DANE COUNTY DEPARTMENT of PUBLIC WORKS, HIGHWAY and TRANSPORTATION

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April 14, 2014

ATTENTION ALL REQUEST FOR BID (RFB) HOLDERS

RFB NO. 314000- ADDENDUM NO. 1

TENANT IMPROVEMENTS FIRST FLOOR

CITY-COUNTY BUILDING

BIDS DUE: THURSDAY, MAY 8, 2014, 2:00 PM. DUE DATE AND TIME ARE NOT CHANGED BY THIS ADDENDUM.

This Addendum is issued to modify, explain or clarify the original Request for Bid (RFB) and is hereby made a part of the RFB. **Acknowledge this addendum on the Bid Form.**

CHANGES TO BIDDING REQUIREMENTS:

1. Documents Index
    a. Add: CV-27-00-00 Communications Cabling, CV-27-00-00-5
    b. Add: CV-28-31-00 Fire Alarm Wiring and Devices, CV-28-31-00-6
    c. Add: 06 20 00 Finish Carpentry

CHANGES TO SPECIFICATIONS:

2. Add the following enclosed specification sections: Division 23 – Heating, Ventilating and Air Conditioning.

CHANGES TO DRAWINGS:

3. None

Enclosures:
Division 23 Specifications as indicated in the Documents Index

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SECTION 23 01 30
HVAC AIR DUCT CLEANING

P A R T 1 - G E N E R A L

SCOPE
This section includes specifications for cleaning duct and HVAC systems on this project. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Shop Drawings
- Design Criteria

PART 2 - PRODUCTS
- General
- Cleaners, Biocides and Encapsulants
- Equipment
- Access Doors

PART 3 - EXECUTION
- General
- Cleaning
- Encapsulants
- Cleaning Report
- Access Doors

RELATED WORK
Section 01 91 13 – Commissioning Requirements
Section 23 33 00 - Air Duct Accessories
Section 23 31 00 - HVAC Ducts and Casings
Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC

REFERENCE
Applicable provisions of Division 1 govern work under this Section.

REFERENCE STANDARDS

NADCA 1992-01	Mechanical Cleaning of Non-Porous Air Conveyance System Components National Air Duct Cleaners Association
NADCA	Understanding Microbial contamination in HVAC Systems
NAIMA	Cleaning Fibrous Glass Insulated Air Duct Systems

QUALITY ASSURANCE
Refer to Division 1, Instructions to Bidders – Qualifications of Bidder and General Conditions - Equals and Substitutions.

A Regular Member in good standing of NADCA (National Air Duct Cleaners Association). Maintain membership for the entire duration of the project. Maintain a staff of at least one Certified Air System Cleaning Specialist (ASCS). If membership of the firm, or any certification of any staff performing work is terminated or expires during the duration of the project, contact DFD immediately.

SHOP DRAWINGS
Refer to Division 1, General Conditions, Submittals.

Include manufacturer's data and/or Contractor data for the following:
- List of equipment to be used.
- Product description and MSDS sheets for cleaners, biocides and encapsulants.
- Access doors.

P A R T 2 - P R O D U C T S

GENERAL
Use products which conform to NFPA 90A, possessing a flame spread rating of not over 25 and a smoke developed rating no higher than 50.

CLEANERS, BIOCIDES AND ENCAPSULANTS
Manufacturer: H.B. Fuller/Foster, Porter, or approved equal.

Cleaners, biocides and encapsulants shall be waterbase products specifically designed for application to HVAC duct interiors and capable of being applied with airless spray equipment. Biocides and encapsulants must be colored differently than substrate to be coated.

Biocidal agents to be formulated for long term fungicidal activity with no loss on aging. Biocidal agents must be registered with the U.S. Environmental Protection Agency for use on the interior of HVAC duct systems.

Cured biocides and encapsulants must provide tough washable elastic protective finish able to withstand light impact or abrasion without breaking down over time or releasing fibers.

EQUIPMENT
Particulate Collection Equipment: Fan/filter unit sized to create sufficient quantity of negative pressure for capture and filtration of air and contaminants dislodged during duct cleaning. Equipment to include prefiltration and HEPA final filtration with 99.97% collection efficiency for 0.3 micron size particles.

Portable pressure washers to be capable of 500 psig to 1000 psig operation.

Power brush systems designed specifically for duct cleaning.

P A R T 3 - E X E C U T I O N

GENERAL
Use products and equipment in accordance with manufacturers instructions.

CLEANING
Clean ductwork systems and associated turning vanes, dampers, coils, VAV boxes, drain pans, plenums, diffusers, registers, grilles and louvers; air handling units and associated fans, coils, drain pans, plenums and dampers; fans; terminal units and other equipment described below:

System/Component	Location	Action
Supply Duct Systems	As Noted on Drawings	Clean

Visually inspect systems and site prior to cleaning. Document and report damaged system components to Owner's Construction Representative prior to cleaning. Mark damper and other component positions prior to cleaning and reset after cleaning to original position. Establish a specific, coordinated plan detailing how each area of the building will be protected during the various phases of work.

Protect building occupants, components and furnishings from cleaning activities. Use polyethylene sheeting covers and barriers where cleaning will disperse debris outside the HVAC systems. Install critical barriers within the building, at inlets/outlets and within the system to prevent migration of dust and debris to clean areas.

Use particulate collection equipment to remove and capture debris. Connect to system downstream of cleaning operations. Wherever possible, duct exhaust to the exterior of the building. Avoid discharge near air intakes and points of entry. Arrange source of makeup air to flow from clean area to work area negatively pressurizing work area. Take measures to control offensive odors and vapors during the cleaning process.

Clean systems using mechanical cleaning methods, such as vacuum cleaning, compressed air sweeping and mechanical brushing, designed to extract contaminants from within the HVAC system and safely remove

contaminants from the facility. No cleaning methods are to be used which damage components of the system or negatively alter the integrity of the system.
Clean fibrous glass thermal or acoustical insulation with HEPA vacuuming equipment. Document locations of damage, deterioration, delamination, mold, fungus growth or excessive moisture which cannot be restored by cleaning or resurfacing with repair coating. Report locations and conditions to Architect/Engineer and Owner's Project Representative for determination of removal and/or replacement.

Where fibrous glass thermal or acoustical insulation is to be removed, scrape and brush metal clean. Remove loose fasteners, weld pins where required for cleaning work and sheet metal covers associated with insulation. Patch and seal fastener openings.

Verification of HVAC system cleanliness will be performed after cleaning and prior to application of biocides and encapsulants. The Contractor shall notify the Owner and Architect/Engineer in advance of verification. Verification will consist of inspection by the Contractor, Owner's Construction Representative and/or Architect/Engineer. If surfaces are visibly clean, no contaminants are evident through visual inspection the HVAC system shall be considered clean. However the Owner reserves the right to further verify system cleanliness through third party gravimetric or wipe testing analysis per NADCA standards.

ENCAPSULANTS
Biocides and encapsulants are to be applied only after cleaning and verification have been completed and surfaces are dry. System fans are to remain off and critical barriers maintained to prevent migration of biocides and encapsulants from the HVAC systems.

Apply encapsulants to the following surfaces where microbial contamination is not suspected:

- Damaged fibrous glass thermal or acoustical insulation.
- Sheet metal where thermal or acoustical insulation internal to the duct has been removed.

Encapsulants to be directly sprayed (not fogged), brushed or rolled onto surfaces to achieve a continuous film of thickness recommended by manufacturer. Increase application rate on porous or rough surfaces. Protect coils, fan blades, bearings, damper linkages and seals, fire/smoke dampers, humidifiers, airflow sensors, pressure sensors, temperature sensors and humidity sensors during application of biocides and encapsulants. Clean any overspray from these components immediately. Allow products to fully cure prior to using HVAC systems. Operate systems during unoccupied hours flushing with fresh air to purge system prior to occupied use.

CLEANING REPORT
Provide a report describing pre-cleaning inspection and damage, systems cleaned, methods and materials used, problems encountered, final verification and any remaining problems noted. Submit three copies to Owner's Construction Representative.

ACCESS DOORS
Install access doors where indicated on the drawings and in locations where access is required for cleaning or inspection. See specification Section 23 33 00 for access door requirements.

Size and numbers of duct access doors to be sufficient to perform the intended service. Minimum access door size shall be 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, or other size as indicated. Install access doors on both inlet and outlet sides of reheat coils as well as other duct mounted coils if not existing.

END OF SECTION

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SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC

P A R T 1 - G E N E R A L

SCOPE

This section includes information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Continuity of Existing Services
- Protection of Finished Surfaces
- Sleeves and Openings
- Sealing and Firestopping
- Equipment Furnished By Others
- Provisions for Future
- Submittals
- Off Site Storage
- Certificates and Inspections
- Operating and Maintenance Data
- Record Drawings
- Commissioning

PART 2 - PRODUCTS
- Access Panels and Doors
- Identification
- Sealing and Firestopping

PART 3 - EXECUTION
- Demolition
- Concrete Work
- Cutting and Patching
- Building Access
- Equipment Access
- Coordination
- Identification
- Lubrication
- Sleeves
- Sealing and Firestopping

RELATED WORK

Section 01 91 13 – Commissioning Requirements
Section 23 05 13 - Common Motor Requirements for HVAC.
Section 23 33 00 - Air Duct Accessories.

REFERENCE

Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS

Abbreviations of standards organizations referenced in other sections are as follows:

AABC	Associated Air Balance Council
ADC	Air Diffusion Council
AGA	American Gas Association
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers

ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
CGA	Compressed Gas Association
IEEE	Institute of Electrical and Electronics Engineers
ISA	Instrument Society of America
MCA	Mechanical Contractors Association
MICA	Midwest Insulation Contractors Association
MSS	Manufacturer's Standardization Society of the Valve & Fitting Industry, Inc.
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association. Inc.
UL	Underwriters Laboratories Inc.
ASTM E814	Standard Test Method for Fire Tests of Through-Penetration Fire Stops
ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
UL1479	Fire Tests of Through-Penetration Firestops
UL723	Surface Burning Characteristics of Building Materials

QUALITY ASSURANCE

Refer to Division 1, General Conditions, Equals and Substitutions.

Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and for obtaining the performance from the system into which these items are placed. This may include changes found necessary during the testing, adjusting, and balancing phase of the project.

CONTINUITY OF EXISTING SERVICES

Do not interrupt or change existing services without prior written approval from County Facilities Personnel. When interruption is required, coordinate the down-time with Facilities to minimize disruption to their activities. Unless specifically stated, all work involved in interrupting or changing existing services is to be done during normal working hours.

PROTECTION OF FINISHED SURFACES

Refer to Division 1, General Requirements, Protection of Finished Surfaces.

Furnish one can of touch-up paint for each different color factory finish which is to be the final finished surface of the product. Deliver touch-up paint with other "loose and detachable parts" as covered in the General Requirements.

SLEEVES AND OPENINGS

Refer to Division 1, General Requirements, Sleeves and Openings.

SEALING AND FIRESTOPPING

Sealing and firestopping of sleeves/openings between ductwork, piping, etc. and the sleeve, structural or partition opening shall be the responsibility of the contractor whose work penetrates the opening. The contractor responsible shall hire individuals skilled in such work to do the sealing and fireproofing. These individuals hired shall normally and routinely be employed in the sealing and fireproofing occupation.

EQUIPMENT FURNISHED BY OTHERS

The following will be furnished by the owner:

- New valves and temperature control valves for existing perimeter convectors.
- Labor associated with removal of existing valves and control valves for existing perimeter convectors.
- Labor associated with installation of new valves and temperature control valves for existing perimeter radiation.

  **Note: The bidding controls contractor is responsible for providing and installing all temperature control wiring/conduit from new convector temperature control valves to new VAV air terminal unit controller.

PROVISIONS FOR FUTURE
None.

SUBMITTALS
Refer to Division 1, General Conditions, Submittals.

Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents.

Before submitting electrically powered equipment, verify that the electrical power and control requirements for the equipment are in agreement with the motor starter schedule on the electrical drawings. Include a statement on the shop drawing transmittal to the architect/engineer that the equipment submitted and the motor starter schedule are in agreement or indicate any discrepancies.

Include wiring diagrams of electrically powered equipment.

Submit sufficient quantities of shop drawings to allow the following distribution:

- Operating and Maintenance Manuals 3 copies
- Testing, Adjusting and Balancing Contractor 1 copy
- A/E 1 copy

Not more than two weeks after award of contract but before any shop drawings are submittal, the contractor shall submit the following piping system data sheet for each piping service on the project. The approved piping system data sheet(s) will be made available to the DFD Project Representative for their use on this project.

Item	Pipe Size	[List each piping service]	Remarks
Pipe	2" & smaller		
Fittings	2" & smaller		
Nipples			
Branch takeoffs	2" & smaller		
D=main, d=branch	2.5" & larger		
Gate valves	2" & smaller		
Ball valves	2" & smaller		
Balancing valves	2" & smaller		
Globe valves	2" & smaller		
Check valves	2" & smaller		
Silent check valves	2" & smaller		
Stop & check valves	2" & smaller		
Flowmeters	2" & smaller		
Strainers	2" & smaller		
Thermometers	Mfr & scale		
Press gauges	Mfr & scale		
Insulation by pipe size	less than 1.25"		
(Type & thickness)	1.25"-2"		
	2.5"-4"		
	5"-6"		
	over 6"		
Hangers	Type, mfr & figure no.		
Hanger accessories			
Pipe identification			
List of specialties and accessories:			

OPERATION AND MAINTENANCE DATA
All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

OFF SITE STORAGE
Ductwork, metal for making ductwork, duct lining, sleeves, pipe/pipe fittings and similar rough-in material will not be accepted for off site storage. For material that can be stored off site, no material will be accepted for off site storage unless shop drawings for that material have been approved.

CERTIFICATES AND INSPECTIONS
Refer also to Division 1, General Conditions, Permits, Regulations, Utilities and Taxes.
Obtain and pay for all required State installation inspections except those provided by the Architect/Engineer in accordance with Wis Adm Code Section ILHR 50.12. Deliver originals of these certificates to the Division Project Representative. Include copies of the certificates in the Operating and Maintenance Instructions.

OPERATING AND MAINTENANCE INSTRUCTIONS
Refer to Division 1, General Requirements, Operating and Maintenance Instructions.

Assemble material in three-ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment. In addition to the data indicated in the General Requirements, include the following information:

- Copies of all approved shop drawings.
- Manufacturer's wiring diagrams for electrically powered equipment
- Records of tests performed to certify compliance with system requirements
- Certificates of inspection by regulatory agencies
- Temperature control record drawings and control sequences
- Parts lists for manufactured equipment
- Valve schedules
- Lubrication instructions, including list/frequency of lubrication done during construction
- Warranties
- Additional information as indicated in the technical specification sections

Also, provide electronic (PDF) copy of Operation and Maintenance Manual on “thumb” drive or DVD.

TRAINING OF OWNER PERSONNEL
Instruct County Facility Personnel in the proper operation and maintenance of systems and equipment provided as part of this project; video tape all training sessions. Include not less than 3 hours of instruction, using the Operating and Maintenance manuals during this instruction. Demonstrate startup and shutdown procedures for all equipment. All training to be during normal working hours.

RECORD DRAWINGS
Refer to Division 1, General Requirements, Record Drawings.

In addition to the data indicated in the General Requirements, maintain temperature control record drawings on originals prepared by the installing contractor/subcontractor. Include copies of these record drawings with the Operating and Maintenance manuals.

COMMISSIONING
The project will be commissioned by a separate 3rd party commissioning agent.

See Section 01 91 13 for all commissioning requirements including construction verification checklists, functional performance testing, meetings and on-site verification.

P A R T 2 - P R O D U C T S

ACCESS PANELS AND DOORS

LAY-IN CEILINGS:
Removable lay-in ceiling tiles in 2 X 2 foot or 2 X 4 foot configuration provided under Section 09500 are sufficient; no additional access provisions are required unless specifically indicated.

PLASTER WALLS AND CEILINGS:
16 gauge frame with not less than a 20 gauge hinged door panel, prime coated steel for general applications, stainless steel for use in toilets, showers, and similar wet areas, concealed hinges, screwdriver operated cam latch for general applications, key lock for use in public areas, UL listed for use in fire rated partitions if required by the application. Use the largest size access opening possible, consistent with the space and the equipment needing service; minimum size is 12" by 12".

IDENTIFICATION

STENCILS:
Not less than 1 inch high letters/numbers for marking pipe and equipment.

SNAP-ON PIPE MARKERS:
Cylindrical self-coiling plastic sheet that snaps over piping insulation and is held tightly in place without the use of adhesive, tape or straps. Not less than 1 inch high letters/numbers and flow direction arrows for piping marking. W. H. Brady, Seton, Marking Services, or equal.

ENGRAVED NAME PLATES:
White letters on a black background, 1/16 inch thick plastic laminate, beveled edges, screw mounting, Setonply Style 2060 by Seton Name Plate Company or Emedolite- Style EIP by EMED Co., or equal by Marking Services, or W. H. Brady.

VALVE TAGS:
Round brass tags with 1/2 inch numbers, 1/4 inch system identification abbreviation, 1-1/4 inch minimum diameter, with brass jack chains or brass "S" hooks around the valve stem, available from EMED Co., Seton Name Plate Company, Marking Services, or W. H. Brady.

SEALING AND FIRESTOPPING

FIRE AND/OR SMOKE RATED PENETRATIONS:

Manufacturers:
3M, Hilti, Rectorseal, STI/SpecSeal, Tremco, or approved equal.

All firestopping systems shall be provided by the same manufacturer.

Submittals:
Contractor shall submit product data for each firestop system. Submittals shall include product characteristics, performance and limitation criteria, test data, MSDS sheets, installation details and procedures for each method of installation applicable to this project. For non-standard conditions where no UL tested system exists, submit manufacturer's drawings for UL system with known performance for which an engineering judgement can be based upon.

Product:
Fire stop systems shall be UL listed or tested by an independent testing laboratory approved by the Department of Commerce.

Use a product that has a rating not less than the rating of the wall or floor being penetrated. Reference architectural drawings for identification of fire and/or smoke rated walls and floors.

Contractor shall use firestop putty, caulk sealant, intumescent wrapstrips, intumescent firestop collars, firestop blocks, firestop mortar or a combination of these products to provide a UL listed system for each application required for this project. Provide mineral wool backing where specified in manufacturer's application detail.

NON-RATED PENETRATIONS:

Pipe Penetrations:
At pipe penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between pipe insulation and sleeve. For non-rated drywall, plaster or wood partitions where sleeve is not required use urethane caulk in annular space between pipe insulation and wall material.

Duct Penetrations:
Where shown or specified, pack annular space with fiberglass batt insulation or mineral wool insulation. Provide 4" sheet metal escutcheon around duct on both sides of partition or floor to cover annular space.

PART 3 - EXECUTION

DEMOLITION

Perform all demolition as indicated on the drawings to accomplish new work. Where demolition work is to be performed adjacent to existing work that remains in an occupied area, construct temporary dust partition to minimize the amount of contamination of the occupied space. Where pipe or duct is removed and not reconnected with new work, cap ends of existing services as if they were new work. Coordinate work with the user agency to minimize disruption to the existing building occupants.

All pipe, wiring and associated conduit, insulation, ductwork, and similar items demolished, abandoned, or deactivated are to be removed from the site by the Contractor. All piping and ductwork specialties are to be removed from the site by the Contractor unless they are dismantled and removed or stored by the user agency. All designated equipment is to be turned over to the user agency for their use at a place and time so designated. Maintain the condition of material and/or equipment that is indicated to be reused equal to that existing before work began.

CUTTING AND PATCHING

Refer to Division 1, General Requirements, Cutting and Patching.

BUILDING ACCESS

Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this contractor, restore any opening to its original condition after the apparatus has been brought into the building.

EQUIPMENT ACCESS

Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance and service. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Access doors in general construction are to be furnished by the Mechanical Contractor and installed by the General Contractor.

Provide color coded thumb tacks or screws, depending on the surface, for use in accessible ceilings which do not require access panels.

COORDINATION

Verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to, diffusers, register, grilles, and recessed or semi-recessed heating and/or cooling terminal units installed in/on architectural surfaces.

Coordinate all work with other contractors prior to installation. Any installed work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.

Cooperate with the test and balance agency in ensuring Section 23 05 93 specification compliance. Verify system completion to the test and balance agency (flushing, pressure testing, chemical treatment, filling of liquid systems, proper pressurization and air venting of hydronic systems, clean filters, clean strainers, duct and pipe systems cleaned, controls adjusted and calibrated, controls cycled through their sequences, etc.), ready for testing, adjusting and balancing work. Install dampers, shutoff and balancing valves, flow measuring devices, gauges, temperature controls, etc., required for functional and balanced systems. Demonstrate the starting, interlocking and control features of each system so the test and balance agency can perform its work.

IDENTIFICATION

Identify equipment in mechanical equipment rooms by stenciling equipment number and service with one coat of black enamel against a light background or white enamel against a dark background. Use a primer where necessary for proper paint adhesion. Do not label equipment such as cabinet heaters and ceiling fans in occupied spaces.

Where stenciling is not appropriate for equipment identification, engraved name plates may be used.

Identify piping not less than once every 20 feet, not less than once in each room, adjacent to each access door or panel, and on both side of the partition where exposed piping passes through walls, floors or roofs. Place flow directional arrows at each pipe identification location. Use one coat of black enamel against a

light background or white enamel against a dark background for stenciling, or provide snap-on pipe markers as specified in Part 2 – Products.

Identify valves with brass tags bearing a system identification and a valve sequence number. Valve tags are not required at a terminal device unless the valves are greater than ten feet from the device or located in another room not visible from the terminal unit. Provide a typewritten valve schedule indicating the valve number and the equipment or areas supplied by each valve; locate schedules in each mechanical room and in each Operating and Maintenance manual. Schedules in mechanical rooms to be framed under clear plastic.

Use engraved name plates to identify control equipment.

Label fire, smoke and combination fire smoke dampers on the exterior surface of ductwork directly adjacent to access doors using a minimum of 0.5 inch height lettering reading, “SMOKE DAMPER” or “FIRE DAMPER”. Smoke and combination fire smoke dampers shall also include a second line listing the individual damper tag. The tags must be coordinated with the mechanical schedules. Utilize stencils or manufactured labels. All other forms of identification are unacceptable. All labels shall be clearly visible from the ceiling access point.

LUBRICATION

Lubricate all bearings with lubricant as recommended by the manufacturer before the equipment is operated for any reason. Once the equipment has been run, maintain lubrication in accordance with the manufacturer's instructions until the work is accepted by DFD. Maintain a log of all lubricants used and frequency of lubrication; include this information in the Operating and Maintenance Manuals at the completion of the project.

SLEEVES

PIPE SLEEVES:

Provide galvanized sheet metal sleeves for pipe penetrations through interior and exterior walls to provide a backing for sealant or firestopping. Patch wall around sleeve to match adjacent wall construction and finish. Grout area around sleeve in masonry construction. In finished spaces where pipe penetration through wall is exposed to view, sheet metal sleeve shall be installed flush with face of wall.

Pipe sleeves are not required in interior non-rated drywall, plaster or wood partitions and sleeves are not required in existing poured concrete walls where penetrations are core drilled.

Pipe sleeves are not required in cored floor pipe penetrations through existing floors that are not located in mechanical rooms, food service areas or wet locations listed above.

DUCT SLEEVES:

Duct sleeves are not required in non-rated partitions or floors.

Provide sleeve required for fire dampers in fire-rated partitions and floors. Reference fire damper details on drawings.

SEALING AND FIRESTOPPING

FIRE AND/OR SMOKE RATED PENETRATIONS:

Install approved product in accordance with the manufacturer's instructions where pipes penetrate a fire/smoke rated surface. When pipe is insulated, use a product which maintains the integrity of the insulation and vapor barrier.

Where firestop mortar is used to infill large fire-rated floor openings that could be required to support weight, provide permanent structural forming. Firestop mortar alone is not adequate to support any substantial weight.

NON-RATED PARTITIONS:
At all interior partitions and exterior walls, pipe penetrations are required to be sealed. Apply sealant to both sides of the penetration in such a manner that the annular space between the pipe sleeve or cored opening and the pipe or insulation is completely blocked.

Duct penetrations through non-rated partitions shall require sheet metal escutcheons with fiberglass or mineral wool insulation fill for spaces that include laboratories, clean rooms, animal rooms, kitchens, cart wash rooms, janitor closets, cart wash rooms, toilet rooms, mechanical rooms, conference rooms, private consultation rooms, and where noted on drawings elsewhere.

END OF SECTION

SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

P A R T 1 - G E N E R A L

SCOPE

This sections includes requirements for single and three phase motors that are used with equipment specified in other sections. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Shop Drawings
- Operating and Maintenance Data
- Electrical Coordination
- Product Criteria

PART 2 - PRODUCTS
- Three Phase, Single Speed Motors
- Single Phase, Single Speed Motors

PART 3 - EXECUTION
- Installation

RELATED WORK

Division 26 00 00 - Electrical
Section 01 91 13 – Commissioning Requirements

REFERENCE

Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS

ANSI/IEEE 112	Test Procedure for Polyphase Induction Motors and Generators
ANSI/NEMA MG-1	Motors and Generators
ANSI/NFPA 70	National Electrical Code

QUALITY ASSURANCE

Refer to division 1, General Conditions, Equals and Substitutions.

SHOP DRAWINGS

Refer to division 1, General Conditions, Submittals.

Include with the equipment which the motor drives the following motor information: motor manufacturer, horsepower, voltage, phase, hertz, rpm, full load efficiency. Include project wiring diagrams prepared by the contractor specifically for this work.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

ELECTRICAL COORDINATION

All starters, overload relay heater coils, disconnect switches and fuses, relays, wire, conduit, pushbuttons, pilot lights, and other devices required for the control of motors or electrical equipment are furnished and installed by the Electrical Contractor, except as specifically noted elsewhere in this division of specifications.

Electrical drawings and/or specifications show number and horsepower rating of all motors furnished by this Contractor, together with their actuating devices if these devices are furnished by the Electrical Contractor. Should any discrepancy in size, horsepower rating, electrical characteristics or means of control be found for any motor or other electrical equipment after contracts are awarded, Contractor is to immediately notify the architect/engineer of such discrepancy. Costs involved in any changes required due to equipment substitutions initiated by this contractor will be the responsibility of this contractor. See related comments in Section 23 05 00 - Common Work Results for HVAC, under Shop Drawings.

Electrical Contractor will provide all power wiring and control wiring, except temperature control wiring.

Furnish project specific wiring diagrams to Electrical Contractor for all equipment and devices furnished by this Contractor and indicated to be wired by the Electrical Contractor.

PRODUCT CRITERIA

Motors to conform to all applicable requirements of NEMA, IEEE, ANSI, and NEC standards and shall be listed by U.L. for the service specified.

Select motors for conditions in which they will be required to perform; i.e., general purpose, splashproof, explosion proof, standard duty, high torque or any other special type as required by the equipment or motor manufacturer's recommendations.

Furnish motors for starting in accordance with utility requirements and compatible with starters as specified.

P A R T 2 - P R O D U C T S

THREE PHASE, SINGLE SPEED MOTORS

Use NEMA rated three phase, 60 hertz motors for all motors 1/2 HP and larger unless specifically indicated.

Use NEMA general purpose, continuous duty, Design B , normal starting torque, T-frame or U-frame motors with Class B or better insulation unless the manufacturer of the equipment on which the motor is being used has different requirements. Use open drip-proof motors unless totally enclosed fan-cooled, totally enclosed non-ventilated, explosion-proof, or encapsulated motors are specified in the equipment sections.

Use grease lubricated anti-friction ball bearings with housings equipped with plugged/capped provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at the end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

All open drip-proof motors to have a 1.15 service factor. Other motor types may have minimum 1.0 service factors.

All motors 1 HP and larger, except specially wound motors and inline pump motors 56 frame and smaller, to be high efficiency design with full load efficiencies which meet or exceed the values listed below when tested in accordance with NEMA MG 1.

FULL LOAD NOMINAL MOTOR EFFICIENCY BY MOTOR SIZE AND SPEED

MOTOR HP	-----Open Drip-Proof Motors------ -------Nominal Motor Speed------- 1200 rpm	1800 rpm	3600 rpm
1	82.5	85.5	77.0
1-1/2	86.5	86.5	84.0
2	87.5	86.5	85.5
3	88.5	89.5	85.5
5	89.5	89.5	86.5

MOTOR HP	----Totally Enclosed Fan-Cooled---- -------Nominal Motor Speed------ 1200 rpm	1800 rpm	3600 rpm
1	82.5	85.5	77.0
1-1/2	87.5	86.5	84.0
2	88.5	86.5	85.5
3	89.5	89.5	86.5
5	89.5	89.5	88.5

SINGLE PHASE, SINGLE SPEED MOTORS

Use NEMA rated 115 volt, single phase, 60 hertz motors for all motors 1/3 HP and smaller.

Use permanent split capacitor or capacitor start, induction run motors equipped with permanently lubricated and sealed ball or sleeve bearings and Class A insulation. Service factor to be not less than 1.35.

P A R T 3 - E X E C U T I O N

INSTALLATION

Mount motors on a rigid base designed to accept a motor, using shims if required under each mounting foot to get a secure installation.

When motor will be flexible coupled to the driven device, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Using a dial indicator, check angular misalignment of the two shafts; adjust motor position as necessary so that the angular misalignment of the shafts does not exceed 0.002 inches per inch diameter of the coupling hub. Again using the dial indicator, check the shaft for run-out to assure concentricity of the shafts; adjust as necessary so that run-out does not exceed 0.002 inch.

When motor will be connected to the driven device by means of a belt drive, mount sheaves on the appropriate shafts in accordance with the manufacturer's instructions. Use a straight edge to check alignment of the sheaves; reposition sheaves as necessary so that the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so that the belt(s) can be added and tighten the base so that the belt tension is in accordance with the drive manufacturer's recommendations. Frequently recheck belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

Verify the proper rotation of each three-phase motor as it is being wired or before the motor is energized for any reason.

Lubricate all motors requiring lubrication. Record lubrication material used and the frequency of use. Include this information in the maintenance manuals.

END OF SECTION

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SECTION 23 05 15
PIPING SPECIALTIES

P A R T 1 - G E N E R A L

SCOPE

This section contains specifications for HVAC piping specialties for all piping systems. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Quality Assurance
- Shop Drawings
- Operation and Maintenance Data
- Design Criteria

PART 2 - PRODUCTS
- Thermometers
- Thermometer Sockets
- Test Wells
- P/T (Pressure/Temperature) Test Plugs
- Hose Connection Caps
- Pressure Gauges
- Expansion Loops
- Strainers
- Air Vents
- Flow Sensing Devices

PART 3 - EXECUTION
- Thermometers
- Thermometer Sockets
- Test Wells
- P/T (Pressure/Temperature) Test Plugs
- Pressure Gauges
- Expansion Loops
- Strainers
- Air Vents

RELATED WORK

Section 01 91 13 – Commissioning Requirements
Section 23 21 13 - Hydronic Piping
Section 23 05 23 - General-Duty Valves for HVAC Piping
Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
Section 23 07 00 - HVAC Insulation

REFERENCE

Applicable provisions of Division 1 govern work under this section.

QUALITY ASSURANCE

Refer to division 1, General Conditions, Equals and Substitutions.

SHOP DRAWINGS

Refer to division 1, General Conditions, Submittals.

Required for all items in this section. Include materials of construction, dimensional data, ratings/capacities/ranges, pressure drop data where appropriate, and identification as referenced in this section and/or on the drawings.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

DESIGN CRITERIA
All piping specialties are to be rated for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.

P A R T 2 - P R O D U C T S

THERMOMETERS
Manufacturers: Ashcroft, Marsh, Taylor, H. O. Trerice, U. S. Gauge, Weiss, Weksler.

Stem Type, cast aluminum case, nine inch scale, clear acrylic window. adjustable angle brass stem with stem of sufficient length so the end of the stem is near the middle of a pipe without reducing the thickness of any insulation, red indicating fluid, black lettering against a white background, with scale ranges as follows:

Service	Scale Range, °F	Min. Increment, °F
Hot Water	30 - 240	2

THERMOMETER SOCKETS
Brass with threaded connections suitable for thermometer stems and temperature control sensing elements in pipeline. Furnish with extension necks for insulated piping systems.

TEST WELLS
Similar to thermometer sockets except with a brass cap that thread into the inside of the test well to prevent dirt from accumulating. Secure cap to body with a short chain. Furnish with extension necks, where appropriate, to accommodate the pipeline insulation.

P/T (PRESSURE/TEMPERATURE) TEST PLUGS
Brass plug with 1/4" NPT threads, EPDM or neoprene valve core, knurled cap with cap strap. Use extended length plugs to clear insulated piping. Adaptors shall have 1/4" FPT connection for standard pressure gauges.

HOSE CONNECTON CAPS
Hose connection caps shall be pressure rated for 150 psig at 180 deg F.

PRESSURE GAUGES
Manufacturers: Ametek/U. S. Gauge Division, Ashcroft, Marsh, Taylor, H. O. Trerice, Weiss, Weksler.

Cast aluminum case of not less than 4.5 inches in diameter, double strength glass window, black lettering on a white background, phosphor bronze bourdon tube with bronze bushings, recalibration from the front of the dial, 99% accuracy over the middle half of the scale, 98.5% accuracy over the remainder of the scale, with scale range as follows:

Service	Scale Range, psig	Min. Increment, psig
Hot Water	0 - 100	2

PRESSURE SNUBBERS:
Bronze construction, suitable for system working pressure, 1/4" size.

COIL SYPHONS:
Bronze or steel construction, suitable for system working pressure, 1/4" size.

GAUGE VALVES:
Use valves as specified in Section 23 05 23 - General-Duty Valves for HVAC Piping. For water systems, use 1/4" ball valves.

EXPANSION LOOPS
Provide expansion loops indicated on the drawings and details.

STRAINERS
Manufacturers: Armstrong, Hoffman, Illinois, Keckley, Metraflex, Mueller Steam, or Sarco.

WATER SYSTEMS:
Y type; cast iron body; stainless steel screens; bolted or threaded screen retainer tapped for a blowoff valve; threaded body in sizes through 2 inch and rated at not less than 175 psi WOG; flanged body in sizes over 2 inch and rated at not less than 125 psi WOG at 240°F. Screen to be 20 mesh for line sizes 2 inch and less, 0.125 inch perforations for line sizes 2-1/2 inch through 4 inch, and 0.25 inch perforations for line sizes 5 inch and larger.

AIR VENTS
MANUAL KEY TYPE VENTS:
Bell and Gossett Model 4V; Eaton/Dole Model 9, 9B, or 14A.

Bronze body with nonferrous internal parts, screwdriver operated, designed to relieve air from the system when vent is opened, rated at not less than 125 psig at 220°F.

MANUAL BALL VALVE VENTS:
Provide 1/4" ball valves for manual venting of air handling unit coils and where indicated elsewhere on drawings and details. Reference specifications section 23 05 23.

AUTOMATIC VENTS:
Thrush Model 720, Bell and Gossett Model 107, Watson McDaniel Model AV813W

Cast iron body with nonferrous internal parts, designed to vent air automatically with float principle without allowing air to enter the system, rated at not less than 125 psig at 220°F.

FLOW SENSING DEVICES
For water flow sensing devices 2 inch and smaller, use balance valves as specified in Section 23 05 23 - General-Duty Valves for HVAC Piping.

P A R T 3 - E X E C U T I O N

THERMOMETERS

STEM TYPE:
Install in piping systems as indicated on the drawings and/or details using a separable socket in each location.

THERMOMETER SOCKETS
Install at each point where a thermometer or temperature control sensing element is located in a pipeline.

TEST WELLS
Install in piping systems as indicated on the drawings and/or details wherever provisions are needed for inserting a thermometer at a later date.

P/T (PRESSURE/TEMPERATURE) TEST PLUGS
Install in piping systems as indicated on the drawings and/or details. Do not insulate over test plugs.

PRESSURE GAUGES
Install in locations where indicated on the drawings and/or details, including any gauge piping, with scale range appropriate to the system operating pressures.

PRESSURE SNUBBERS:
Install in gauge piping for all gauges used on water services.

COIL SYPHONS:
Install in gauge piping for all gauges used on steam services.

GAUGE VALVES
Install at each gauge location as close to the main as possible and at each location where a gauge tapping is indicated.

EXPANSION LOOPS
Install where indicated on the drawings or details, locating anchors and guides as detailed.

STRAINERS

Install all strainers where indicated on the project details, allowing sufficient space for the screens to be removed. Rotate screen retainer where required by the installation so blowdown can remove accumulated dirt from the strainer body.

WATER SYSTEMS:

Install a ball valve for blowdown in the tapped screen retainer; valve to be the same size as the tapping.

AIR VENTS

MANUAL KEY TYPE VENTS:

Install at all high points where air may collect and not be carried by the system fluid. Use a soft Type L copper "pigtail" so the vent can be positioned for venting and collecting any water that might escape.

MANUAL BALL VALVE VENTS:

Install on air handling coils and where indicated elsewhere as shown on drawings and details.

AUTOMATIC VENTS:

Install on the top of air separators on systems using bladder type expansion tanks. Install at other locations as indicated on the drawings or details. All locations to have a ball valve installed upstream of the vent for maintenance purposes.

END OF SECTION

SECTION 23 05 23
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

SCOPE

This section includes valve specifications for all HVAC systems except where indicated under Related Work. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Quality Assurance
- Submittals
- Operation and Maintenance Data
- Design Criteria

PART 2 - PRODUCTS
- Manufacturers
- Water System Valves
  - Gate Valves
  - Ball Valves
  - Butterfly Valves
  - Globe Valves
  - Swing Check Valves
  - Spring Loaded Check Valves
  - Balance Valves
  - Drain Valves
- Specialty Valves and Valve Accessories
  - Gauge Valves
  - Chain Wheel Operators

PART 3 - EXECUTION
- General
- Shut-off Valves
- Balancing Valves
- Calibrated Balancing Valves
- Drain Valves
- Spring Loaded Check Valves
- Swing Check Valves

RELATED WORK

Section 01 91 13 – Commissioning Requirements
Section 23 05 15 - Piping Specialties
Section 23 09 14 - Pneumatic and Electric Instrumentation and Control Devices for HVAC

REFERENCE

Applicable provisions of Division 1 govern work under this section.

QUALITY ASSURANCE

Refer to division 1, General Conditions, Equals and Substitutions.

SUBMITTALS

Refer to division 1, General Conditions, Submittals.

Contractors shall submit a schedule of all valves indicating type of service, dimensions, materials of construction, and pressure/temperature ratings for all valves to be used on the project. Temperature ratings specified are for continuous operation.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

DESIGN CRITERIA
Where valves are specified for individual mechanical services (i.e. hot water heating, steam, etc.) all valves shall be of the same manufacturer unless prior written approval is obtained from DFD.

P A R T 2 - P R O D U C T S

MANUFACTURERS
Anvil, Apollo, Armstrong, Bell & Gossett, Cash-Acme, Dresser Consolidated, Conval, Crane, Anderson Greenwood and Crosby, Danfoss-Flomatic, DeZurik, Durco, Fisher, Grinnell, Griswold, Hammond, Hancock, Hoffman, Jamesbury, Keystone, Kunkle, Leslie, Lunkenheimer/Cincinnati, Metraflex, Milwaukee, Mueller, Newco, Nexus, Nibco, Powell, RP&C, Sarco, Spence, Stockham, Taco, Tasco, Thrush-Amtrol, Vogt, Watts, or approved equal.

WATER SYSTEM VALVES
All water system valves to be rated at not less than 125 psig water working pressure at 240°F unless noted otherwise.

GATE VALVES:
2" and smaller: Use ball valves; gate valves will not be accepted in sizes 2" and smaller.

2-1/2" and larger: Use butterfly valves; gate valves will not be accepted in sizes 2-1/2" and larger.

BALL VALVES:
2" and smaller: Two piece bronze body; threaded or soldered ends, as appropriate to the pipe material; stainless steel or chrome plated brass/bronze ball; conventional port; glass filled teflon seat; threaded packing gland follower; blowout-proof stem; 600 psig WOG.

Valve stems shall allow operators to clear insulation without interference. Provide stem extensions when valve operators interfere with pipe insulation.

Apollo 70-100/200 series, Hammond 8301/8311, Milwaukee BA100/150, Nibco T/S 585-70, Stockham S206/216.

2-1/2" and over: Ball valves will not be accepted in sizes over 2 inch.

BUTTERFLY VALVES:
2" and smaller: Use ball valves; butterfly valves will not be accepted in sizes 2 inch and smaller.

2-1/2" and larger: Cast iron body; stainless steel shaft; Teflon, nylatron, or acetal bearings; EPDM resilient seat. Disk to be bronze, aluminum-bronze, nickel plated ductile iron, cast iron with welded nickel edge, or 316 - stainless steel. Pressure rated to 150 psig. Valve assembly to be bi-directionally bubble tight to 150 psig with no downstream flange/pipe attached. Nylon coated ductile iron discs are not acceptable. Polymid or polyamide coated valves are not acceptable.

Valve stems shall allow operators to clear insulation without interference. Provide stem extensions when valve operators interfere with pipe insulation.

Use threaded lug type valves for installation with class 125/150 flanges.

Centerline series 200, DeZurik BOS-CL, Keystone Fig. 222, Nibco LD2000 (2-1/2”-12”)/LD1000 (14” and above), Bray Series 31H, Victaulic 300 series (2-1/2”-12”)/709 series (14”-24”).

Provide ten-position lever actuators for valves 6" and smaller.

GLOBE VALVES:
Do not use globe valves for water service, except in temperature control applications.

SWING CHECK VALVES:
2" and smaller: Class 125, bronze body, threaded or soldered ends, regrindable seat, bronze disc, threaded cap, suitable for installation in a horizontal or vertical line with flow upward.

Crane 137/1342, Hammond IB912/IB940, Lunkenheimer 2144/2145, Milwaukee 509/1509, Nibco T-413-B/S-413-B, Powell 578/1825, Stockham B-309/B-319.

2-1/2" and larger: Class 125, cast iron body, flanged ends, bronze trim, bolted cap, renewable bronze seat and disc, non-asbestos gasket, suitable for installation in a horizontal or vertical line with flow upward.

Crane 373, Hammond IR1124, Lunkenheimer 1790, Milwaukee F2974, Nibco F918, Powell 559, Stockham G-931.

SPRING LOADED CHECK VALVES:
2" and smaller: Class 125, bronze body, threaded, solder or wafer ends, bronze trim, stainless steel spring, teflon seat unless only bronze available.

APCO 300 series, ConBraCo 61 series, Mueller 303BP, Nibco T-480-Y/S-480-Y, Val-Matic 1400 series.

2-1/2" and larger: Class 125, cast iron or semi-steel body, wafer or globe flanged type, bronze trim, bronze or EPDM seat, stainless steel spring, stainless steel stem if stem is required. Valves with ductile iron in contact with the working fluid will not be accepted.

APCO 600 series, Metraflex 900 series, Milwaukee 1800 series, Mueller Steam 101M-AP/105M-AP, Nibco F910 series, Val-Matic 1800 series, Victaulic series 716.

BALANCE VALVES:
2" and smaller: Bronze or copper alloy body with calibrated ball, globe or venturi/valve arrangement, integral pointer and calibrated scale to register degree of valve opening, memory stop, drain tapping, threaded or soldered ends, with or without integral unions, P/T or Shraeder pressure taps with integral check valves and seals, adjustable memory stop, suitable for 200 psig water working pressure at 250°F.

Armstrong CBV, Bell & Gossett Circuit Setter Plus, Griswold Quickset, Nexus Orturi, Nibco 1710 Series, Taco Accu-Flo, Tour & Anderson STAS/STAD, Victaulic series 786/787.

Include one bellows type differential pressure meter kit that includes a six inch diameter gauge with 270° arc readout and having an accuracy of ±1% of full scale or better and suitable for the differential pressures of the valves supplied for this project, over-range protection, color coded hoses not less than ten feet in length with brass connectors suitable for connection to the low and high pressure connections on the balance valves, instrument valving so meter can be vented and drained, pressure and temperature rating at least equal to that of the valves. Provide meter and all accessories in a durable case with carrying handle.

Barton 247A, Midwest 809.

2-1/2" and larger: Use butterfly valves as specified in this section along with a flow sensing device as specified in Section 23 05 15.

DRAIN VALVES:
Use 3/4 inch ball valve with threaded hose adapter except strainer blowdown valves to be the same size as the blowdown connection.

SPECIALTY VALVES AND VALVE ACCESSORIES

GAUGE VALVES:
Water Service: Use 1/4" ball valves.

STEM EXTENSIONS:
Provide stem extensions when valve operators interfere with pipe insulation.

P A R T 3 - E X E C U T I O N

GENERAL
Properly align piping before installation of valves in an upright position; operators installed below the valves will not be accepted.

Install valves in strict accordance with valve manufacturer's installation recommendations. Do not support weight of piping system on valve ends.

Install all temperature control valves.

Install all valves with the stem in the upright position. Valves may be installed with the stem in the horizontal position only where space limitations do not allow installation in an upright position or where large valves are provided with chain wheel operators. Where valves 2-1/2" and larger are located more than 12'-0" above mechanical room floors, install valve with stem in the horizontal position and provide a chain wheel operator. Valves installed with the stems down, will not be accepted.

Install stem extensions when shipped loose from valve.

Prior to flushing of piping systems, place all valves in the full-open position.

SHUT-OFF VALVES
Install shut-off valves at all equipment, at each branch take-off from mains, and at each automatic valve for isolation or repair.

WATER SYSTEM:
Butterfly valves installed at the location of a flow sensing device are to have a memory stop.

BALANCING VALVES
Provide balancing valves for all major equipment and at each major branch takeoff and at the discharge of each pump as indicated on drawings and details.

CALIBRATED BALANCE VALVES:
Install where indicated on the drawings and details for balancing of hydronic systems.

DRAIN VALVES
Provide drain valves for complete drainage of all systems. Locations of drain valves include low points of piping systems, equipment locations specified or detailed including reheat coils, other locations required for drainage of systems.

SPRING LOADED CHECK VALVES
Install a spring loaded check valve in each pump discharge line where two pumps operate in parallel and no combination shutoff, check and balancing valve is being used.

SWING CHECK VALVES
Provide swing check valves where specified, detailed, and at steam condensate lines where they rise at outlet of traps. In such cases, provide isolation valves to allow repair or replacement of check valve.

END OF SECTION

SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

P A R T 1 - G E N E R A L

SCOPE
This section includes specifications for supports of all HVAC equipment and materials as well as piping system anchors. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Description
- Shop Drawings
- Design Criteria

PART 2 - PRODUCTS
- Pipe Hanger and Support Manufacturers
- Structural Supports
- Pipe Hangers and Supports
- Beam Clamps
- Concrete Inserts
- Anchors

PART 3 - EXECUTION
- Installation
- Hanger and Support Spacing
- Anchors

RELATED WORK
Section 01 91 13 – Commissioning Requirements
Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment
Section 23 07 00 - HVAC Insulation

REFERENCE
Applicable provisions of Division 1 shall govern work under this section.

REFERENCE STANDARDS
MSS SP-58 Materials, Design, Manufacture, Selection, Application, and Installation

QUALITY ASSURANCE
Refer to Division 1, General Conditions, Equals and Substitutions.

DESCRIPTION
Provide all supporting devices as required for the installation of mechanical equipment and materials. All supports and installation procedures are to conform to the latest requirements of the ANSI Code for pressure piping.

Do not hang any mechanical item directly from a metal deck or run piping so it rests on the bottom chord of any truss or joist.

Support apparatus and material under all conditions of operation, variations in installed and operating weight of equipment and piping, to prevent excess stress, and allow for proper expansion and contraction.

Protect insulation at all hanger points; see Related Work above.

SHOP DRAWINGS
Refer to division 1, General Conditions, Submittals.

Schedule of all hanger and support devices indicating shields, attachment methods, and type of device for each pipe size and type of service. Reference section 23 05 00.

DESIGN CRITERIA

Materials and application of pipe hangers and supports shall be in accordance with MSS Standard Practice SP-58 unless noted otherwise.

Piping connected to base mounted pumps, compressors, or other rotating or reciprocating equipment is to have vibration isolation supports for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Standard pipe hangers/supports as specified in this section are required beyond the 100 pipe diameter/3 support distance.

Piping flexible connections and vibration isolation supports are required for piping connected to coils that are in a fan assembly where the entire assembly is mounted on vibration supports; the vibration isolation supports are required for a distance of one hundred pipe diameters or three supports away from the equipment, whichever is greater. Piping flexible connection and vibration isolation supports are not required when the fan section is separately and independently isolated by means of vibration supports and duct flexible connections. Standard pipe hangers/supports as specified in this section are required when there are no vibration isolation devices in the piping and beyond the 100 pipe diameter/3 support distance.

Piping supported by laying on the bottom chord of joists or trusses will not be accepted.

Fasteners depending on soft lead for holding power or requiring powder actuation will not be accepted.

Allow sufficient space between adjacent pipes and ducts for insulation, valve operation, routine maintenance, etc.

P A R T 2 - P R O D U C T S

PIPE HANGER AND SUPPORT MANUFACTURERS

Anvil, B-Line, Fee and Mason, Kindorf, Michigan Hanger, Unistrut, or approved equal. Anvil figure numbers are listed below; equivalent material by other manufacturers is acceptable.

STRUCTURAL SUPPORTS

Provide all supporting steel required for the installation of mechanical equipment and materials, whether or not it is specifically indicated or sized, including angles, channels, beams, etc. to suspend or floor support tanks and equipment.

PIPE HANGERS AND SUPPORTS

HANGERS FOR STEEL PIPE SIZES 1/2” THROUGH 2”:
Carbon steel, adjustable, clevis, black finish. Anvil figure 65 or 260.

HANGERS FOR STEEL PIPE SIZES 2-1/2” AND OVER:
Carbon steel, adjustable, clevis, black finish. Anvil figure 260.

Adjustable steel yoke, cast iron roll, double hanger. Anvil figure 181.

MULTIPLE OR TRAPEZE HANGERS:
Steel channels with welded spacers and hanger rods if calculations are submitted.

WALL SUPPORT:
Welded steel bracket with hanger. B-Line 3068 Series, Anvil 194 Series.

Perforated epoxy painted finish, 16-12 gauge min., steel channels securely anchored to wall structure with interlocking, split type, bolt secured, galvanized pipe/tubing clamps. B-Line type S channel with B-2000 series clamps, Anvil type AS200 H with AS 1200 clamps. When copper piping is being supported, provide flexible elastomeric/thermoplastic isolation cushion material to completely encircle the piping and avoid contact with the channel or clamp, equal to B-Line B1999 Vibra Cushion or provide manufacturers clamp and cushion assemblies, B-Line BVT series, Anvil cushion clamp assembly.

COPPER PIPE SUPPORT:
Carbon steel ring, adjustable, copper plated or polyvinylchloride coated.

INSULATION PROTECTION SHIELDS:
Galvanized carbon steel of not less than 18 gauge for use on insulated pipe 2-1/2 inch and larger. Minimum shield length is 12 inches. Equal to Anvil figure 167.

STEEL HANGER RODS:
Threaded both ends, threaded one end, or continuous threaded, black finish.

Size rods for individual hangers and trapeze support as indicated in the following schedule.

Total weight of equipment, including valves, fittings, pipe, pipe content, and insulation, are not to exceed the limits indicated.

Maximum Load (Lbs.) (650°F Maximum Temp.)	Rod Diameter (inches)
610	3/8
1130	1/2
1810	5/8
2710	3/4

Provide rods complete with adjusting and lock nuts.

BEAM CLAMPS
MSS SP-58 Type 23 malleable black iron clamp for attachment to beam flange to 0.62 inches thick for single threaded rods of 3/8, 1/2, and 5/8 inch diameter, for use with pipe sizes 4 inch and less. Furnish with a hardened steel cup point set screw. Anvil figure 86.

MSS SP-58 Type 28 or Type 29 forged steel jaw type clamp with a tie rod to lock clamp in place, suitable for rod sizes to 1-1/2 inch diameter but limited in application to pipe sizes 8 inch and less without prior approval. Anvil figure 228.

CONCRETE INSERTS
Carbon steel expansion anchors, vibration resistant, with ASTM B633 zinc plating. Use drill bit of same manufacturer as anchor. Hilti, Rawl, Redhead.

ANCHORS
Use welding steel shapes, plates, and bars to secure piping to the structure.

P A R T 3 - E X E C U T I O N

INSTALLATION
Install supports to provide for free expansion of the piping and duct system. Support all piping from the structure using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. Fasten ceiling plates and wall brackets securely to the structure and test to demonstrate the adequacy of the fastening.

Piping shall be supported independently from ductwork and all other trades.

Where piping can be conveniently grouped to allow the use of trapeze type supports, use standard structural shapes for the supporting steel.

Perform all welding in accordance with standards of the American Welding Society. Clean surfaces of loose scale, rust, paint or other foreign matter and properly align before welding. Use wire brush on welds after welding. Welds shall show uniform section, smoothness of weld metal and freedom from porosity and clinkers. Where necessary to achieve smooth connections, joints shall be dressed smooth.

HANGER AND SUPPORT SPACING
Place a hanger within 12 inches of each horizontal elbow, valve, strainer, or similar piping specialty item.

Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers.

Support riser piping independently of connected horizontal piping.

Adjust hangers to obtain the slope specified in the piping section of this specification.

Space hangers for pipe as follows:

Pipe Material	Pipe Size	Max. Spacing
Steel	1/2" through 1-1/4"	6'-6"
Steel	1-1/2" through 6"	10'-0"
Copper	1/2" through 1-1/4"	5'-0"
Copper	1-1/2" and larger	8'-0"

ANCHORS

Install where indicated on the drawings and details. Where not specifically indicated, install anchors at ends of principal pipe runs and at intermediate points in pipe runs between expansion loops. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

END OF SECTION

SECTION 23 07 00
HVAC INSULATION

P A R T 1 - G E N E R A L

SCOPE

This section includes insulation specifications for heating, ventilating and air conditioning piping, ductwork and equipment. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference Standards
- Quality Assurance
- Description
- Definitions
- Shop Drawings
- Operation and Maintenance Data
- Environmental Requirements

PART 2 - PRODUCTS
- Materials
- Insulation Types
- Jackets
- Insulation Inserts and Pipe Shields
- Accessories

PART 3 - EXECUTION
- Examination
- Installation
- Protective Jacket Installation
- Piping, Valve and Fitting Insulation
- Piping Protective Jackets
- Pipe Insulation Schedule
- Duct Insulation
- Duct Insulation Schedule
- Equipment Insulation Schedule

RELATED WORK

Section 01 91 13 – Commissioning Requirements
Section 23 05 00 - Common Work Results for HVAC
Section 23 21 13 - Hydronic Piping
Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
Section 23 31 00 - HVAC Ducts and Casings

REFERENCE

Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS

ASTM B209	Aluminum and Aluminum Alloy Sheet and Plate
ASTM C165	Test Method for Compressive Properties of Thermal Insulations
ASTM C177	Heat Flux and Thermal Transmission Properties
ASTM C195	Mineral Fiber Thermal Insulation Cement
ASTM C240	Cellular Glass Insulation Block
ASTM C302	Density of Preformed Pipe Insulation
ASTM C303	Density of Preformed Block Insulation
ASTM C355	Test Methods for Test for Water Vapor Transmission of Thick Materials
ASTM C449	Mineral Fiber Hydraulic Setting Thermal Insulation Cement
ASTM C518	Heat Flux and Thermal Transmission Properties
ASTM C533	Calcium Silicate Block and Pipe Thermal Insulation
ASTM C534	Preformed Flexible Elastomeric Thermal Insulation
ASTM C547	Mineral Fiber Preformed Pipe Insulation
ASTM C552	Cellular Glass Block and Pipe Thermal Insulation

ASTM C553	Mineral Fiber Blanket and Felt Insulation
ASTM C578	Preformed, Block Type Cellular Polystyrene Thermal Insulation
ASTM C591	Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
ASTM C610	Expanded Perlite Block and Thermal Pipe Insulation
ASTM C612	Mineral Fiber Block and Board Thermal Insulation
ASTM C921	Properties of Jacketing Materials for Thermal Insulation
ASTM C1136	Flexible Low Permeance Vapor Retarders for Thermal Insulation
ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension
ASTM D1000	Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications
ASTM D1621	Standard Test Method for Compressive Properties Of Rigid Cellular Plastics
ASTM D1622	Standard Test Method for Apparent Density of Rigid Cellular Plastics
ASTM D1940	Method of Test for Porosity of Rigid Cellular Plastics
ASTM D2126	Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
ASTM D2240	Standard Test Method for Rubber Property—Durometer Hardness
ASTM E84	Surface Burning Characteristics of Building Materials
ASTM E814	Standard Test Method for Fire Tests of Penetration Firestop Systems
ASTM E2336	Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems
MICA	National Commercial & Industrial Insulation Standards
NFPA 225	Surface Burning Characteristics of Building Materials
UL 723	Surface Burning Characteristics of Building Materials

QUALITY ASSURANCE

Refer to division 1, General Conditions, Equals and Substitutions

Label all insulating products delivered to the construction site with the manufacturer's name and description of materials.

Insulation systems shall be applied by experienced contractors. Within the past five (5) years, the contractor shall be able to document the successful completion of a minimum of three (3) projects of at least 50% of the size and similar scope of the work specified in this section.

DESCRIPTION

Furnish and install all insulating materials and accessories as specified or as required for a complete installation. The following types of insulation are specified in this section:

- Pipe Insulation
- Duct Insulation
- Equipment Insulation

Install all insulation in accordance with the latest edition of MICA (Midwest Insulation Contractors Association) Standard and manufacturer's installation instructions. Exceptions to these standards will only be accepted where specifically modified in these specifications, or where prior written approval has been obtained from the DFD Project Representative.

DEFINITIONS

Concealed: shafts, furred spaces, space above finished ceilings, utility tunnels and crawl spaces. All other areas, including walk-through tunnels, shall be considered as exposed.

SHOP DRAWINGS

Refer to division 1, General Conditions, Submittals.

Submit a schedule of all insulating materials to be used on the project, including adhesives, fastening methods, fitting materials along with material safety data sheets and intended use of each material. Include manufacturer's technical data sheets indicating density, thermal characteristics, jacket type, and manufacturer's installation instructions.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

ENVIRONMENTAL REQUIREMENTS

Do not store insulation materials on grade or where they are at risk of becoming wet. Do not install insulation products that have been exposed to water.

Protect installed insulation work with plastic sheeting to prevent water damage.

P A R T 2 - P R O D U C T S

MATERIALS

Manufacturers: Armacell, Certainteed, Manson, Childers, Dow, Extol, Fibrex, Halstead, H.B. Fuller, Imcoa, Johns Manville, Knauf, Owens-Corning, Partek, Pittsburgh Corning, Rubatex, VentureTape or approved equal.

Materials or accessories containing asbestos will not be accepted.

Use composite insulation systems (insulation, jackets, sealants, mastics, and adhesives) that have a flame spread rating of 25 or less and smoke developed rating of 50 or less, with the following exceptions:

Pipe insulation which is not located in an air plenum may have a flame spread rating not over 25 and a smoke developed rating no higher than 450 when tested in accordance with UL 723 and ASTM E84.

INSULATION TYPES

Insulating materials shall be fire retardant, moisture and mildew resistant, and vermin proof. Insulation shall be suitable to receive jackets, adhesives and coatings as indicated.

FLEXIBLE FIBERGLASS INSULATION:
Minimum nominal density of 0.75 lbs. per cu. ft., and thermal conductivity of not more than 0.3 at 75 degrees F, rated for service to 250 degrees F.

RIGID FIBERGLASS INSULATION:
Minimum nominal density of 3 lbs. per cu. ft., and thermal conductivity of not more than 0.23 at 75 degrees F, minimum compressive strength of 25 PSF at 10% deformation, rated for service to 450 degrees F.

JACKETS

PVC FITTING COVERS AND JACKETS (PFJ):
White PVC film, gloss finish one side, semi-gloss other side, FS LP-535D, Composition A, Type II, Grade GU. Ultraviolet inhibited indoor/outdoor grade to be used where exposed to high humidity, ultraviolet radiation, in kitchens or food processing areas or installed outdoors. Jacket thickness to be minimum .02" indoors/.03"outdoors for piping 12" and smaller, .03" indoors/.04" outdoors for piping 15" and larger.

ALL SERVICE JACKETS (ASJ):
Heavy duty, fire retardant material with white kraft reinforced foil vapor barrier, factory applied to insulation with a self-sealing pressure sensitive adhesive lap, maximum permeance of .02 perms and minimum beach puncture resistance of 50 units.

FOIL SCRIM ALL SERVICE JACKETS (FSJ):
Glass fiber reinforced foil kraft laminate, factory applied to insulation. Maximum permeance of .02 perms and minimum beach puncture resistance of 25 units.

INSULATION INSERTS AND PIPE SHIELDS

Manufacturers: B-Line, Pipe Shields, Value Engineered Products

Construct inserts with calcium silicate or polyisocyanurate (service temperatures below 300 degrees F only), minimum 140 psi compressive strength. Piping 12" and larger, supplement with high density 600 psi structural calcium silicate insert. Provide galvanized steel shield. Insert and shield to be minimum 180 degree coverage on bottom supported piping and full 360 degree coverage on clamped piping. On roller mounted piping and piping designed to slide on support, provide additional load distribution steel plate.

Where contractor proposes shop/site fabricated inserts and shields, submit schedule of materials, thicknesses, gauges and lengths for each pipe size to demonstrate equivalency to pre-engineered/premanufactured product described above. On low temperature systems, high density rigid polyisocyanurate may be substituted for calcium silicate provided insert and shield length and shield gauge are increased to compensate for lower insulation compressive strength.

Precompressed 20# density molded fiberglass blocks, Hamfab or equal, of the same thickness as adjacent insulation may be substituted for calcium silicate inserts with one 1"x6" block for piping through 2-1/2" and three 1"x6" blocks for piping through 4". Submit shield schedule to demonstrate equivalency to pre-engineered/premanufactured product described above.

Wood blocks will not be accepted.

ACCESSORIES

All products shall be compatible with surfaces and materials on which they are applied, and be suitable for use at operating temperatures of the systems to which they are applied.

Adhesives, sealants, and protective finishes shall be as recommended by insulation manufacturer for applications specified.

Insulation bands to be 3/4 inch wide, constructed of aluminum or stainless steel. Minimum thickness to be .015 inch for aluminum and .010 inch for stainless steel.

Tack fasteners to be stainless steel ring grooved shank tacks.

Staples to be clinch style.

Insulating cement to be ANSI/ASTM C195, hydraulic setting mineral wool.

Finishing cement to be ASTM C449.

Fibrous glass or canvas fabric reinforcing shall have a minimum untreated weight of 6 oz./sq. yd.

Bedding compounds to be non-shrinking and permanently flexible.

Vapor barrier coatings to have maximum applied water vapor permeance of .05 perms.

Fungicidal water base coating (Foster 40-20 or equal) to be compatible with vapor barrier coating.

P A R T 3 - E X E C U T I O N

EXAMINATION

Verify that all piping, equipment, and ductwork are tested and approved prior to installing insulation. Do not insulate systems until testing and inspection procedures are completed.

Verify that all surfaces are clean, dry and without foreign material before applying insulation materials.

Fix and repair any existing insulation damaged during demolition and new construction. Provide continuous insulation and locations where existing walls/partitions have be removed and existing insulation was not previously continuous thru removed wall/partition.

INSTALLATION

All materials shall be installed by skilled labor regularly engaged in this type of work. All materials shall be installed in strict accordance with manufacturer's recommendations, building codes, and industry standards. Do not install products when the ambient temperature or conditions are not consistent with the manufacturer's recommendations. Surfaces to be insulated must be clean and dry.

Locate insulation and cover seams in the least visible location. All surface finishes shall be extended in such a manner as to protect all raw edges, ends and surfaces of insulation.

Install insulation with smooth and even surfaces. Poorly fitted joints or use of filler in voids will not be accepted. Provide neatly beveled and coated terminations at all nameplates, uninsulated fittings, or at other locations where insulation terminates.

Install fabric reinforcing without wrinkles. Overlap seams a minimum of 2 inches.

Use full length material (as delivered from manufacturer) wherever possible. Scrap piecing of insulation or pieces cut undersize and stretched to fit will not be accepted.

All pipe and duct insulation shall be continuous through walls, ceiling or floor openings and through sleeves except where firestop or firesafing materials are required. Vapor barriers shall be maintained continuous through all penetrations.

Provide a continuous unbroken moisture vapor barrier on insulation applied to systems noted below. Attachments to cold surfaces shall be insulated and vapor sealed to prevent condensation.

Provide a complete vapor barrier for insulation on the following systems:

- Insulated Duct
- Equipment, ductwork or piping with a surface temperature below 65 degrees F

PROTECTIVE JACKET INSTALLATION

SELF-ADHERING JACKETS (SAJ):

Install according to manufacturer's recommendations. Cut allowing minimum 4" overlap on ends and 6" on longitudinal joints. Align parallel to surface. Remove release paper and press flat to surface to avoid wrinkles. Rub entire surface for full adhesion and sealing at joint overlaps. On exterior applications, provide a bead of compatible caulk along exposed edges.

Piping with self-adhering (SAJ) jackets shall have elbows, fittings, valves and butt joints wrapped with 2 layers of vapor retarding tape. Piping with a PVC jacket (PFJ) installed over the self-adhering (SAJ) jacket may be provided with a single, lapped layer of vapor retarding tape for elbows, fittings and valves under the PVC jacket. Vapor retarding tape shall be compatible with the jacket material used.

VAPOR RETARDING JACKETS (VRJ):

Piping with vapor retarding (VRJ) jackets shall have elbows, fittings, valves and butt joints wrapped with 2 layers of vapor retarding tape. Piping with a PVC jacket (PFJ) installed over the vapor retarding (VRJ) jackets may be provided with a single, lapped layer of vapor retarding tape for elbows, fittings and valves under the PVC jacket. Vapor retarding tape shall be compatible with the jacket material used.

PVC FITTING COVERS AND JACKETS (PFJ):

Lap seams and joints a minimum of 2 inches and continuously seal PVC with welding solvent recommended by jacket manufacturer. Lap slip joint ends 4" without fasteners where required to absorb expansion and contraction. For sections where vapor barrier is not required and jacket requires routine removal, tack fasteners may be used. Secure PVC fitting covers with tack fasteners. For systems requiring a vapor barrier, apply a 1-1/2" band of mastic over ends, throat, seams and penetrations.

PIPING, VALVE, AND FITTING INSULATION

GENERAL:

Install insulation with butt joints and longitudinal seams closed tightly. Provide minimum 2" lap on jacket seams and 2" tape on butt joints, firmly cemented with lap adhesive unless otherwise noted. Additionally secure with staples along seams and butt joints. Coat staples, longitudinal and transverse seams with vapor barrier mastic on systems requiring vapor barrier.

Install insulation continuous through pipe hangers and supports with hangers and supports on the exterior of insulation. Where a vapor barrier is not required or where roller hangers are not being used, hangers and supports may be attached directly to piping with insulation completely covering hanger or support and jacket sealed at support rod penetration. Where riser clamps are required to be attached directly to piping requiring vapor barrier, extend insulation and vapor barrier jacketing/coating around riser clamp.

Where insulated piping is installed on hangers and supports, the insulation shall be installed continuous through the hangers and supports. High density inserts shall be provided as required to prevent the weight of the piping from crushing the insulation. Pipe shields are required at all support locations. The insulation shall not be notched or cut to accommodate the supporting channels.

Fully insulate all reheat coil piping, fittings and valves (with the exception of unions) up to coil connection to prevent condensation when coil is inactive during cooling season. Provide a vapor proof seal between the pipe insulation and the insulated coil casing.

INSULATION INSERTS AND PIPE SHIELDS:

Provide pipe shields at all hanger and support locations. Rigid insulation inserts shall be installed between the pipe and the insulation shields. Quantity and placement of inserts shall be according to the manufacturer's installation instructions, however the inserts shall be no less than 12" in length. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed as required for system.

Provide insulation inserts and pipe shields at all hanger and support locations. Inserts may be omitted on 3/4" and smaller copper piping provided 12" long 22 gauge pipe shields are used.

FITTINGS AND VALVES:
Fittings, valves, unions, flanges, couplings and specialties may be insulated with factory molded or built up insulation of the same thickness as adjoining insulation. Where the ambient temperature exceeds 150 degrees F, cover insulation with fabric reinforcing and mastic. Where the ambient temperatures do not exceed 150 degrees, furnish and install PVC fitting covers.

ELASTOMERIC AND POLYOLEFIN:
Where practical, slip insulation on piping during pipe installation when pipe ends are open. Miter cut fittings allowing sufficient length to prevent stretching. Completely seal seams and joints for vapor tight installation. For elastomeric insulation, apply full bed of adhesive to both surfaces. For polyeolefin, seal factory preglued seams with roller and field seams and joints with full bed of hot melt polyolefin glue to both surfaces. Cover elastomeric insulation on systems operating below 40 degrees F with vapor barrier mastic.

PIPING PROTECTIVE JACKETS
In addition to the jackets specified in the pipe insulation schedule below the following protective jackets are required:

Provide a protective PVC jacket (PFJ) for the following insulated piping:
- Piping exposed in finished locations

PIPE INSULATION SCHEDULE:
Provide insulation on new and existing remodeled piping as indicated in the following schedule:

Service	**Insulation**	**Jacket**	**Insulation Thickness by Pipe Size**			
			≤ 1-1/4”	**1-1/2"**	**2" to 4”**	**4" to 6"**
Heating Hot Water	Rigid Fiberglass	ASJ	1.5"	1.5"	2"	2"

The following piping and fittings are not to be insulated:
- Hot water piping inside radiation, convector, or cabinet heater enclosures
- Piping unions for systems not requiring a vapor barrier

For systems with fluid temperatures 65° F or less, furnish and install removable elastomeric insulation covers, plugs or caps for all mechanical equipment and devices that require access by balancing contractors or service and maintenance personnel. Examples include but are not limited to: flow sensing devices, circuit setters, manual ball valve air vents, drain valves, blowdown valves, pressure/temperature test plugs, grease fittings, pump bearing caps, equipment labels, etc. Covers shall be tight fitting to ensure a complete vapor barrier.

DUCT INSULATION
GENERAL:
Secure flexible duct insulation on sides and bottom of ductwork over 24" wide and all rigid duct insulation with weld pins. Space fasteners 18” on center or less as required to prevent sagging.

Secure rigid board insulation to ductwork with weld pins. Apply insulation with joints firmly butted as close as possible to the equipment surface. Pins shall be located a maximum of 3” from each edge and spaced no greater than 12” on center.

Install weld pins without damage to the interior galvanized surface of the duct. Clip pins back to washer and cover penetrations with tape of same material as jacket. Firmly butt seams and joints and cover with 4” tape of same material as jacket. Seal tape with plastic applicator and secure with staples. All joints, seams, edges and penetrations to be fully vapor sealed.

Stop and point insulation around access doors and damper operators to allow operation without disturbing insulation or jacket material.

External supply duct insulation is not required where ductwork contains continuous 1” acoustical liner. Provide 4” overlap of external insulation over ends of acoustically lined sections.

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.

Where insulated low temperature (below 45ºF) 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.

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.

DUCT INSULATION SCHEDULE:
Provide duct insulation on new and existing remodeled ductwork in the following schedule:

Service	**Insulation Type**	**Jacket**	**Insulation Thickness**
Exposed supply ducts*	Rigid Fiberglass	FSJ	2"
Concealed supply ducts	Flexible Fiberglass	FSJ	1-1/2"

* Exposed supply branch ducts located in the space they are serving do not require insulation. Exposed supply main ducts running through spaces they serve shall be insulated as exposed supply ducts scheduled above.

EQUIPMENT INSULATION SCHEDULE:
Provide equipment insulation as follows:

Equipment	**Insulation**	**Jacket**	**Thickness Type**
Reheat coil casing in exposed supply ducts	Rigid Fiberglass	FSJ	2"
Reheat coil casing in concealed supply ducts	Flexible Fiberglass	FSJ	1-1/2"

END OF SECTION

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SECTION 23 09 23
DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

P A R T 1 - G E N E R A L

SCOPE

The existing building utilizes an Alterton direct digital control (DDC) system. This project will add (18) new air terminal units with DDC control that will be integrated into the existing building Alerton DDC system. This project shall provide:

- All new controllers required to integrate (18) new VAV air terminals into the existing building automation system.
- (18) new hot water reheat DDC temperature control valves for new VAV air terminals.
- (15) new hot water DDC temperature control valves for existing hot water convectors.
- (1) new space temperature sensor in new Data / IT Closet.
- (1) new reverse acting thermostat for Data/IT Closet fan.
- All control wiring (low and line voltage) for a complete operating system.
- Update of existing 1st floor City County Building automation graphics to include new air terminals, convectors, etc. associated with this project.

All new air terminals and air terminal controls shall be integrated into the Alertron DDC system.

All new controllers, control wiring and temperature control valves shall follow current City County Building protocols to provide building continuity in regards to controllers, wiring and equipment.

Work in this section includes Direct Digital Control (DDC) panels, main communication trunk, software programming, and other equipment and accessories necessary to constitute a complete Direct Digital Control (DDC) system.

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Submittals
- Operation and Maintenance Data
- Material Delivery and Storage

PART 2 - PRODUCTS
- General
- Control Valves
- Thermostats

PART 3 - EXECUTION
- General
- Installation
- Sequence of Operation
- Owner Training
- Points List

RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

Section 01 91 13 – Commissioning Requirements

REFERENCE

Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS

FCC Part 15, Subpart J, Class A - Digital Electronic Equipment to Radio Communication Interference

QUALITY ASSURANCE

APPROVED MANUFACTURER:
Alterton.

INSTALLER:
The installer shall be specialized and experienced in Alterton DDC control systems and installation for not less than 5 years. All engineering work shall be done by qualified employees of Alterton, or qualified employees of an Alerton Authorized Representative that provides engineering and commissioning of Alerton control equipment. Where installing contractor is an authorized representative of Alerton, submit written confirmation of such authorization. Indicate in letter of authorization that the installing contractor has successfully completed all necessary training required for the engineering, installation, and commissioning of equipment and systems to be provided for the project and that such authorization has been in effect for a period of not less than three years. The letter of authorization should also indicate that the installing contractor is authorized to install Alerton DDC equipment at the project location at the time the project is bid. Installation of the equipment shall be done by qualified mechanics and/or electricians in the direct employ or be directly subcontracted and under the supervision of Alerton or Authorized Alerton Representative. The contractor providing and installing the equipment under this specification section shall be the same contractor providing and installing equipment under the 23 09 14 specification section.

The owners preferred Alterton temperature control system installer is:

Environmental Systems Inc.
Brookfield, Wisconsin Office
3410 Gateway Road
Brookfield, WI 53045
Office: 262-544-8860
Facsimile: 262-544-0783
Contact: Jerry Gitlewski

RESPONSE TIME:
During warrantee period, three (3) hours or less, 24-hours/day, 7 days/week.

ELECTRICAL STANDARDS:
Provide electrical products, which have been tested, listed and labeled by Underwriters' Laboratories (UL) and comply with NEMA standards.

DDC Standards: DDC manufacturer shall provide written proof with shop drawings that the equipment being provided is in compliance with F.C.C. rules governing the control of interference caused by Digital Electronic Equipment to Radio Communications (Part 15, Subpart J, Class A).

SUBMITTALS
Provide submittals on all DDC control work.

Details of construction, layout, and location of each temperature control panel within the building, including instruments location in panel and labeling. Indicate which piece of mechanical equipment is associated with each controller and what area within the building is being served by that equipment. For terminal unit control, provide a room schedule that would list mechanical equipment tag, room number of space served, address of DDC controller, and any other pertinent information required for service.

A complete description of each control sequence for equipment that is not controlled by direct digital controls. Direct digital controlled equipment control sequences will be provided by the DDC control contractor.

PRODUCT DATA
Submit manufacturer's specifications for each control device furnished, including installation instructions and startup instructions. General catalog sheets showing a series of the same device is not acceptable unless the specific model is clearly marked. Annotated software program documentation shall be submitted for system sequences, along with descriptive narratives of the sequence of operation of the entire system involved. Submit wiring diagram for each electrical control device along with other details required to demonstrate that the system has been coordinated and will function as a system.

MAINTENANCE DATA
Submit maintenance data and spare parts lists for each control device. Include this data in maintenance manual.

RECORD DRAWINGS
Provide as-built record control drawings, including sequences, for the installation of all DDC controls.

OPERATION AND MAINTENANCE DATA
All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

MATERIAL DELIVERY AND STORAGE
Provide factory shipping cartons for each piece of equipment and control device. This contractor is responsible for storage of equipment and materials inside and protected from the weather.

P A R T 2 - P R O D U C T S

GENERAL
Provide DDC control and actuation to accomplish Sequence of Operation (indicated below) and DDC Points list. Provide all controllers, temperature control panels, wiring, etc. for a complete installation.

Controls installed as part of this project shall be fully compatible with existing DDC controls located within the facility.

Provide updated DDC/BAS graphics reflecting new work and sequences of control.

Provide all required installation, termination, wiring, power, graphics and programming for a complete operating system.

CONTROL VALVES
Provide all control valves as shown on the plans/details and as required to perform functions specified. Spring ranges must be selected to prevent overlap of operation and simultaneous heating and cooling.

Size operators to allow smooth and positive operation of devices served and to provide sufficient torque capacity for tight shutoff against system temperatures and pressure encountered. Use fully proportional actuators with 0-10VDC inputs and zero and span adjustments unless specified otherwise. If TriState with feedback is specified, valve position shall be fed back to the controller and controller shall position valve based on this feedback. Electric actuators, for applications other than terminal units, shall be provided with a manual override capability. All electric actuators shall be provided with a visible position indicator.

All power required for electric actuation shall be provided by this contractor if it is not able to be directly provided from the DDC controller.

Provide operators that are full proportioning or two-position, as required for specified sequence of operation.

Provide operators with linkages and brackets for mounting on device served.

All valves unless specifically noted on the plans or indicated below shall be globe style valves.

VALVE SERVING	**TYPE** Globe Butterfly (BF) Ball Press Independent Ball (PI Ball)	**SIGNAL** 0-10 VDC TriState (24VAC) 2-Position Elect Pneumatic (Pneu)	**SPRING RETURN REQUIRED** Yes No	**FAIL POSITION** Open (thru Coil) Closed (bypass Coil) Last Position
Reheat Coil or Radiation	Globe or Ball	0-10 VDC or TriState w/feedback	No	Last Position

Use equal percentage valves for two-way control valves; size for a pressure drop not less than 4 psi or more than 6 psi. Note: For low flows, the required minimum Cv size will result in lower pressure drop than 4 psi.

Globe valves 2" and smaller: Cast bronze or forged brass body, brass plug and brass or stainless steel seat, stainless steel stem, screwed ends, suitable for use on water systems at 150 psig and 240° F. Seat leakage with actuator supplied will meet ANSI class IV leakage (0.01%). For globe valves that are specified to fail in place, valves shall be open when the stem is up. Only the following globe valve body styles will be acceptable for terminal unit control: Siemens Powermite 599 VF Series (599 VE Series Zone Valves are not acceptable), Invensys VB7200 Series, Johnson Controls VG7000 Series, and Honeywell V5011/V5013 Series. Minimum size for globe valves shall be 1.5 Cv.

THERMOSTATS

Thermostats shall match existing thermostats (finish and functionality) located in adjacent areas of the City County Building.

P A R T 3 - E X E C U T I O N

GENERAL

All electronic work required as an integral part of the Direct Digital Control system work is the responsibility of this contractor.

This contractor shall provide all labor, materials, engineering, software, permits, tools, checkout and certificates required to install a complete Direct Digital Control system as herein specified.

This Direct Digital Control system as herein specified shall be fully integrated and completely installed by this section. It shall include all required computer CPU software and hardware. Include the engineering, installation, supervision, calibration, software programming, and checkout necessary for a fully operational system.

INSTALLATION

All work and materials are to conform in every detail to the rules and requirements of the National Electrical Code and present manufacturing standards. All material shall be UL approved.

Install system and materials in accordance with manufacturer's instructions, rough-in drawings and details on drawings.

Any line voltage wiring to be by this contractor.

Control panels serving equipment fed by emergency power shall also be served by emergency power.

Label all control devices with the exception of dampers, valves, and terminal unit devices with permanent printed labels that correspond to control drawings. Temperature control junction and pullboxes shall be identified utilizing spray painted green covers. Other electrical system identification shall follow the 26 05 53 specification.

All control devices and electrical boxes mounted on insulated ductwork shall be mounted over the insulation. Provide mounting stand-offs where necessary for adequate support. Cutting and removal of insulation to mount devices directly on ductwork is not acceptable. This contractor shall coordinate with the insulation contractor to provide for continuous insulation of ductwork.

Provide all electrical relays and wiring, line and low voltage, for control systems, devices and components. Install all high voltage and low voltage wiring (includes low voltage cable) in rigid metal conduit. All conduit must be installed in accordance with electrical sections (Division 26) of this specification and the National Electrical code.

Conduit shall be a minimum of 1/2 " for low voltage control provided the pipe fill does not exceed 40%.

Minimum low voltage wiring gauge to be 18 AWG for outputs and 20 AWG for inputs. All low voltage wiring to be stranded.

Low voltage wiring can be run without conduit above accessible lay-in tile ceilings. All wiring in mechanical rooms, above inaccessible hard ceilings, exterior locations, and in any exposed areas, and in all other locations should be in conduit. Wire for wall sensors must be run in conduit. Wiring for radiation valves shall be run in conduit where routed through walls.

Where wiring is installed free-air, installation shall consider the following:

- Wiring shall utilize the cable tray wherever possible.
- Wiring shall run at right angles and be kept clear of other trades work.
- Wiring shall be supported utilizing "J" or "Bridal-type" steel mounting rings anchored to ceiling concrete, piping supports, walls above ceiling or structural steel beams. Mounting rings shall be of open design (not a closed loop) to allow additional wire to be strung without being threaded through the ring. For mounting rings that do not completely surround the wire, attach the wire to the mounting ring with a strap.
- Supports shall be spaced at a maximum 4-foot interval unless limited by building construction. If wiring "sag" at mid-span exceeds 6-inches; another support shall be used.
- Wiring shall never be laid directly on the ceiling grid or attached in any manner to the ceiling grid wires.
- Wall penetrations shall be sleeved.

Wiring shall not be attached to existing cabling, existing tubing, plumbing or steam piping, ductwork, ceiling supports or electrical or communications conduit.

Mount control panels adjacent to associated equipment on vibration-free walls or free-standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face.

Provide as-built control drawings of all systems served by each local panel in a location adjacent to or inside of panel cover. Provide a protective cover or envelope for drawings.

Provide all necessary routers and or repeaters to accomplish connection to the BAN via the panel-mounted port provided.

All tubing, cable and individual wiring is to be permanently tagged, with numbers corresponding with "Record Drawings", spares are to be labelled as "Spare".

Provide technician to work with air balancing contractor and/or provide balancing contractor with necessary hardware to over-ride DDC controllers for air balancing.

Provide documentation to demonstrate that all points, input and output, have been checked out and verified operational, note any points not operating properly with notation of reason.

SEQUENCE OF OPERATION

<u>VARIABLE AIR VOLUME TERMINALS WITH HOT WATER REHEAT</u>

Systems consist of:

- Variable air volume terminal
- Hot water reheat coil with 2-way temperature control valve.
- DDC space sensor.
- Lighting Occupancy Sensor (Sensor provided and installed by electrical contractor)

Provide all line and low voltage wiring for a complete operating system.

Provide a DDC space temperature sensor to control, in sequence, a modulating electronic control valve for the hot water reheat coil and actuator for terminal air flow. When space temperature is below setpoint, the air terminal damper shall modulate toward the cooling minimum flow position. After the air terminal damper is at its minimum flow, the hot water valve shall modulate open to maintain space temperature. If the air terminal has a heating airflow, the hot water control valve and air terminal shall open in parallel.

The reverse shall occur when space temperature is below setpoint. The heating coil valve shall be commanded closed whenever the associated AHU is off. Provide a discharge air temperature sensor for monitoring purposes.

Each space temperature sensor shall have a manual override button that shall index the space to the occupied mode for a period of two hours (adj.). If an occupancy sensor is specified, it shall index the terminal unit DDC controller to occupied mode for a minimum of 30 minutes (adj.).

Provide separate adjustable cooling and heating setpoints for both the occupied and unoccupied modes. When the space temperature is between the heating and cooling setpoints, the heating valve shall be closed and the airflow at heating and cooling minimum flow.

Occupancy sensors will be provided by the Division 26 contractor. Provide wiring from all occupancy sensor contacts to building automation system for space occupied/unoccupied control. When the occupancy sensor signals the zone is unoccupied, the minimum flow setpoint shall be zero CFM (adj.) and the heating and cooling temperature setpoints will be maintained at either the occupied or unoccupied heating and cooling setpoints as defined by the weekly schedule (grouped or individually). When the occupancy sensor signals the zone is occupied, the occupied minimum flow setpoint shall be as scheduled and the occupied heating and cooling temperature setpoints shall be maintained regardless of the weekly schedule. All programming for the above sequence shall reside in the terminal unit controller and a supervisory controller shall not be required to reset any flow or temperature setpoints based on the occupancy sensor.

Where there are multiple occupancy sensors associated with a VAV zone that serves multiple spaces, all occupancy sensors must be "unoccupied" for the air terminal to move to zero airflow setpoint.

VARIABLE AIR VOLUME TERMINALS WITH HOT WATER REHEAT AND PERIMETER RADIATION

Systems consist of:

- Variable air volume terminal
- Hot water reheat coil with 2-way temperature control valve.
- Existing hot water convector with new DDC control valve and actuator
- DDC discharge air sensor.
- DDC space sensor.
- Lighting Occupancy Sensor (Sensor provided and installed by electrical contractor)

Provide all line and low voltage wiring for a complete operating system.

Mount discharge air temperature sensor a minimum of 3 duct diameters downstream of reheat coil

Provide a DDC space temperature sensor to control, in sequence, a modulating electronic control valve for the hot water reheat coil and actuator for terminal air flow. When space temperature is below setpoint, the air terminal damper shall modulate toward the cooling minimum flow position. After the air terminal damper is at its minimum flow, the hot water reheat valve and perimeter radiation valve shall modulate open in parallel to maintain space temperature..

The reverse shall occur when space temperature is below setpoint.

The heating coil valves shall be commanded closed whenever the associated AHU is off. Provide a discharge air temperature sensor for monitoring purposes.

Each space temperature sensor shall have a manual override button that shall index the space to the occupied mode for a period of two hours (adj.). If an occupancy sensor is specified, it shall index the terminal unit DDC controller to occupied mode for a minimum of 30 minutes (adj.).

Provide separate adjustable cooling and heating setpoints for both the occupied and unoccupied modes. When the space temperature is between the heating and cooling setpoints, the heating valve shall be closed and the airflow at heating and cooling minimum flow.

Occupancy sensors will be provided by the Division 26 contractor. Provide wiring from select occupancy sensor contacts to building automation system for space occupied/unoccupied control. When the occupancy sensor signals the zone is unoccupied, the terminal airflow shall go to minimum flow setpoint (adj.) and the heating and cooling temperature setpoints will be maintained at either the occupied or unoccupied heating and cooling setpoints as defined by the weekly schedule. When the occupancy sensor signals the zone is occupied, the occupied minimum flow setpoint shall be as scheduled and the occupied heating and cooling temperature setpoints shall be maintained regardless of the weekly schedule. All programming for the above sequence shall reside in the terminal unit controller and a supervisory controller shall not be required to reset any flow or temperature setpoints based on the occupancy sensor.

The following VAV terminals shall be integrated with occupancy sensor control: VAV-1-1, VAV-1-3, VAV-1-5, VAV-1-9, VAV-1-14, VAV-1-15, VAV-1-16, VAV-1-17.

TRANSER FAN (TF-1)

Systems consist of:

- Ceiling mounted transfer fan.
- DDC space sensor.
- Reverse acting thermostat.

On a rise in space temperature above setpoint, the fan shall energize. Upon a drop in space temperature below setpoint, the fan shall de-energize.

Provide DDC space temperature sensor in space for BAS to monitor and alarm on space temperature.

OWNER TRAINING

Provide factory authorized representative and/or field personnel knowledgeable with the operations, maintenance and troubleshooting of the system and/or components defined within this section for a minimum period of 2 hours.

Provide two follow-up visits for troubleshooting and instruction, one six months after substantial completion and the other at the end of the warranty period. Length of each visit to be not less than 2 hours or the time necessary to provide required information and complete troubleshooting and inspection activity for all controls.

END OF SECTION

DDC INPUT / OUTPUT SUMMARY TABLE

PROJECT:
CCB Tenant Improvements - First Floor

LOCATION:
Madison, WI

Air Terminal Units & Data / IT Closet

HARDWARE

POINT DESCRIPTION	Control Relay	24VAC	Contactor	2-Pos Actuator	Tri-State Actuator	Duration Adjust Actuator	4-20 mA	0-10 VDC	Current Sensing Switch	Control Relay Contact	Switch Closure	Auxiliary Contact	Diff Pressure Switch	Flow Switch	Temperature	Relative Humidity	Differential Pressure	Gauge Pressure	Static Pressure	Flow
	OUTPUT – DIGITAL				OUTPUT – ANALOG				INPUT – DIGITAL						INPUT – ANALOG					
AIR TERMINALS																				
Zone Temperature															X					
Temperature Setpoint Adjust																X				
Unnocupied Override Button											X									
Occupancy Sensor												X								
Supply Air Damper [1 & 2]					X	X	X	X										X		
Supply Air Flow																				X
Discharge Air Temperature															X					
Reheat Valve [1]					X	X	X	X												
Perimeter Radiation Valve [1]					X	X	X	X												
DATA / IT CLOSET																				
Space Temperature															X					

SOFTWARE

POINT DESCRIPTION	Equipment Status	Maintenance	Pressure	High Limit	Low Limit			Day/Night Setback	Demand Limiting	Dial-up I/O	Duty Cycling	Optimum Start/Stop	Scheduled Start/Stop	Totalization	Trend		Equipment Integration	Fire Alarm Integration	Security/Access Integration	Elect PQM Integration	Boiler Integeration	Dry-bulb Economizer	HW/OA Reset	OA Lockout	Smoke Control	Fire Alarm Override	Comments
	ALARMS – DIGITAL			ALARMS – ANALOG				ENERGY MANAGEMENT SYSTEM FUNCTIONS																			
AIR TERMINALS																											
Zone Temperature				X	X										X												
Temperature Setpoint Adjust																											Integral w/Sensor
Unnocupied Override Button																											Integral w/Sensor
Occupancy Sensor																											
Supply Air Damper [1 & 2]																											
Supply Air Flow															X												
Discharge Air Temperature															X												
Reheat Valve [1]															X												
Perimeter Radiation Valve [1]															X												
DATA / IT CLOSET																											
Space Temperature		X		X	X										X												

Notes:

1. Analog outputs must utilize a calculated proportional command from software. Actual output can be any type but floating outputs shall have feedback from the acutator so actual actuator position is known.
2. Damper actuators can utilize stepper type motors.

SECTION 23 21 13
HYDRONIC PIPING

P A R T 1 - G E N E R A L

SCOPE
This section contains specifications for all HVAC hydronic pipe and pipe fittings for this project. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Shop Drawings
- Quality Assurance
- Delivery, Storage, and Handling
- Design Criteria
- Welder Qualifications

PART 2 - PRODUCTS
- Heating Hot Water
- Cooling Coil Condensate
- Unions and Flanges
- Gaskets
- Unions and Flanges
- Mechanical Grooved Pipe Connections

PART 3 - EXECUTION
- Preparation
- Erection
- Welded Pipe Joints
- Threaded Pipe Joints
- Mechanical Grooved Pipe Connections
- Copper Pipe Joints
- Water Systems
- Cooling Coil Condensate
- Unions and Flanges
- Gaskets
- Piping System Leak Tests
- Hydronic Piping System Flushing
- Piping System Test Report

RELATED WORK
Section 01 91 13 – Commissioning Requirements
Section 23 05 23 - General-Duty Valves for HVAC Piping
Section 23 05 15 - Piping Specialties
Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
Section 23 07 00 - HVAC Insulation
Section 23 25 00 - HVAC Water Treatment.

REFERENCE
Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS

ANSI B16.3	Malleable Iron Threaded Fittings
ANSI B16.4	Cast Iron Threaded Fittings
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.22	Wrought Copper and Wrought Copper Alloy Solder Joint Pressure Fittings
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
ASTM A105	Forgings, Carbon Steel, for Piping Components
ASTM A126	Gray Cast Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A181	Forgings, Carbon Steel for General Purpose Piping
ASTM A197	Cupola Malleable Iron
ASTM A234	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM B75	Seamless Copper Tube
ASTM B88	Seamless Copper Water Tube

SHOP DRAWINGS

Refer to division 1, General Conditions, Submittals.

Contractor shall submit schedule indicating the ASTM specification number of the pipe being proposed along with its type and grade and sufficient information to indicate the type and rating of fittings for each service.

TYPE F STEEL PIPE:
Statement from manufacturer on his letterhead that the pipe furnished meets the ASTM specification contained in this section.

TYPE E OR S STEEL PIPE:
Mill certification papers, also known as material test reports, for the pipe furnished for this project, in English. Heat numbers on these papers to match the heat numbers stencilled on the pipe. Chemical analysis indicated on the mill certification papers to meet or exceed the requirements of the referenced ASTM specification.

COPPER TUBE:
Statement from manufacturer on his letterhead that the pipe furnished meets the ASTM specification contained in this section.

QUALITY ASSURANCE

Order all Type E and Type S steel pipe with heat numbers rolled, stamped, or stenciled to each length or each bundle, depending on the size of the pipe, and in accordance with the appropriate ASTM specification.

Any installed material not meeting the specification requirements must be replaced with material that meets these specifications without additional cost to the Owner.

DELIVERY, STORAGE, AND HANDLING

Promptly inspect shipments to insure that the material is undamaged and complies with specifications.

Cover pipe to eliminate rust and corrosion while allowing sufficient ventilation to avoid condensation. Do not store materials directly on grade. Protect pipe, tube, and fitting ends so they are not damaged. Where end caps are provided or specified, take precautions so the caps remain in place. Protect fittings, flanges, and unions by storage inside or by durable, waterproof, above ground packaging.

Offsite storage agreements will not relieve the contractor from using proper storage techniques.

Storage and protection methods must allow inspection to verify products.

DESIGN CRITERIA

Use only new material, free of defects, rust and scale, and meeting the latest revision of ASTM specifications as listed in this specification.

Construct all piping for the highest pressures and temperatures in the respective system in accordance with ANSI B31, but not less than 125 psig unless specifically indicated otherwise.

Where weld fittings or mechanical grooved fittings are used, use only long radius elbows having a centerline radius of 1.5 pipe diameters.

Where ASTM A53 type F pipe is specified, ASTM A53 grade A type E or S, or ASTM A53 grade B type E or S may be substituted at Contractor's option. Where ASTM A53 grade A pipe is specified, ASTM A53 grade B pipe may be substituted at Contractor's option. Where the grade or type is not specified, Contractor may choose from those commercially available.

Where ASTM B88, type L hard temper copper tubing is specified, ASTM B88, type K hard temper copper tubing may be substituted at Contractor's option.

WELDER QUALIFICATIONS

Before any metallic welding is performed, the Contractor shall submit his Standard Welding Procedure Specifications, Procedure Qualification Records and Qualification Test Records for each Welder along with associated continuity records to demonstrate compliance with ASME Section IX, paragraph QW-322.

The Contractor shall maintain a complete set of welder qualification documents at the jobsite, including Test Records and Continunity Records for each welder.

The A/E or DFD reserves the right to test the work of any welder employed on the project, at the Contractor's expense. Testing will include a visual examination of the pipe and weld and may include radiography of any suspect welds. If the work of the welder is found to be unsatisfactory, the welder shall be prevented from doing further welding on the project. Any welds deemed unacceptable will be repaired at the contractor’s expense.

P A R T 2 - P R O D U C T S

HEATING HOT WATER

2" and Smaller: ASTM A53, type F, standard weight (schedule 40) black steel pipe with ASTM A126/ANSI B16.4, class 125, standard weight cast iron threaded fittings.

2-1/2" and Larger: ASTM A53, standard weight (schedule 40) black steel pipe with ASTM A234 grade WPB/ANSI B16.9 standard weight, seamless, carbon steel weld fittings.

Contractor may use ASTM B88 seamless, type L, hard temper copper tube with ANSI B16.22 wrought copper solder-joint fittings in lieu of steel pipe for all sizes. Mechanically formed tee fittings may be used in lieu of wrought copper solder-joint tee fittings for branch takeoff up to one-half (1/2) the diameter of the main.

COOLING COIL CONDENSATE

ASTM B88, type L hard temper copper tubing with ASTM B145/ANSI B16.23 cast red bronze or ASTM B75/ANSI B16.29 wrought solder-type drainage fittings.

UNIONS AND FLANGES

2" and Smaller: ASTM A197/ANSI B16.3 malleable iron unions with brass seats. Use black malleable iron on black steel piping and galvanized malleable iron on galvanized steel piping. Use ANSI B16.18 cast copper alloy unions on copper piping. Use unions of a pressure class equal to or higher than that specified for the fittings of the respective piping service but not less than 250 psi.

2-1/2" and Larger: ASTM A181 or A105, grade 1 hot forged steel flanges of threaded, welding and of a pressure class compatible with that specified for valves, piping specialties and fittings of the respective piping service. Flanges smaller than 2-1/2" may be used as needed for connecting to equipment and piping specialties. Use raised face flanges ANSI B16.5 for mating with other raised face flanges on equipment with flat ring or full face gaskets. Use ANSI B16.1 flat face flanges with full face gaskets for mating with other flat face flanges on equipment.

GASKETS
Water and Glycol Systems: Branded, compressed, non-asbestos sheet gaskets. Klingersil C4401, Garlock 3000, JM Clipper 978 or approved equal.

MECHANICAL GROOVED PIPE CONNECTIONS
Will not be allowed on this project.

P A R T 3 - E X E C U T I O N

ERECTION
Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be rejected and removed from the job site immediately. Excluding minor surface rust, piping that exhibits significant oxidation or corrosion will be rejected.

Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any item that is not clean. Remove all lose dirt, scale, oil, chips, burrs and other foreign material from the internal and external surfaces of all pipe and piping components prior to assembly, including debris associated with cutting, threading and welding.

During fabrication and assembly, remove slag and weld spatter from internal pipe surfaces at all joints by peening, chipping and wire brushing.

During construction, until system is fully operational, keep all openings in piping and equipment closed except when actual work is being performed on that item of the system. Use plugs, caps, blind flanges or other items designed for this purpose.

Furnish and install all flanges, caps, bypasses, drains, valves, etc. required to facilitate flushing and draining all heating and cooling system piping.

Install all piping parallel to building walls and ceilings and at heights which do not obstruct any portion of a window, doorway, stairway, or passageway. Where interferences develop in the field, offset or reroute piping as required to clear such interferences. In all cases, consult drawings for exact location of pipe spaces, ceiling heights, door and window openings, or other architectural details before installing piping.

Provide anchors, expansion joints, swing joints and/or expansion loops so that piping may expand and contract without damage to itself, equipment, or building.

Mitered ells, notched tees, and orange peel reducers are not acceptable. On threaded piping, bushings are not acceptable.

"Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.

Install drains throughout the systems to permit complete drainage.

Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment

Install all valves, control valves, and piping specialties, including items furnished by others, as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping services indicated in this section.

WELDED PIPE JOINTS
Make all welded joints by fusion welding in accordance with ASME Codes, ANSI B31, and State Codes where applicable.

All pipe welding shall be completed by Qualified Welders in accordance with the Contractor's Procedure Specifications.

Electrodes shall be Lincoln, or approved equal, with coating and diameter as recommended by the manufacturer for the type and thickness of work being done.

THREADED PIPE JOINTS
Use a Teflon based thread lubricant or Teflon tape when making joints; no hard setting pipe thread cement or caulking will be allowed.

MECHANICAL GROOVED PIPE CONNECTIONS
Are not allowed on this project.

COPPER PIPE JOINTS
Remove all slivers and burrs remaining from the cutting operation by reaming and filing both pipe surfaces. Clean fitting and tube with emery cloth or sandpaper. Remove residue from the cleaning operation, apply flux, and assemble joint. Use 95-5 solder or brazing to secure joint as specified for the specific piping service.

Where mechanically formed tee fittings are allowed, form mechanically extracted collars in a continuous operation, consisting of drilling a pilot hole and drawing out the tube surface to form a collar having a height of not less than three times the thickness of the tube wall. Use an adjustable collaring device. Notch and dimple the branch tube. Braze the joint, applying heat properly so that pipe and tee do not distort; remove distorted connections.

WATER SYSTEM
Run water mains level or pitch horizontal mains up 1 inch in 40 feet in the direction of flow. Install manual air vents at all high points where air may collect. If vent is not in an accessible location, extend air vent piping to the nearest code acceptable drain location with vent valve located at the drain.

Main branches and runouts to terminal equipment may be made at the top, top 45 degree, side, and/or bottom 45 degree of the main provided that there are drain valves suitably located for complete system drainage and manual air vents are located at all top and top 45 degree connections. Bottom connections are not acceptable unless approved by the DFD Mechanical Inspector.

Use top or top 45 degree connection to main for upfeed risers and bottom 45 degree connection to main for downfeed risers. Bottom connections are not acceptable.

Use a minimum of two elbows in each pipe line to a piece of terminal equipment to provide flexibility for expansion and contraction of the piping systems. Offset pipe connections at equipment to allow for service, such as removal of the terminal device.

Use eccentric fittings for changes in horizontal pipe sizes with the fittings installed for proper air venting. Concentric fittings may be used for changes in vertical pipe sizes.

COOLING COIL CONDENSATE
Trap each cooling coil drain pan connection with a trap seal of sufficient depth to prevent conditioned air from moving through the piping. Extend drain piping to nearest code approved drain location. Construct trap with plugged tee for cleanout purposes as detailed.

UNIONS AND FLANGES
Install a union or flange, as required, at each automatic control valve and at each piping specialty or piece of equipment which may require removal for maintenance, repair, or replacement. Where a valve is located at a piece of equipment, locate the flange or union connection on the equipment side of the valve. Concealed unions or flanges are not acceptable.

GASKETS

Store horizontally in cool, dry location and protect from sunlight, water and chemicals. Inspect flange surfaces for warping, radial scoring or heavy tool marks. Inspect fasteners, nuts and washers for burrs or cracks. Replace defective materials.

Align flanges parallel and perpendicular with bolt holes centered without using excessive force. Center gasket in opening. Lubricate fastener threads, nuts and washers with lubricant formulated for application.

Draw flanges together evenly to avoid pinching gasket. Tighten fasteners in cross pattern sequence (12 – 6 o'clock, 3 – 9 o'clock, etc.), one pass by hand and four passes by torque wrench at 30% full torque, 60% full torque and two passes at full torque per ASME B16.5.

PIPING SYSTEM LEAK TESTS

Verify that the piping system being tested is fully connected to all components and that all equipment is properly installed, wired, and ready for operation. If required for the additional pressure load under test, provide temporary restraints at expansion joints or isolate them during the test. Verify that hangers can withstand any additional weight load that may be imposed by the test.

Provide all piping, fittings, blind flanges, and equipment to perform the testing.

Conduct pressure test with test medium of air or water unless specifically indicated. Minimum test time is indicated in the table below; additional time may be necessary to conduct an examination for leakage. Each test must be witnessed by the A/E or an approved representative from the County. If leaks are found, repair the area with new materials and repeat the test; caulking will not be acceptable.

Do not insulate pipe until it has been successfully tested.

For hydrostatic tests, use clean water and remove all air from the piping being tested by means of air vents or loosening of flanges/unions. Measure and record test pressure at the high point in the system.

System	Pressure	Medium	Duration
Heating hot water	100 psig	Water	8 hr

All pressure tests are to be documented.

On piping that cannot be tested because of connection to an active line, provide temporary blind flanges and hydrostatically test new section of piping. After completion of test, remove temporary flanges and make final connections to piping. Die penetrate test pass weld or x-ray the piping that was not hydrostatically tested up to the active system.

HYDRONIC PIPING SYSTEM FLUSHING

All new heating hot water system piping shall be flushed thoroughly before the systems are put in to operation. Subseqent to executing the chemical cleaning processes specified in Section 23 25 00 – HVAC WATER TREATMENT, and prior to adding scale and corrosion inhibitors, flush all piping and components with a clean source of water until the discharge from the system is clean. Discharge shall be from drains provided at all low points in the piping, ends of headers and as otherwise necessary to flush and drain the entire system.

END OF SECTION

PIPING SYSTEM LEAKAGE TEST REPORT

Date Submitted: _____

Project Name: _____

Location: _____

Contractor: _____

☐ **HVAC** ☐ **Refrigeration** ☐ **Controls**

☐ **Power Plant** ☐ **Plumbing** ☐ **Sprinkler**

Test Medium: ☐ **Air** ☐ **Water** ☐ **Other** _____

Test performed per specification section No. _____

Specified Test Duration _____ **Hours** **Specified Test Pressure** _____ **PSIG**

System Identification: _____

Describe Location: _____

_____

Test Date: _____

Start Test Time: _____ **Initial Pressure:** _____ **PSIG**

Stop Test Time: _____ **Final Pressure:** _____ **PSIG**

Tested By: _____ **Witnessed By:** _____

Title: _____ **Title:** _____

Signed: _____ **Signed:** _____

Date: _____ **Date:** _____

Comments: _____

_____

_____

PIPING SYSTEM FLUSHING REPORT (revised 10/1/2012)

Date Submitted: _____

Project Name: _____

Location: _____

Contractor: _____

System Identification (check one):

❒ **Chilled Water** ❒ **Process Chilled Water** ❒ **Heat Reclaim**

❒ **Heating Hot Water** ❒ **Other** _____

Describe procedure: _____

_____

_____

_____

_____

_____

Flush Date: _____ **Start Time:** _____ **Stop Time:** _____

Pressure of Water Source: _____ **PSIG Describe water source and method of connection to source :**

_____

_____

_____

PIPING SYSTEM FLUSHING REPORT (page 2)

Flushed By: _____ **Witnessed By:** _____

Title: _____ **Title:** _____

Company: _____ **Signed:** _____

Signed: _____ **Date:** _____

Date: _____

Describe results: _____

_____

_____

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SECTION 23 25 00
HVAC WATER TREATMENT

P A R T 1 - G E N E R A L

SCOPE
This section includes specifications for chemical treatment of all new water piping. All new water piping, (branch and main piping) shall be cleaned. Included are the following topics:

PART 1 - GENERAL
- Scope
- Reference
- Related Work
- Quality Assurance
- Shop Drawings
- Operation and Maintenance Data
- Design Criteria
- Maintenance Service

PART 2 - PRODUCTS
- Manufacturers
- System Cleaner
- System Inhibitor
- Closed Water System Treatment

PART 3 - EXECUTION
- Preparation
- Cleaning Sequence
- Closed Water Systems

Appendix
- Pipe Cleaning and Treatment Report

REFERENCE
Applicable provisions of Division 1 shall govern work under this Section.

RELATED WORK
Section 01 91 13 – Commissioning Requirements
Section 23 05 15 - Piping Specialties

QUALITY ASSURANCE
Refer to division 1, General Conditions, Equals and Substitutions.

SHOP DRAWINGS
Refer to division 1, General Conditions, Submittals.

Required for all equipment and chemicals specified including data concerning dimensions, capacities, materials of construction, weights, operating sequence, composite wiring diagrams and appropriate identification. Chemical data to include the description of the chemical, its composition, its function, and the associated material safety data sheet.

OPERATION AND MAINTENANCE DATA
Provide for the services of the manufacturer's trained representative to approve the installation and instruct the user agency in the operation of each system.

Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

DESIGN CRITERIA
This project will be responsible for flushing and cleaning of all new hot water piping in the areas of renovation only. The existing hot water heating loop currently has a chemical treatment system installed.

All chemicals used must be compatible with the existing chemical treatment system
Provide electrical devices, motors, wiring, pumps, etc. to provide system cleaning and flushout.

MAINTENANCE SERVICE
Not required. The County currently contracts for chemical treatment.

P A R T 2 - P R O D U C T S

MANUFACTURERS
Betz Entac, Dearborn Div. - W. R. Grace & Co., Fremont Industries, Mitco Water Labs, Mogul Corporation, Nalco Chemical Co., Western Water Management, or approved equal.

SYSTEM CLEANER
Blend of organic alkaline penetrants, emulsifiers, surfactants and corrosion inhibitors that remove grease and petroleum products from the interior of piping systems. Cleaners that contain trisodium phosphate are specifically not acceptable.

All chemicals used must be compatible with the existing chemical treatment system

SYSTEM INHIBITOR
Scale and corrosion inhibitor consisting of boron nitrite, benzol thiazol, benzotriazole, mercapto-benzo-thiazole, and tolyltrizole silicates.

All chemicals used must be compatible with the existing chemical treatment system

CLOSED WATER SYSTEM TREATMENT
Sequestering agent to reduce deposits and adjust pH: polyphosphate.

Corrosion inhibitors: boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.

Conductivity enhancers: phosphates or phosphonates.

P A R T 3 - E X E C U T I O N

PREPARATION
Prior to cleaning, verify that systems are operational, filled, started, and vented. Use water meter to record capacity in each system.

Place terminal control valves in the full-open position

CLEANING SEQUENCE

GENERAL
Clean all new hot water mains and branch piping.

Systems are to be cleaned before they are used for any purpose except conduct pressure test before cleaning. Add cleaner to closed systems at concentrations as recommended by the manufacturer. Remove water filter elements from the system before starting circulation. For steam systems, fill boilers only, using the water and cleaner solution.

Use neutralizer agents on recommendation of the system cleaner supplier and approval of the Architect/Engineer.

Remove, clean, and replace strainer screens.

Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

Use Division of Facilities Development form to document system cleaning, flushing, and proper startup.

HOT WATER HEATING SYSTEMS

Add cleaner to the system water until the M alkalinity value is 250 above that of the initial fill water. Verify the M alkalinity level before and after the addition of the cleaner by means of chemical tests that are observed by the Owner's construction representative; include results of all tests in the Operating and Maintenance manuals. Apply heat while circulating, slowly raising temperature to 160°F and maintain for 12 hours minimum; vent all high points to assure 100% system circulation. Remove heat and circulate to 100°F or less; drain system as quickly as possible and refill with clean water. Circulate for 6 hours at design temperature, vent air at all high points, then drain. Refill with clean water and repeat until the system cleaner is removed and the M alkalinity level returns to normal. Remove and clean all strainers. Re-vent the system. Treat with scale and corrosion inhibitors before using the system for building heating or cooling.

CLOSED WATER CHEMICAL TREATMENT SYSTEM

The existing building chemical treatment system will be used for treating the existing, expanded hot water heating loop.

Prior to allowing the new hot water piping to be tied into the existing building hot water heating loop, all new piping must be pressure tested and cleaned as indicated above, with documentation (Pipe Cleaning and Treatment Report). Prior to allowing building hot water to circulate thru new piping and return back to the building, notify City County Building Facilities Personnel that the new piping connection is ready for use.

PIPE CLEANING AND TREATMENT REPORT

Date Submitted:_____

Project **Name:**_____
Location:_____
Contractor:_____

System Tested: **Hot Water**___ **Glycol Water**___ **Chilled Water**___ **Fuel Oil**____

System Volume:_____

Materials Used (Provide MSDS for each)

Cleaner:_____ **Quantity Used:**_____
Inhibitor:_____ **Quantity Used:**_____
Sequestering Agent:_____ **Quantity Used:**_____
Algaecide:_____ **Quantity Used:**_____
Neutralizer:_____ **Quantity Used:**_____

M Alkalinity

Prior to Cleaning:_____ **During Cleaning:**_____ **After Flushing:**_____

System Temperature

Prior to Cleaning:_____ **During Cleaning:**_____

Duration	**Date/Time Start**	**Date/Time Stop**
Initial Circulation	_____	_____
Draindown	_____	_____
System Refill	_____	_____
Final Circulation	_____	_____
Heating system Warmup	_____	_____

Component Checklist (Describe procedures performed at each)

Strainers:_____

Filters:_____

Vents:_____

Drains:_____

Traps:_____

Branch Lines:_____

Terminal Units:_____

AdditionalComments_____

END OF SECTION

SECTION 23 31 00
HVAC DUCTS and CASINGS

P A R T 1 - G E N E R A L

SCOPE

This section includes specifications for all duct systems used on this project. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Shop Drawings
- Design Criteria

PART 2 - PRODUCTS
- General
- Ductwork Pressure Class
- Materials
- High Pressure Ductwork (Pressure class 3 inch and over)
- Low Pressure Ductwork (Maximum 2 inch pressure class)
- Duct Sealant
- Gaskets

PART 3 - EXECUTION
- Installation
- Ductwork Support
- High Pressure Duct (Pressure class 3 inch and over)
- Low Pressure Duct (Maximum 2 inch pressure class)
- Cleaning
- Leakage Test

APPENDIX
- Duct Leakage Test Report

RELATED WORK

Section 01 91 13 – Commissioning Requirements
Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC
Section 23 33 00 – Air Duct Accessories

REFERENCE

Applicable provisions of Division 1 govern work under this Section.

REFERENCE STANDARDS

ASTM A90	Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles
ASTM A623	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
ASTM A527	Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality
ASTM 924	Standard Specification for General Requirements for Sheet Steel, Metallic-coated by the Hot-dip Method
ASTM C 1071	Specification for Fibrous Glass Duct Lining Insulation
ASTM C 411	Test Method for Hot Surface Performance of High Temperature Thermal Insulation
ASTM E 84	Test Method for Surface Burning Characteristics of Building Materials
ASTM C 1338	Test Method for Determining Fungal Resistance of Insulation Materials and Facings
ASTM G 21	Standard Practice for Determining Resistance of Synthetic Polymeric Materials

to

ASTM C 916 Standard Specification for Adhesives for Duct Thermal InsulationNFPA 90A Standard for the Installation of Air Conditioning and Ventilating Systems

UL 181	Standard for Safety for Factory Made Air Ducts and Air Connectors.
NAIMA	Fibrous Glass Duct Liner Standard

QUALITY ASSURANCE

Refer to division 1, General Conditions, Equals and Substitutions.

SHOP DRAWINGS

Refer to division 1, General Conditions, Submittals.

Include manufacturer's data and/or Contractor data for the following:

- Schedule of duct systems including material of construction, gauge, pressure class, system class, method of reinforcement, joint construction, fitting construction, and support methods, all with details as appropriate.
- Duct sealant and gasket material.
- Duct liner including data on thermal conductivity, air friction correction factor, and limitation on temperature and velocity.

DESIGN CRITERIA

Construct all ductwork to be free from vibration, chatter, objectionable pulsations and leakage under specified operating conditions.

Use material, weight, thickness, gauge, construction and installation methods as outlined in the following SMACNA publications, unless noted otherwise:

- HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition, 2005
- HVAC Air Duct Leakage Test Manual, 2nd Edition, 2012
- HVAC Systems - Duct Design, 4th Edition, 2006
- Rectangular Industrial Duct Construction Standard, 2nd Edition, 2004
- Round Industrial Duct Construction Standards, 2nd Edition, 1999

Use products which conform to NFPA 90A, possessing a flame spread rating of not over 25 and a smoke developed rating no higher than 50.

DELIVERY, STORAGE AND HANDLING

Promptly inspect shipments to ensure that Ductwork is undamaged and complies with the specification.

Protect Ductwork against damage.

Protect Ductwork by storing inside or by durable, waterproof, above ground packaging. Do not store material on grade. Protect Ductwork from dirt, dust, construction debris and foreign material. Where end caps/packaging are provided, take precautions so caps/packaging remain in place and free from damage.

Offsite storage agreements do not relieve the contractor from using proper storage techniques.

Storage and protection methods must allow inspection to verify products.

P A R T 2 - P R O D U C T S

GENERAL

All sheet metal used for construction of duct shall be 24 gauge or heavier except for round and spiral ductwork and spiral duct take-offs 12" and below may be 26 gauge where allowed in SMACNA HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition, 2005.

Duct sizes indicated on plans are net inside dimensions; where duct liner is specified, dimensions are net, inside of liner.

DUCTWORK PRESSURE CLASS

Minimum acceptable duct pressure class, for all ductwork except transfer ductwork, is 2 inch W.G. positive or negative, depending on the application. Transfer ductwork minimum acceptable duct pressure class is 1 inch W.G. positive or negative, depending on the application. Duct system pressure classes not indicated on the drawings to be as follows:

Supply duct upstream of VAV boxes	_____ 4 in. pressure class
Supply duct downstream of VAV terminals	_____ 2 in. pressure class
Transfer ducts	_____ 2 in. pressure class
Exhaust ducts	_____ 2 in. pressure class
Return ducts	_____ 3 in. pressure class

MATERIALS

GALVANIZED STEEL SHEET:

Use ASTM A 653 galvanized steel sheet of lock forming quality. Galvanized coating to be 1.25 ounces per square foot, both sides of sheet, G90 in accordance with ASTM A90. Provide "Paint Grip" finish or galvanneal sheetmetal for ductwork that will be painted.

ALUMINUM SHEET:

Use ANSI/ASTM B209 aluminum sheet, alloy 3003H-14, capable of double seaming without fracture.

HIGH PRESSURE DUCTWORK (Pressure class 3 inch and over)

Manufacturers: Ajax, Semco, United Sheet Metal, Sheet Metal Connectors or approved equal.

Machine formed round and/or flat oval spiral lock seam duct constructed of galvanized steel.

Rectangular high pressure duct using a transverse joint system as manufactured by Ductmate, Nexus, TDC, TDF, or approved equal, may be used at contractor's option. Duct to be flanged, gasketed and sealed.

Contractor fabricated ductwork meeting specified construction standards is acceptable with prior approval of Architect/Engineer. Submit construction details, a description of materials to be used, type of service, reinforcing methods, and sealing procedures.

Use a perforated inner liner on double wall high-pressure duct. Annular space between inner liner and outer duct to be filled with 1 inch glass fiber insulation.

Use cemented slip joints with 2 inch minimum overlap, flanged connections, or welded/brazed connections, unless noted otherwise for special applications. Prime coat welded joints.

Provide standard 90 degree conical tee takeoffs except for exhaust at velocities over 2000 feet per minute, use 45° lateral connections; straight taps or bullhead tees are not acceptable.

Internal bracing will not be accepted on ductwork below 48 inches.

Use turning vanes as specified in Section 23 33 12.

Provide bellmouth fittings or expanded fittings at each duct connection to air plenums.

Provide pressure relief fittings as indicated on the plans and/or details.

Transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence.

LOW PRESSURE DUCTWORK (Maximum 2 inch pressure class)

Fabricate and install ductwork in sizes indicated on the drawings and in accordance with SMACNA recommendations, except as modified below.

Construct so that all interior surfaces are smooth. Use slip and drive or flanged and bolted construction when fabricating rectangular ductwork. Use spiral lock seam construction when fabricating round spiral ductwork. Sheet metal screws may be used on duct hangers, transverse joints and other SMACNA approved locations if the screw does not extend more than 1/2 inch into the duct.

Use elbows and tees with a center line radius to width or diameter ratio of 1.5 wherever space permits. When a shorter radius must be used due to limited space, install single wall sheet metal splitter vanes in accordance with SMACNA publications, Type RE 3. Where space will not allow and the C value of the radius elbow, as given in SMACNA publications, exceeds 0.31, use rectangular elbows with turning vanes as specified in Section 23 33 00. Square throat-radius heel elbows will not be acceptable. Straight taps or bullhead tees are not acceptable.

Where rectangular elbows are used, provide turning vanes in accordance with Section 23 33 00.

Provide expanded take-offs or 45 degree entry fittings for branch duct connections with branch ductwork airflow velocities greater than 700 fpm. Square edge 90-degree take-off fittings or straight taps will not be accepted.

Button punch snaplock construction will not be accepted on aluminum ductwork.

Round ducts may be substituted for rectangular ducts if sized in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission of the Architect/Engineer.

Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

DUCT SEALANT

Manufacturer: 3M 800, 3M 900, H.B. Fuller/Foster, Hardcast, Hardcast Peal & Seal, Lockformer cold sealant, Mon-Eco Industries, United Sheet Metal, or approved equal. Silicone sealants are not allowed in any type of ductwork installation.

Install sealants in strict accordance with manufacturer's recommendations, paying special attention to temperature limitations. Allow sealant to fully cure before pressure testing of ductwork, or before startup of air handling systems.

GASKETS

2 INCH PRESSURE CLASS AND LOWER:
Soft neoprene or butyl gaskets in combination with duct sealant for flanged joints.

3 INCH PRESSURE CLASS AND HIGHER:
Butyl gaskets.

PART 3 - EXECUTION

INSTALLATION

Verify dimensions at the site, making field measurements and drawings necessary for fabrication and erection. Check plans showing work of other trades and consult with Architect in the event of any interference.

Make allowances for beams, pipes or other obstructions in building construction and for work of other contractors. Transform, divide or offset ducts as required, in accordance with SMACNA HVAC Duct Construction Standards, Figure 4-7, except do not reduce duct to less than six inches in any dimension and do not exceed an 8:1 aspect ratio. Where it is necessary to take pipes or similar obstructions through ducts, construct easement as indicated in SMACNA HVAC Duct Construction Standards, Figure 4-8, Fig. E. In all cases, seal to prevent air leakage. Pipes or similar obstructions may not pass through high pressure or fume exhaust ductwork.

Test openings for test and balance work will be provided under Section 23 05 93.

Provide frames constructed of angles or channels for coils, filters, dampers or other devices installed in duct systems, and make all connections to such equipment including equipment furnished by others. Secure frames with gaskets and screws or nut, bolts and washers.

Do not install ductwork through dedicated electrical rooms or spaces unless the ductwork is serving this room or space.

Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

Provide adequate access to ductwork for cleaning purposes.

Provide temporary capping of ductwork openings to prevent entry of dirt, dust and foreign material.

Protect diffusers, registers and grilles with plastic wrap or some other approved form of protection to maintain dirt and dust free and to prevent entry of dirt, dust and foreign material into the Ductwork.

During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

DUCTWORK SUPPORT

Support ductwork in accordance with SMACNA HVAC Duct Construction Standards, Figure 5-5, except supporting ductwork with secure wire method is not allowed.

Support with 3/32 inch, 7 x 7, stainless steel air-craft cable, with matching fastener rated for 50% of actual load, will be allowed on round ductwork under 12 inches if installed as detailed, with cable double looped on duct and at point of support.

HIGH PRESSURE DUCT (Pressure class 3 inch and over)

Seal all duct in accordance with SMACNA seal class "A"; all seams, joints, and penetrations shall be sealed.

See plans for locations of single wall and double wall high pressure ductwork.

LOW PRESSURE DUCT (Maximum 2 inch pressure class)

Seal all duct, with the exception of transfer ducts, in accordance with SMACNA seal class "A"; all seams, joints, and penetrations shall be sealed.
Install a manual balancing damper in each branch duct and for each diffuser or grille. The use of splitter dampers, extractors, or grille face dampers will not be accepted for balancing dampers.

Hangers must be wrapped around bottom edge of duct and securely fastened to duct with sheetmetal screws or pop rivets. Trapeze hangers may be used at contractor's option.

CLEANING

Remove all dirt and foreign matter from the entire duct system and clean diffusers, registers, grilles and the inside of air-handling units before operating fans.

Clean duct systems with high power vacuum machines where systems have been used for temporary heat, air-conditioning, or ventilation purposes during construction. Protect equipment that may be harmed by excessive dirt with filters, or bypass during cleaning.

LEAKAGE TEST

Test all ductwork in accordance with test methods described in Section 5 of SMACNA HVAC Air Duct Leakage Test Manual. Do not insulate ductwork until it has been successfully tested. Test pressure shall be equal to the duct pressure class.

If excessive air leakage is found locate leaks, repair the duct in the area of the leak, seal the duct, and retest.

Leakage rate shall not exceed more than 5% of the system air quantity for low pressure ductwork, determined in accordance with Appendix C of the SMACNA HVAC Air Duct Leakage Test Manual.

Leakage rate shall not exceed more that 1% of the system air quantity for high pressure ductwork, determined in accordance with Appendix C of the SMACNA HVAC Air Duct Leakage Test Manual.

Leakage test for ductwork downstream of air terminal devices may be omitted but will not relieve the contractor from duct sealing requirements.

Submit a signed report to the A/E, indicating test apparatus used, results of the leakage test, and any remedial work required to bring duct systems into compliance with specified leakage rates.

DUCT LEAKAGE TEST REPORT

Project	**Name:**_____	
	Location:_____	
	Contractor:_____	
	Date Submitted:_____	
System Data	**Fan No:**_____	**Leakage Class C_L):**_____
	Fan Design CFM:_____	**Duct Pressure Class(P_C):**_____
		Test Pressure P_T):_____
Test Equipment	**Manufacturer:**_____	**Model No:**_____ **Serial No:**_____

For large systems, use the reverse side for a simple sketch of the entire duct system. Then use letter designations to Indicate the various duct sections being tested at one time. Also use the reverse side for test comments.

Design Data					Field Test Data							
			Allowable Leakage		Diameter		Pressure (in. wc.)					
Duct Section	Duct Shape	Duct Surface (Ft^2)	Leakage Factor ($P^{.65}C_L$)	CFM for Section	Tube (D_1)	Orifice (D_2)	In Duct (P)	Across Orifice (P_{drop})	Date	Performed By	Observed By	Actual CFM
TOTAL												

END OF SECTION

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SECTION 23 33 00
AIR DUCT ACCESSORIES

P A R T 1 - G E N E R A L

SCOPE

This sections includes accessories used in the installation of duct systems. Included are the following topics:

PART 1 - GENERAL
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Shop Drawings
- Operation and Maintenance Data

PART 2 - PRODUCTS
- Manual Volume Dampers
- Turning Vanes
- Fire Dampers
- Control Dampers
- Smoke Detectors
- Access Doors
- Flexible Duct
- Duct Lining
- Flashings
- Duct Flexible Connections

PART 3 - EXECUTION
- Manual Volume Dampers
- Turning Vanes
- Fire Dampers
- Control Dampers
- Smoke Detectors
- Access Doors
- Flexible Duct
- Duct Lining
- Flashings
- Duct Flexible Connections

RELATED WORK

Section 01 91 13 – Commissioning Requirements
Section 23 05 29 – Hanger and Supports for HVAC Piping and Equipment
Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment
Section 23 31 00 – HVAC Ducts and Casings

REFERENCE

Applicable provisions of Division 1 govern work under this Section.

REFERENCE STANDARDS

NFPA 90A Standard for Installation of Air Conditioning and Ventilating Systems
SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2nd Edition, 1995
UL 214
UL 555 (6^{th} edition) Standard for Fire Dampers and Ceiling Dampers

QUALITY ASSURANCE

Refer to division 1, General Conditions, Equals and Substitutions

SHOP DRAWINGS
Refer to division 1, General Conditions, Submittals.

Submit for all accessories and include dimensions, capacities, ratings, installation instructions, and appropriate identification.
Include certified test data on dynamic insertion loss, self-noise power levels, and aerodynamic performance of sound attenuators.

Submit manufacturer's color charts where finish color is specified to be selected by the Architect/Engineer.

OPERATION AND MAINTENANCE DATA
All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

P A R T 2 - P R O D U C T S

MANUAL VOLUME DAMPERS
Manufacturers: Ruskin, Vent Products, Air Balance, or approved equal.

Dampers must be constructed in accordance with SMACNA Fig. 2-12, Fig. 2-13, and notes relating to these figures, except as modified below.

Reinforce all blades to prevent vibration, flutter, or other noise. Construct dampers in multiple sections with mullions where width is over 48 inches. Use rivets or tack welds to secure individual components; sheet metal screws will not be accepted. Provide operators with locking devices and damper position indicators for each damper; use an elevated platform on insulated ducts. Provide end bearings or bushings for all volume damper rods penetrating ductwork constructed to a 3" w.c. pressure class or above.

TURNING VANES
Manufacturers: Aero Dyne, Anemostat, Barber-Colman, Hart & Cooley, or approved equal.

Construct turning vanes and runners for square elbows in accordance with SMACNA Fig. 2-3 and Fig. 2-4 except use only airfoil type vanes. Construct turning vanes for short radius elbows and elbows where one dimension changes in the turn in accordance with SMACNA Fig. 2-5 and Fig. 2-6.

FIRE DAMPERS
Manufacturers: Air Balance, Advanced Air, American Warming and Ventilating, Greenheck, Phillips-Aire, Prefco, Ruskin, Safe-Air or approved equal.

STATIC FIRE DAMPERS
Static fire damper assemblies must be UL 555 (6^{th} edition) listed and labeled for static applications (where air systems do not operate during a fire) and meet requirements of NFPA 90A. Damper must be type B curtain type with blades out of the air stream; dampers with blades in the air stream will not be accepted. Damper fire rating to be compatible with the rating of the building assembly in which the damper is used.

CONTROL DAMPERS
Control dampers are specified in section 23 09 14.

SMOKE DETECTORS
Smoke detectors are furnished and installed by the Electrical Contractor.

ACCESS DOORS
Access door to be designed and constructed for the pressure class of the duct in which the door is to be installed. Doors in exposed areas shall be hinged type with cam sash lock. Hinges shall be aluminum or steel full length continuous piano type. Doors in concealed spaces may be secured in place with cam sash latches. For both hinged and non-hinged doors provide sufficient number of camp sash latches to provide air tight seal when door is closed. Do not use hinged doors in concealed spaces if this will restrict access. Use minimum 1” deep 24 gauge galvanized steel double wall access doors with minimum 24 gauge galvanized steel frames. For non-galvanized ductwork, use minimum 1” deep double wall access door with frame that shall use materials of construction identical to adjacent ductwork. Provide double neoprene gasket that shall provide seals from the frame to the door and frame to the duct. When access doors are installed in insulated ductwork or equipment provide insulated doors with insulation equivalent to what is

provided for adjacent ductwork or equipment. Access doors constructed with sheet metal screw fasteners will not be accepted.

Use insulated, 1-1/2 hour UL 1978 listed and labeled access doors in kitchen exhaust ducts.

FLEXIBLE DUCT
Manufacturers: Anco Products, Clevaflex, Thermaflex, Flexmaster or approved equal.

Factory fabricated , UL 181 listed as a class 1 duct, and having a flame spread of 25 or less and a smoke developed rating of 50 or under in accordance with NFPA 90A.

Suitable for pressures and temperatures involved but not less than a 180°F service temperature and ±2 inch pressure class, depending on the application.

Duct to be composed of polyester film, aluminum laminate or woven and coated fiberglass fabric bonded permanently to corrosion resistant coated steel wire helix. Two-ply, laminated, and corrugated aluminum construction may also be used.

Where duct is specified to be insulated, provide a minimum 1 inch fiberglass insulation blanket with maximum thermal conductance of 0.23 K (75 degrees F.) and vapor barrier jacket of polyethylene or metalized reinforced film laminate. Maximum perm rating of vapor barrier jacket to be 0.1 perm.

DUCT LINING
Manufacturer: Manville, Owens-Corning, Knauf, or approved equal.

1 inch thick, flexible, mat faced insulation made from inorganic glass fibers bonded with a thermosetting resin with thermal conductivity of .25 Btu inch / hour sq.ft. deg F.
Meet erosion testing per UL 181 or ASTM C 1071 for 5000 fpm maximum air velocity. ASTM C 411 maximum operating temperature rating of 250 deg F. ASTM E84 flame spread less than 25 and smoke developed less than 50.

Meet requirements of ASTM C 1338 and ASTM G21 for fungi resistance.

Install liner using adhesive conforming to ASTM C 916.

FLASHINGS
Flashing and curbs for duct and pipe penetrations of roof assemblies to be in accordance with details.

DUCT FLEXIBLE CONNECTIONS
Material to be fire retardant, be UL 214 listed, and meet the requirements of NFPA 90A.

Connections to be a minimum of 3 inches wide, crimped into metal edging strip, and air tight. Connections to have adequate flexibility and width to allow for thermal expansion/contraction, vibration of connected equipment, and other movement.

Use coated glass fiber fabric for all applications. Material for inside applications to be double coated with neoprene, air and water tight, suitable for temperatures between -10°F and 200°F, and have a nominal weight of 30 ounces per square yard.

P A R T 3 - E X E C U T I O N

MANUAL VOLUME DAMPERS
Install manual volume dampers in each branch duct and for each grille, register, or diffuser as far away from the outlet as possible while still maintaining accessibility to the damper. Install so there is no flutter or vibration of the damper blade(s).

TURNING VANES
Install turning vanes in all rectangular, mitered elbows in accordance with SMACNA standards and/or manufacturer's recommendations.

Install double wall, airfoil, 2 inch radius vanes in ducts with vane runner length 18" or greater and air velocity less than 2000 fpm. Install double wall, airfoil, 4-1/2 inch radius vanes in ducts with vane runner length 18" or greater and air velocity 2000 fpm or greater.

If duct size changes in a mitered elbow, use single wall type vanes with a trailing edge extension. If duct size changes in a radius elbow or if short radius elbows must be used, install sheetmetal turning vanes in accordance with SMACNA Figure 2-5 and Figure 2-6.

FIRE DAMPERS

Install dampers in strict accordance with manufacturer's installation instructions. Install damper sleeves with retaining angles on both sides of rated partition. Connections of ductwork to fire damper assemblies to be as specified on the installation instructions. Where it is necessary to set dampers out from the rated wall, install a sleeve extension encased in two hour rated fire proofing insulation. Install an access door at each fire damper, located to permit resetting the damper replacing the fusible link.

Manually test each fire damper for proper operation by removing the fusible link. Repair or replace any fire damper that does not close completely. Re-install fusible link after test.

CONTROL DAMPERS

Install dampers in locations indicated on the drawings, as detailed, and according to the manufacturer's instructions. Install blank-off plates or transitions where required for proper mixing of airstreams in mixing plenums. Provide adequate operating clearance and access to the operator. Install an access door adjacent to each control damper for inspection and maintenance.

SMOKE DETECTORS

Installation and wiring of detectors will be by the Electrical Contractor. Install an access door at each detector location.

ACCESS DOORS

Install access doors where specified, indicated on the drawings, and in locations where maintenance, service, cleaning or inspection is required. Examples include, but are not limited to motorized dampers, fire and smoke dampers, smoke detectors, fan bearings, heating and cooling coils, filters, valves, and control devices needing periodic maintenance.

Size and numbers of duct access doors to be sufficient to perform the intended service. Minimum access door size shall be 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, or other size as indicated. Install access doors on both inlet and outlet sides of reheat coils as well as other duct mounted coils.

Label fire, smoke and combination fire smoke dampers on the exterior surface of ductwork directly adjacent to access doors using a minimum of 0.5 inch height lettering reading, “SMOKE DAMPER” or “FIRE DAMPER”. Smoke and combination fire smoke dampers shall also include a second line listing the individual damper tag. The tags must be coordinated with the mechanical schedules. Utilize stencils or manufactured labels. All other forms of identification are unacceptable. All labels shall be clearly visible from the ceiling access point.

FLEXIBLE DUCT

Flexible duct may only be used for final connections of air inlets and outlets at diffuser, register, and grille locations. Where flexible duct is used, it shall be the minimum length required to make the final connections, but no greater than 5 feet in length, and have no more than one (1) 90 degree bend.

Secure inner jacket of flexible duct in place with stainless steel metal band clamp. Secure insulation vapor barrier jacket in place with steel or nylon draw band. Sheetmetal screws and/or duct tape will not be accepted.

Flexible duct used to compensate for misalignment of main duct or branch duct will not be accepted.

Individual sections of flexible ductwork shall be of one piece construction. Splicing of short sections will not be accepted.

Flexible ductwork used as transfer duct shall be sized for a maximum velocity of 300 fpm.

Penetration of any partition, wall, or floor with flexible duct will not be accepted.

DUCT LINING

Only apply lining to the following ductwork:

- Transfer Air Ducts.
- Return Air Ducts (as noted on drawings).

Install liner in compliance with the latest edition of NAIMA's Fibrous Glass Duct Liner Standard. Locate longitudinal joints at the corners of duct only. Cut and fit to assure lapped, compressed joints. Coat all transverse and longitudinal joints and edges with adhesive. Provide metal nosing on leading edge where lined duct is preceded by unlined duct. Adhere liner to duct with full coverage area of adhesive. Additionally secure liner to duct using mechanical fasteners spaced as recommended by the liner manufacturer without compressing liner more than 1/8" with the fasteners.

FLASHINGS

Flashing for roof curbs, equipment supports or rails located on roof, will be installed by others.

DUCT FLEXIBLE CONNECTIONS

Install at all duct connections to rotating or vibrating equipment, including air handling units (unless unit is internally isolated), fans, or other motorized equipment in accordance with SMACNA Figure 2-19. Install thrust restraints to prevent excess strain on duct flexible connections at fan inlets and outlets; see Related Work.

For applications in corrosive environments or fume exhaust systems, use a double layer of the Teflon¿ coated fabric when making the connector.

END OF SECTION

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SECTION 23 34 00
HVAC FANS

P A R T 1 - G E N E R A L

SCOPE
This section includes specifications for fans that are not an integral part of a manufactured device. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Shop Drawings
- Operation and Maintenance Data
- Design Criteria

PART 2 - PRODUCTS
- General
- Ceiling Exhaust Fans

PART 3 - EXECUTION
- Installation

RELATED WORK
Section 01 91 13 – Commissioning Requirements
Section 23 05 13 - Common Motor Requirements for HVAC Equipment
Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment

REFERENCE
Applicable provisions of Division 1 govern work under this Section.

REFERENCE STANDARDS

AMCA 203	AMCA Fan Application Manual - Troubleshooting
AMCA 210	Laboratory Method of Testing Fans for Rating
AMCA 300	Reverberant Room Method for Sound Testing of Fans
NFPA 90A	Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 96	Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
UL 762	Power Roof Ventilators For Restaurant Exhaust Appliances

QUALITY ASSURANCE
Refer to division 1, General Conditions, Equals and Substitutions.

SHOP DRAWINGS
Refer to division 1, General Conditions, Submittals.

Include dimensions, capacities, fan curves, materials of construction, ratings, weights, motors and drives, sound power levels, appropriate identification and vibration isolation for all equipment. Sound power levels to be based on tests performed in accordance with AMCA Standard 300.

OPERATION AND MAINTENANCE DATA
All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

DESIGN CRITERIA
Tested and certify all fans in accordance with the applicable AMCA test code.

Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at scheduled static pressure. The motor furnished with the fan shall not operate into the motor service factor when operating under these conditions.

Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA Publication 203, Appendix L.

Where inlet and outlet ductwork at any fan is changed from that shown on the drawings, provide any motor, drive and/or wiring changes required due to increased static pressure or baffling necessary to prevent uneven airflow or improve mixing.

All internal insulation and other components exposed to the airstream are to meet the flame spread and smoke ratings contained in NFPA 90A.

All roof mounted equipment to be provided with curbs or equipment stands in accordance with specification in Section 23 05 29.

P A R T 2 - P R O D U C T S

GENERAL

Furnish complete with motors, wheels, drive assemblies, bearings, vibration isolation devices, and accessories required for specified performance and proper operation. All single phase motors to have inherent thermal overload protection.

Statically and dynamically balance all fans so they operate without objectionable noise or vibration.

CEILING EXHAUST FANS

Carnes, Greenheck, Penn, Jenn-Air, Cook, ACME, or approved equal.

Centrifugal blower wheel, steel housing with acoustical lining, integral exhaust grille, adjustable mounting brackets to allow for any ceiling thickness, permanently lubricated motor, integral junction box.

P A R T 3 - E X E C U T I O N

INSTALLATION

Install as shown on the drawings, as detailed, and according to manufacturer's installation instructions. On units provided with a drain connection, reduce drain connection down to ½" fitting and leave open.

Install thrust restraints in accordance with the requirements of Section 23 05 48.

Contractor shall balance blade assembly of destratification fans after installation to assure stable operation.

END OF SECTION

SECTION 23 36 00
AIR TERMINAL UNITS

PART 1 - GENERAL

SCOPE

This section includes specifications for air terminal equipment. Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Reference
- Reference Standards
- Quality Assurance
- Shop Drawings
- Operation and Maintenance Data
- Design Criteria

PART 2 - PRODUCTS
- Supply Air Terminal Boxes
- Access Doors
- Insulation

PART 3 - EXECUTION
- Installation
- Reheat Coils
- Access Doors
- Insulation
- Adjusting

RELATED WORK

Section 01 91 13 – Commissioning Requirements
Section 23 09 14 - Pneumatic and Electric Instrumentation and Control Devices for HVAC
Section 23 09 93 – Sequence of Operation for HVAC Controls
Section 23 31 00 - HVAC Ducts and Casings
Section 23 33 00 - Air Duct Accessories

REFERENCE

Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS

NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
UL 181 - Factory-Made Air Ducts and Connectors.
ARI-ADC Standard 880
ASTM E84 – Surface Burning Characteristics of Building Materials
UL 723 – Surface Burning Characteristics of Building Materials

QUALITY ASSURANCE

Refer to division 1, General Conditions, Equals and Substitutions.

SHOP DRAWINGS

Refer to division 1, General Conditions, Submittals.

Contractor shall submit air terminal unit data including materials of construction, dimensions, scheduled flow rates, pressure drops, radiated and discharge sound power levels, reset volume controller data, actuator spring range and torque data.

OPERATION AND MAINTENANCE DATA
All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

DESIGN CRITERIA
Select sizes, capacities, configuration, and operating characteristics as shown on the plans and/or as scheduled.

PART 2 - PRODUCTS

SUPPLY AIR TERMINAL BOXES
Units shall be single duct and pressure independent.

MANUFACTURERS:
Carnes, Envirotec, Metal-Aire, Titus, Trane, Price or equal.

CONSTRUCTION:
Unit casing shall be minimum 22 gauge steel and internally insulated with 13/16" rigid fiberglass insulation with a foil scrim face or ¾" thick polyolefin closed cell insulation. Construction to meet UL 181 and NFPA 90A. Casing shall be sealed to limit leakage to a maximum of 15 cfm at 6.0 inches of static pressure. Casing outlet shall have slip and drive joint for connection to discharge ductwork.

Metal damper blade shall be mounted to shaft having self-lubricated bearings. Shaft end shall be marked to indicate damper position and shall have a built-in stop to prevent overstroking. Damper blade shall close off against gasket to limit leakage to 10 cfm at 6.0 inches of differential static pressure. Damper linkage shall be sized to accept at least 40 inch-pounds of torque to the damper shaft. Damper shaft shall be provided with a marking indicating damper position.

Round inlet collar shall be equipped with a multi-point flow sensor that shall amplify the measured velocity pressure. Pneumatic tubing from flow sensor to differential pressure transducer shall be UL listed, fire retardant (FR) type.

Provide factory access door in bottom on unit.

HOT WATER REHEAT COIL**:**
Construct coils of copper tubes and aluminum fins in a serpentine arrangement with piping connections on the same end. Provide galvanized steel casing, end supports, top and bottom channels to allowance for expansion of finned tube section. Factory test coils at 200 psig.

Headers may be cast iron with tubes expanded into the header, steel pipe with tubes brazed to the header, or seamless copper with tubes brazed to the header.

Frames to be flanged for a gasketed connection to adjacent ductwork or constructed for slip and drive connection to the ductwork.

Minimum reheat coil size is 8 inches x 8 inches.

ACCESS DOORS

STANDARD ACCESS DOORS:
Access door to be designed and constructed for the pressure class of the duct in which the door is to be installed. Doors in exposed areas shall be hinged type with cam sash lock. Hinges shall be steel full length continuous piano type. Doors in concealed spaces may be secured in place with cam sash latches. For both hinged and non hinged doors provide sufficient number of camp sash latches to provide air tight seal when door is closed. Do not use hinged doors in concealed spaces if this will restrict access. Use minimum 1" deep 24 gauge galvanized steel double wall access doors with minimum 24 gauge galvanized steel frames. For non-galvanized ductwork, use minimum 1" deep double wall access door with frame that shall use materials of construction identical to adjacent ductwork. Provide double neoprene gasket that shall provide seals from the frame to the door and frame to the duct. When access doors are installed in insulated ductwork or equipment provide insulated doors with insulation equivalent to what is provided for adjacent ductwork or equipment. Access doors constructed with sheet metal screw fasteners will not be accepted.

ROUND DUCT ACCESS DOORS:
For duct pressure class positive or negative up to 6 in. wg. Access doors shall be constructed from 16 gauge stainless steel for fume exhaust ducts and 16 gauge galvanized steel for general exhaust or return ducts. Hinges shall be continuous piano style constructed from the same material as the access door. Access doors shall be sealed with ¼" closed cell butyl gasketing permanently bonded on all four sides and no fewer than two draw latches with strike plates. The strike plates shall match the duct/access door material.

For duct pressure class positive or negative up to 10 in. wg. Access doors shall be the sandwich type and constructed from two layers of stamped 22 gauge stainless steel for fume exhaust ducts and 22 gauge galvanized steel for general or return ducts. Access doors shall be sealed with ¼" butyl gasketing permanently bonded to all four sides of the inside door. The bolts and springs shall be constructed from the same material as the access door. The knobs shall be constructed from polypropylene with threaded metal inserts and able to be fastened without the use of wrenches.

INSULATION
Materials or accessories containing asbestos will not be accepted.

Use composite insulation systems (insulation, jackets, sealants, and adhesives) that have a flame spread rating of 25 or less and smoke developed rating of 50 or less.

The following two internal insulation options may be utilized.

RIGID FIBERGLASS INSULATION:
Minimum nominal density of 3 lbs. per cu. ft., and thermal conductivity of not more than 0.23 at 75 degrees F, minimum compressive strength of 25 PSF at 10% deformation, rated for service to 450 degrees F.

Foil-scrim-kraft vapor barrier jacket, factory applied to insulation, maximum permeance of .02 perms. All exposed insulation edges shall be covered with metal nosing.

POLYOLEFIN INSULATION:
Flexible closed cell, minimum nominal density of 1.5 lbs. per cu. ft., thermal conductivity of not more than 0.24 at 75 degrees F, minimum compressive strength of 5 psi at 25% deformation, maximum water vapor permeability of 0.0 perm inch, maximum water absorption of 0% by weight and volume, rated for service range of -165 degrees F to 210 degrees F.

PART 3 - EXECUTION

INSTALLATION

Install air terminal units as indicated on project drawings and in accordance with the manufacturer's installation instructions.

Mount air terminal boxes with a minimum 3 feet of straight ductwork upstream of inlet flow sensor for sizes 12" diameter and below. Provide a minimum of 3X the inlet diameter of straight duct upstream of the inlet flow sensor for inlet sizes above 12" diameter.

Where hot water reheat coils are provided with air terminal boxes the following two options may be used.

Field mount coil separate from box with a 12-18" section of duct between the air terminal box and reheat coil. The reheat coil and 12-18" section of duct shall be wrapped with external insulation as indicated in specification section 23 07 00 – HVAC Insulation.

Factory mount coil in extended supply air terminal unit. The supply air terminal unit shall be extended at the factory 12-18" and internally insulated to match the insulation used for the supply air terminal unit

Provide at least 24" of clearance on controller side of the air terminal unit. The clearance area shall extend the full length of the supply air terminal unit and the full length (including the access door) of the exhaust/return air terminal unit

Support air terminal units from building structure using sheet metal straps or trapeze hanger with rods. Do not mount air terminal units off of adjacent ductwork or piping.

REHEAT COILS

Comb bent or crushed fins and clean dust and debris from each coil before enclosing coils in ductwork. Pitch coil casings in accordance with manufacturer's instructions. Install a drain valve on the coil side of the shutoff valves for each reheat coil.

Pipe coils with multiple rows for counter flow arrangement.

ACCESS DOORS

DUCT ACCESS DOORS – SQUARE DUCT:

Provide duct access doors in duct or extended supply air terminal unit upstream and downstream of the reheat coil. Duct access doors shall be as large as duct allows with a maximum size of 18"x18". Install heating coils in accordance with Section 23 73 12 - Air Handling Unit Coils.

DUCT ACCESS DOORS – ROUND DUCT:

Install round duct access doors on the side of the duct upstream of the return/exhaust terminal unit. At no time shall the access door be installed in the bottom of the duct. Piano hinged style access doors shall be installed with the piano hinges located ½ above the bottom of the duct to allow the access door to swing down toward the floor.

INSULATION

RIGID FIBERGLASS INSULATION:
All rigid duct insulation edges shall be covered with metal nosing. Foil scrim face must completely separate the rigid fiberglass duct material from the air stream.

POLYOLEFIN INSULATION:
Apply full cover coat of adhesive to surface to be insulated, insulation and edge butt joints. Place insulation with edge joints firmly butted pressing to surface for full adhesion. Seal seams and joints vapor tight.

ADJUSTING

Coordinate adjustment of air terminal units with section 23 05 93 - Testing, Adjusting and Balancing.

END OF SECTION

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SECTION 23 37 13
DIFFUSERS, REGISTERS & GRILLES

PART 1 - GENERAL

SCOPE

This section includes specifications for air terminal equipment. Included are the following topics:

RELATED WORK

Section 01 91 13 – Commissioning Requirements
Section 23 31 00 - HVAC Ducts and Casings
Section 23 33 00 - Air Duct Accessories
Section 23 05 93 - Testing, Adjusting and Balancing for HVAC

REFERENCE

Applicable provisions of Division 1 govern work under this section.

REFERENCE STANDARDS

NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
UL 181 - Factory-Made Air Ducts and Connectors.
ARI-ADC Standard 880

QUALITY ASSURANCE

Refer to division 1, General Conditions, Equals and Substitutions.

SUBMITTALS

Refer to division 1, General Conditions, Submittals.

Furnish submittal information including, but not limited to, the following:

- Manufacturer's name and model number
- Identification as referenced in the documents
- Capacities/ratings
- Materials of construction
- Sound ratings
- Dimensions
- Finish
- Color selection charts where applicable
- Manufacturer's installation instructions
- All other appropriate data

DESIGN CRITERIA

All performance data shall be based on tests conducted in accordance with Air Diffusion Council (ADC) Test Code 1062 GRD 84.

PART 2 - PRODUCTS

MANUFACTURERS

Manufacturers: Carnes, Krueger, Titus, Metal-Aire, and E.H. Price, and United Sheet Metal.

Acceptable manufacturers for specific products are listed under each item.

SQUARE CEILING DIFFUSERS - Plaque

Titus model OMNI, Carnes series SFPA/SHPA, Price model SMDP, Metal Aire series 5750, and Krueger series PLQ/5PLQ.

Aluminum (Steel) unless otherwise indicated, louvered face furnished with frame type appropriate to installation.

Directional blow pattern as shown on the drawings and/or as scheduled.

One-piece removable square face plaque with one-piece backpan.

White, baked enamel finish or powder coat finish, unless otherwise indicated.

SQUARE CEILING DIFFUSERS

Titus model TDC/TDC-AA, Carnes series SK or SE, Price model SMD/AMD, Metal Aire series 5500 or 5500S, and Krueger series S.

Aluminum (Steel) unless otherwise indicated, louvered face furnished with frame type appropriate to installation.

Directional blow pattern as shown on the drawings and/or as scheduled.

One-piece construction louver cones with no corner joints.

White, baked enamel finish or powder coat finish, unless otherwise indicated.

PLENUM SLOT DIFFUSER - with Gasketed Blade

Titus model TBD-80, Carnes model DA, Price model TBD4, Metal Aire series PHP, and Krueger series PTBS, Raymon-Donco Series BA/BS.

Steel, furnished with T-bars compatible with ceiling components. Extruded aluminum pattern with a gasket on top edge to form a seal against the plenum wall or slot divider. Pattern control field adjustable from vertical to horizontal discharge.

Provide24 gauge galvanized steel (uninsulated) insulated plenum,. Provide round or oval inlet collar designed to fit standard flexible duct sizes.

Double metal thickness slot face.

White, baked enamel finish or powder coat finish, unless otherwise indicated. Flat black diffuser vanes and frame interior.

SIDE-WALL REGISTERS AND GRILLES

Titus series 300 (supply) and series 350 (return/exhaust), Carnes model R series, Price model 520 (Supply) or 530 (return/exhaust), Metal Aire series V4000 or H4000, Krueger series 880.

Aluminum otherwise indicated, with frame type appropriate to installation.

Double deflection type blade supply registers and supply grilles allow deflection adjustment in all direction.

Opposed blade volume control damper supply registers, operable from face.

Fixed blade (45 degree) core return and exhaust registers and grilles.

Opposed blade volume control damper return registers, operable from face.

Register and grille sizes as shown on drawings and/or as scheduled.

White, baked enamel finish or powder coat finish, unless otherwise indicated.

Screw holes on surface counter sunk to accept recessed type screws.

EGGCRATE GRILLE

Titus model 50, Carnes model RAE or RAT, Price model 80, Metal Aire model CC, Krueger model EGC.

Aluminum construction with frame type appropriate to installation.

Grille face 1/2" x 1/2" or 1" x 1" grid pattern 1" deep with a minimum of 85% free area.

Grille sizes and finishes as shown on drawings and/or as scheduled.

White, baked enamel finish or powder coat finish, unless otherwise indicated..

Screw holes on surface counter sunk to accept recessed type screws.

HEAVY DUTY SIDE-WALL RETURN/EXHAUST GRILLE

Titus model 30, Carnes Sturdicore, Price 91, Metal Aire series SBG, Krueger series 480, Price model 91.

Grille border 16-gauge steel and grille blades 14-gauge steel suitable for gymnasium applications.

Fixed blade (0 degree, 45 degree).

Grille sizes as shown on drawings and/or as scheduled.

White, baked enamel finish or powder coat finish, unless otherwise indicated.

DOOR GRILLE
Titus Series 700, Carnes Series RF or RG, Metal Aire Series DG, Price ATG/STG

Aluminum (Steel). Sight tight.

Grille sizes, frame types, and finishes as shown on drawings and/or as scheduled.

White, baked enamel finish or powder coat finish, unless otherwise indicated.

PART 3 - EXECUTION

INSTALLATION
Install grilles, registers and diffusers as shown on drawings and according to manufacturer's instructions.

Furnish diffusers with equalizing grids where it is not possible to maintain minimum 2 duct diameter straight duct into diffuser. Equalizing grids shall consist of individually adjustable vanes designed for equalizing airflow into diffuser neck and providing directional control of airflow.

Unless otherwise indicated, size ductwork drops to diffusers or grilles to match unit collar size.

Seal connections between ductwork drops and diffusers/grilles airtight.

Where diffusers, registers and grilles cannot be installed to avoid seeing inside duct, paint inside of duct with flat black paint to reduce visibility.

END OF SECTION