition curb specification, bid and submittal is included in specification exhibits.

1.4 SUBMITTALS

A. Shop drawings and product data for manufactured products and assemblies required for this project are in Specification Exhibits.

1.5 OPERATION AND MAINTENANCE DATA

A. Manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data and parts listing for this project are in Specification Exhibits.

1.6 DELIVERY, STORAGE AND HANDLING

A. Store and protect products under provisions of General Conditions and Division 01.

B. Protect units from physical damage by storing off site until roof mounting frames are in place, ready for immediate installation of units.

1.7 WARRANTY

A. Pre-purchase equipment provided with manufacturer's warranty. Warranty includes the following:

1. Five-year entire unit, parts only.

2. Five-year compressor unit, parts only.

3. Ten-year extended heat exchanger parts only warranty.

4. Two-year entire unit labor warranty.

1.8 MAINTENANCE SERVICE (PRE-PURCHASED)

A. Manufacturer shall provide complete service and maintenance of packaged rooftop units for one year from Date of Substantial Completion with two-trips during the first year under pre-purchase agreement.

1.9 EXTRA MATERIALS (PRE-PURCHASED)

A. Manufacturer shall provide two set of filters under pre-purchase agreement.

PART 2 - PRODUCTS

2.1 PRE-PURCHASED UNIT

A. Daikin DPSA060 with Thybar transition curb

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing roof curb and transition curb dimensions conform to the new unit as illustrated by the manufacturer.

B. Verify that proper power supply is available.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Mount units on factory-built roof mounting frame providing watertight enclosure to protect ductwork and utility services. Install roof mounting frame level.

C. The equipment schedule on the drawings states the minimum and maximum gas pressure range that is the basis of design. The rooftop unit shall operate properly throughout the specified range. If the rooftop unit manufacturer requires a gas pressure lower than the upper value of the specified pressure range, the contractor shall furnish and install a gas regulator and accessories as per the manufacturer's installation instructions and requirements.

3.3 MANUFACTURER'S FIELD SERVICES (PRE-PURCHASED)

A. Installing contractor shall provide labor as required for pre-purchased startup services demonstration as described below.

B. Manufacturer's representative shall provide startup services by factory-trained manufacturer's representative in accordance with the Conditions of the Contract. Services shall include but not be limited to:

1. Inspection of rooftop unit installation to confirm it meets manufacturer's requirements including overall condition of the unit, shipping brace removal, operational and maintenance clearances, electrical connections, fan vibration isolator adjustment, controls integration, and field installed accessories.

2. Provide startup of rooftop units per the manufacturer's operation manual.

C. Manufacturer's representative shall provide in conjunction with the Controls Contractor, a minimum of four (4) hours of commissioning of the rooftop unit integration to the building automation system (BAS).

1. Verify that control wiring is per the manufacturer's requirements.
2. Verify that the rooftop unit is communicating with the BAS.
3. Verify that all required points have been successfully mapped to the BAS and are calibrated correctly.
4. Troubleshoot any communication issues.

3.4 DEMONSTRATION (PRE-PURCHASED)

A. Installing contractor shall provide labor as required for pre-purchased demonstration as described below.

B. Manufacturer's representative shall provide a minimum of four (4) hours of systems demonstration and training by a factory-trained manufacturer's representative in accordance with the Conditions of the Contract. Coordinate with the Owner so that all shifts are included in the training.

3.5 FIELD INSPECTION AND REPORT (PRE-PURCHASED)

A. Manufacturer's representative shall provide a report, prepared by the manufacturer's representative, stating that systems installed and services provided under this Section are in accordance with the manufacturer's recommendations and are properly operating.

END OF SECTION

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