

SECTION 230130

HVAC AIR-DISTRIBUTION SYSTEM CLEANING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes cleaning HVAC air-distribution equipment, ducts, plenums, and system components.

1.3 DEFINITIONS

- A. ASCS: Air systems cleaning specialist.
- B. NADCA: National Air Duct Cleaners Association.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For an ASCS.
- B. Strategies and procedures plan.
- C. Cleanliness verification report.

1.5 QUALITY ASSURANCE

- A. ASCS Qualifications: A certified member of NADCA.
 - 1. Certification: Employ an ASCS certified by NADCA on a full-time basis.
 - 2. Supervisor Qualifications: Certified as an ASCS by NADCA.
- B. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.
- C. Cleaning Conference: Conduct conference at Project site.

1. Review methods and procedures related to HVAC air-distribution system cleaning including, but not limited to, review of the cleaning strategies and procedures plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine existing distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.
- B. Perform "Project Evaluation and Recommendation" according to NADCA ACR 2006.
- C. Prepare written report listing conditions detrimental to performance of the Work.
- D. Proceed with work only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare a written plan that includes strategies and step-by-step procedures. At a minimum, include the following:
 1. Supervisor contact information.
 2. Work schedule including location, times, and impact on occupied areas.
 3. Methods and materials planned for each HVAC component type.
 4. Required support from other trades.
 5. Equipment and material storage requirements.
 6. Exhaust equipment setup locations.
- B. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.
- C. Comply with NADCA ACR 2006, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

3.3 CLEANING

- A. Comply with NADCA ACR 2006.
- B. Remove visible surface contaminants and deposits from within the HVAC system.

C. Systems and Components to Be Cleaned:

1. All new air devices for supply and return.
2. All new Ductwork
3. All new air conditioning units:
 - a. Interior surfaces of the unit casing.
 - b. Coil surfaces compartment.
 - c. Condensate drain pans.
 - d. Fans, fan blades, and fan housings.
4. All new Filters and filter housings.

D. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.

E. Particulate Collection:

1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,

F. Control odors and mist vapors during the cleaning and restoration process.

G. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.

H. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.

I. Clean all air-distribution devices, registers, grilles, and diffusers.

J. Clean visible surface contamination deposits according to NADCA ACR 2006 and the following:

1. Clean air-handling units, airstream surfaces, components, condensate collectors, and drains.
2. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
3. Clean evaporator coils, reheat coils, and other airstream components.

K. Duct Systems:

1. Create service openings in the HVAC system as necessary to accommodate cleaning.
2. Mechanically clean duct systems specified to remove all visible contaminants so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).

L. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.

M. Mechanical Cleaning Methodology:

1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.
 - a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
 - b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials such as duct and plenum liners.
2. Cleaning Mineral-Fiber Insulation Components:
 - a. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR 2006.
 - b. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).
 - c. Fibrous materials that become wet shall be discarded and replaced.

N. Coil Cleaning:

1. Measure static-pressure differential across each coil.
2. See NADCA ACR 2006, "Coil Surface Cleaning" Section. Type 1, or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing Coil Cleaning Verification (see applicable NADCA ACR 2006).
3. Coil drain pans shall be subject to NADCA ACR 2006, "Non-Porous Surfaces Cleaning Verification." Ensure that condensate drain pans are operational.

4. Electric-resistance coils shall be de-energized, locked out, and tagged before cleaning.
 5. Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer's written recommendations when available.
 6. Rinse thoroughly with clean water to remove any latent residues.
- O. Antimicrobial Agents and Coatings:
1. Apply antimicrobial agents and coatings if active fungal growth is reasonably suspected or where unacceptable levels of fungal contamination have been verified. Apply antimicrobial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.
 2. When used, antimicrobial treatments and coatings shall be applied after the system is rendered clean.
 3. Apply antimicrobial agents and coatings directly onto surfaces of interior ductwork.
 4. Sanitizing agent products shall be registered by the EPA as specifically intended for use in HVAC systems and ductwork.

3.4 CLEANLINESS VERIFICATION

- A. Verify cleanliness according to NADCA ACR 2006, "Verification of HVAC System Cleanliness" Section.
- B. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents and coatings.
- C. Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.
- D. Additional Verification:
1. Perform surface comparison testing or NADCA vacuum test.
 2. Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.
- E. Verification of Coil Cleaning:
1. Measure static-pressure differential across each coil.
 2. Coil will be considered clean if cleaning restored the coil static-pressure differential within 10 percent of the differential measured when the coil was first installed.
 3. Coil will be considered clean if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection.

- F. Prepare a written cleanliness verification report. At a minimum, include the following:
1. Written documentation of the success of the cleaning.
 2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
 3. Surface comparison test results if required.
 4. Gravimetric analysis (nonporous surfaces only).
 5. System areas found to be damaged.
- G. Photographic Documentation: Comply with requirements in Section 013233 "Photographic Documentation."

3.5 RESTORATION

- A. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR 2006, "Restoration and Repair of Mechanical Systems" Section.
- B. Restore service openings capable of future reopening. Comply with requirements in Section 233113 "Metal Ducts." Include location of service openings in Project closeout report.
- C. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts."
- D. Replace damaged insulation according to Section 230713 "Duct Insulation."
- E. Ensure that closures do not hinder or alter airflow.
- F. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.
- G. Reseal fibrous-glass ducts. Comply with requirements in Section 233116 "Nonmetal Ducts."

END OF SECTION 230130

SECTION 230500

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes and applies to all work included in Division 23.
- B. Work in this Section includes providing labor, materials, equipment, services necessary, fabrication, installation and testing for fully operational and safe systems including all necessary materials, appurtenances and features whether specified or shown in the contract documents or not, in conformity with all applicable codes and authorities having jurisdiction for the following:
 - 1. Mechanical work covered by all sections within Division 23 of the specifications, including, but not limited to:
 - a. HVAC Demolition.
 - b. Cleaning of ductwork, casings, plenums, etc.
 - c. Motors.
 - d. Air Outlets.
 - e. Hot Water Reheat Coils.
 - f. Testing and balancing.
 - g. Painting and finishing.
 - h. Supports.
- C. Provide cutting and patching, for the Mechanical Work.

1.3 DEFINITIONS

- A. "Furnish" or "Provide": to supply, install and connect up complete and ready safe and regular operation of particular work referred to unless specifically otherwise noted.
- B. "Install": to erect, mount and connect complete with related accessories.
- C. "Supply": to purchase, procure, acquire and deliver complete with related accessories.

- D. "Work": labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.
- E. "Piping": pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.
- F. "Wiring": raceway, fittings, wire, boxes and related items.
- G. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- H. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- I. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- J. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings, in chases, in enclosures, in trenches or in crawl spaces.
- K. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- L. "Indicated," "Shown" or "Noted": as indicated, shown or noted on drawings or specifications.
- M. "Similar" or "Equal" of base bid manufacture: in the Engineer's opinion, equal in materials, weight, size, design, and efficiency of specified product, conforming with 2.01 MANUFACTURERS.
- N. "Reviewed," "Satisfactory," or "Directed": as reviewed, satisfactory, or directed by or to Architect.
- O. "Motor Controllers": manual or magnetic starters (with or without switches), individual pushbuttons or hand-off-automatic (HOA) switches controlling the operation of motors.
- P. "Control" or "Actuating Devices": automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.

1.4 ABBREVIATIONS

- A. The following are industry abbreviations for plastic materials.
 - 1. CPVC: Chlorinated polyvinyl chloride plastic.

2. PE: Polyethylene plastic.
 3. PVC: Polyvinyl chloride plastic.
- B. The following are industry abbreviations for rubber materials:
1. EPDM: Ethylenepropylenediene terpolymer rubber.
 2. NBR: Acrylonitrilebutadiene rubber.
- C. Following is a list of abbreviations and symbols that are used in the specifications:

Word or Symbol	Abbreviation or Symbol Used in Specifications
ϕ	phase
air conditioning unit	ACU
alternating current	AC
ampere	amp
brake horsepower (bhp)	BHP
British thermal units	Btu
Celsius	C
cfh	CFH
cubic feet per minute	cfm
cubic feet per second	cfs
degree	°
direct current	DC
emergency power system	EPS
etcetera (etc.)	etc.
Fahrenheit	F
feet	ft.
feet per minute	fpm
gallon	gal.
gallons per minute	gpm
hertz	Hz
horsepower	hp
inches	in.
kilovolt	kV
kilowatt	kW

Word or Symbol	Abbreviation or Symbol Used in Specifications
KVA	kVA
length	length
manufacturer	Mfr.
minute	minute
number	No.
ounce	oz.
percent	%
plus and minus	±
pound or pounds	lb. or lbs.
pounds per square inch (psi)	psi
power factor	pf
psig	psig
PVC	PVC
revolutions per minute (rpm)	rpm
square foot or square feet	sq. ft.
times	times (unless used in an equation, then use x)
uninterruptible power supply (UPS)	UPS
Variable Frequency Drive	VFD
volt	V
water gauge	w.g.
width	width
wiregauge	awg
WWP	WWP

1.5 JOB CONDITIONS

- A. Examine all drawings and specifications in a manner to be fully cognizant of all work required under this Division.
- B. Adjoining work of other Divisions shall be examined for interferences and conditions affecting this Division.
- C. Examine site related work and surfaces before starting work of any Section.
 1. Report to Architect, in writing, conditions which will prevent proper provision of this work.

2. Beginning work of any Section without reporting unsuitable conditions to Architect constitutes acceptance of conditions by Contractor.
 3. Perform any required removal, repair or replacement of this work caused by unsuitable conditions at no additional cost to Owner.
- D. Connections to existing work.
1. Verification of existing:
 - a. Before submitting bid, Mechanical Contractor shall become thoroughly familiar with actual existing conditions and systems at the building, and of the existing installations to which connections must be made, including any necessary alterations, and existing building engineering practices and requirements. The intent of the work is shown on the drawings and described herein, and no consideration will be granted by reason of lack of familiarity on the part of the contractor with actual physical conditions, requirements, and practices at the site.
 2. The Contractor, before demolition of existing ductwork and connection to existing duct, shall take air readings of existing system where new ductwork gets connected to existing supply and return ducts and to existing air handling equipment (i.e., air conditioning units, exhaust and return fans, etc.).
 3. Install new work and connect to existing work with minimum interference to existing facilities.
 4. Temporary shutdowns of existing services:
 - a. At no additional charges.
 - b. At times not to interfere with normal operation of existing facilities.
 - c. Only with written consent of Owner.
 5. Maintain continuous operation of existing facilities as required with necessary temporary connections between new and existing work.
 6. Restore existing disturbed work to original condition.
- E. Removal and relocation of existing work.
1. Disconnect, remove or relocate material, equipment, plumbing fixtures, piping and other work noted and required by removal or changes in existing construction.
 2. Where existing pipes, conduits and/or ducts which are to remain prevent installation of new work as indicated, relocate, or arrange for relocation, of existing pipes, conduits and/or ducts.
 3. Provide new material and equipment required for relocated equipment.
 4. Plug or cap active piping or ductwork behind or below finish.
 5. Do not leave long dead-end branches. Cap or plug as close as possible to active line.
 6. Remove unused piping, ductwork and material.
 7. Dispose of removed fixtures and equipment as directed.
 8. Turn over removed fixtures and equipment to Owner as directed.
- F. Special Traffic Requirements:
1. Maintain emergency and service entrances useable to pedestrian, truck, and ambulance traffic at all times.

2. If asbestos insulation is found when working in existing areas, immediately stop work and notify Architect. Do not restart work until advised in writing by Architect that it is safe to do so following abatement, encapsulation, etc.

1.6 CLEARANCE FROM ELECTRICAL EQUIPMENT

- A. Piping or ductwork:
 1. Prohibited in:
 - a. Electric rooms and closets.
 - b. Telephone rooms and closets.
 - c. Elevator machine rooms.
 - d. Electric switchboard room.
 2. Prohibited above an area within 5 ft. of:
 - a. Transformers.
 - b. Motor control centers.
 - c. Bus ducts.

1.7 SUBMITTALS

- A. Submit the following items as hereinafter specified:
 1. Names and qualifications of test and balance agencies.
 2. Layout Drawings.
 3. Coordinated Drawings.
 4. As-built Record Drawings (Submitted to Client).
 5. Record Files (Submitted to Client).
 6. Operating and Maintenance Manuals.
 7. Welding certificates.
 8. Equipment and material submittals as required by sections within this division.
- B. Items shall comply with the requirements as hereinafter specified.
- C. Submit shop drawings, product data, samples and certificates of compliance required by contract documents.
 1. See Division 1, Submittals for reference of minimum requirements, if not stated here-in-below.
- D. Schedule of submittals, as agreed to by the Engineer, will set the basis of the minimum required submittals. Submittals shall be provided by the Contractor promptly and in accordance with the Schedule of submittals and in such sequence as to cause no delay in work or in work of any other divisions.
- E. Resubmission Requirements:
 1. In addition to Division 1 requirements, make any corrections or change in Submittals required. Resubmit for review until no exceptions are taken or a resubmission is not required.
 2. Shop Drawings and Product Data:

- a. Revise initial drawings or data, and resubmit as specified for initial submittal.
 - b. Indicate any changes which have been made other than those requested.
 3. Samples: Submit new samples as required for initial submittal.
 4. Clearly identify re-submittal by original submittal date, number and revision number and indicate all changes from previous submittal.
 5. If more than two submissions are required (initial submittal and one re-submittal) based on rejection or lack of compliance by submittal, then the Contractor shall:
 - a. Arrange for additional reviews by the Design Engineers.
 - b. Pay all costs for such additional reviews.
- F. Corrections or comments made on the shop drawings during review do not relieve the Contractor from compliance with requirements of the drawings and specifications. Shop drawing checking by the Engineer is only for review of general conformance with the design concept of the project and general compliance with the information given in the contract documents. The Contractor is responsible for:
1. Confirming and correlating all quantities and dimensions.
 2. Selecting fabrication processes and techniques of construction.
 3. Coordinating his work with that of all other trades.
 4. Performing his work in a safe and satisfactory manner.
- G. Substitutions:
1. See Division 1, Substitutions.
 2. The bid shall include products per paragraph 2.01 MANUFACTURERS. Engineer will consider formal requests for substitution of products in place of those specified only if these are submitted with the bid for evaluation and in accordance with all conditions specified hereafter.
 3. Requests for substitutions after award of contract shall be considered only in case of product unavailability. Product unavailability shall be verified in writing by manufacturer.
 4. Submit separate request for each substitution at time of bid, or at appropriate time thereafter in the event of non-availability of item included in bid. Support each request with:
 - a. Complete data substantiating compliance of proposed substitution with requirements stated in Contract documents.
 - b. Data relating to changes in construction schedule.
 - c. Any effect of substitution on other Work in this and other Divisions, and any other related contracts, and changes required in other work or products.
 5. Contractor shall be responsible at no extra cost to Owner for any changes resulting from proposed substitutions which affect work of other Sections or Divisions, or related contracts.
 6. Claims for additional costs caused by substitution which may subsequently become apparent shall be met by the Contractor.
 7. Substitutions will not be considered for acceptance when acceptance will require revision of Contract Documents, unless Contractor bears cost of redesign.

8. Where any redesign of electrical, mechanical or other work is required due to substitution, arrangement or equipment layout other than herein specified or shown:
 - a. Arrange for required redesign by Engineer.
 - b. All subject to Architect's approval.
9. Substitute products shall not be ordered or installed without prior written approval/acceptance by Architect.
10. Engineer will have sole discretion to determine acceptability of proposed substitutions and reserves the right to reject any such substitution.
11. Approval of substitutions shall not relieve Contractor from full compliance with requirements of Contract documents.
 - a. General contractor shall request individual layout drawings from mechanical and electrical trades, per section 230500, paragraph 1.8, and section 260500, paragraph 1.05.
 - b. Contractor shall assure that each mechanical and electrical trade has coordinated work with other trades. Stamp each layout submittal and sign to certify that these layouts have been coordinated.

H. Layout (Shop) Drawings:

1. Submit Layout Drawings indicating work within existing mechanical rooms areas containing steam chilled water piping, air handlers and for any areas. See Division 1 specification sections for additional requirements on layout drawings.
2. Layout CADD Drawings for mechanical rooms shall be at a scale of 3/8"=1'0".
3. Prepare layout shop drawings for all areas.
4. From the layout drawings, prepare and submit Coordinated Drawings as herein specified below.

I. Coordinated Drawings:

1. This Contractor shall prepare coordinated drawings which shall show work of all trades including, but not limited to:
 - a. Items noted in the Supplemental General conditions.
 - b. Coordinated Ductwork with penetrations at floors, walls, ceiling and roof.
 - c. Piping, including:
 - 1) HVAC, plumbing and fire protection.
 - 2) Minor Piping such as drains, air vents, condensate piping, etc.
 - 3) Sleeves and penetrations.
 - 4) Expansion devices, anchors, guides and hangers.
 - d. Mechanical Equipment.
 - e. Supports and suspension devices.
 - f. Ductwork/Piping high points and low points.
 - g. Equipment support and suspension devices including hangers, supports and bracing.
 - h. Structural and architectural constraints including:
 - 1) Beams, braces, trusses, flanges, constraints, walls, openings ratings, doors, wall types, glazing.
 - i. Show location of:
 - 1) Valves.
 - 2) Piping specialties.

- 3) Dampers.
 - 4) Access doors.
 - 5) Control and electrical panels.
 - 6) Disconnect switches
 - 7) Others as required.
2. Drawings shall indicate coordination with work in other Divisions which must be incorporated in mechanical spaces, including, but not limited to:
 - a. Irrigation equipment and piping.
 - b. Pneumatic tube system.
 - c. Computer equipment.
 3. Provide sections and elevations for rooftop air handling unit with routed duct mains, areas with routed piping mains, and areas adjacent to the existing structure.
 4. Preparation of drawings:
 - a. Prepare reproducible CADD drawings.
 - b. Submit to other trades for review of space allocated to all trades.
 - c. Revise drawings to compensate for requirements of existing conditions and conditions created by other trades.
 5. Final prepared drawings shall show that other trades affected have made reviews and signed, by each trade, at completion of coordination.
 6. Coordinated shop drawings shall be for all areas.
 7. Contractor is to assure that each trade has coordinated work with other trades, prior to submittal.

J. As-built (Record) Drawings:

1. Provide after installation is complete. Final signoff and Owner acceptance will not occur prior to submission of As-built drawings to Owner.
2. Indicate as-built conditions and all revisions that occurred subsequent to "Coordinated Drawings" submittal, fully illustrating all revisions made by all trades in the course of work.
3. Dimension physical locations of ductwork, and piping with reference elevations and distances above finished floors, below beams, from wall faces, underground (invert elevations) and from column lines.
4. Exact location, type and function of concealed valves, dampers, controllers, piping, air vents, piping drains and isolators.
5. Indicate all equipment sizes and capacities and tag numbers.
6. Provide drawing on reproducible CADD mylar.
7. These drawings shall be for as-built record purposes for the Owner's use and are not considered shop drawings.

K. Record Files:

1. Provide 5 (five) electronic file copies of the As-built CADD drawings in the media (CDROM, Disks, Tape, etc.) of Owner's choice.
2. Include hard copy and electronic copy of file naming convention, layering standards, drawing index and file descriptions.
3. Electronic files shall be modifiable and shall include all associated referenced background files.

- L. Operating Instructions, Maintenance Manuals and Parts Lists:
1. Before requesting acceptance of work, submit one set for review by Architect.
 2. After review, furnish five printed and bound sets.
 3. Include:
 - a. Manufacturer's name, model number, service manual, spare parts list, and descriptive literature for all components, cross referenced and numbered on Record Drawings as required.
 - b. Maintenance instructions.
 - c. Listing of possible breakdown and repairs.
 - d. Instruction for starting, operation and programming.
 - e. Detailed and simplified one line, color coded flow and wiring diagram.
 - f. Field test report, including:
 - 1) Instrument set points.
 - 2) Normal operating valves.
 - g. Name, address and phone number of contractors equipment suppliers and service agencies.
 - h. Assemble manufacturer's equipment manuals in chronological order, following the specification alphanumeric system, in heavy duty 3ring binders clearly titled on the spine and front cover with appropriate index dividers.

M. Quantity of Submittals Required.

1. Layout (Shop) Drawings and Coordinated Drawings:
 - a. Submit two prints.
 - b. Upon review, 3 prints will be annotated and returned. Prints will be retained by the Engineer.
 - c. Copies of these prints will serve as record copies for Architect.
2. Product Data (brochures):
 - a. Submit two copies of product data.
 - b. Upon review, 3 copies will be returned.
 - c. If comments are required, they will be returned with each copy.
 - d. One copy will be retained by the Engineer.

1.8 RELATED WORK AND REQUIREMENTS

- A. Requirements of General Conditions and Division No.1 apply to all work in this division.
- B. Carefully check the documents of each section with those of other sections and Divisions. Ascertain the requirements of any interfacing materials or equipment being furnished and/or installed by those sections and Divisions, and provide the proper installation and/or required interface.
- C. As a minimum requirement and condition, the Contractor shall provide CADD generated drawings (for the purpose of Layout Drawings, Coordinated Drawings, As-built Drawings and Record Drawings) with a proven layering standard. Deviation from this requirement shall be:

1. At the sole discretion of the Engineer.
 2. Submitted as a substitution within the specified time frame.
- D. Related work specified elsewhere:
1. Providing temporary heat.
 2. Providing finish painting, including pipe stenciling.
 3. Access doors.
 4. Cutting and patching, except as noted in "AIA Document A201" and "Supplementary Conditions for Mechanical and Electrical Work.
 5. Louvers in doors.
 6. Undercut doors.
 7. Plenums other than sheet metal.
 8. Flashing.

1.9 QUALITY ASSURANCE

- A. All equipment and accessories to be the product of a manufacturer regularly engaged in its manufacture.
- B. Supply all equipment and accessories new and free from defects.
- C. Supply all equipment and accessories in compliance with the applicable standards and with all applicable national, state and local codes.
- D. All items of a given type shall be the products of the same manufacturer.
- E. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding CodeSteel."
- F. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.10 REFERENCE STANDARDS

- A. Published codes, specifications, standards, tests or recommended methods of trade, industry or governmental organizations apply to work in this Division where cited below:
 1. AABC: Associated Air Balance Council.
 2. ADC: Air Diffuser Council.
 3. AMCA: Air Moving and Conditioning Association.
 4. ANSI: American National Standards Institute.
 5. ARI: Air-Conditioning and Refrigeration Institute.

6. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers.
7. ASME: American Society of Mechanical Engineers.
- 8.ASSE: American Society of Sanitary Engineers.
9. ASTM: American Society for Testing and Materials.
10. AWS: American Welding Standards.
11. FM: Factory Mutual.
12. Local Utility Authorities.
13. National, State and Local Codes of all authorities having jurisdiction.
14. NEMA: National Electrical Manufacturer's Association.
15. NFPA: National Fire Protection Association.
16. OSHA: Occupational Safety and Health Act.
17. PDI: Plumbing and Drainage Institute.
18. State Energy Code having jurisdiction
19. UBC: Uniform Building Code.
20. UL: Underwriters' Laboratories, Inc.
21. UMC: Uniform Mechanical Code.
22. UPC: Uniform Plumbing Code.

- B. In addition to complying with all other legal requirements, comply with current provisions of governing codes and regulations in effect during progress of the Work, and with the following:
1. Drawings and specification requirements shall govern where they exceed Code and Regulation requirements.
 2. Where requirements between governing Codes and Regulations vary, the more restrictive provisions shall apply.
 3. Nothing contained in Contract Documents shall be construed as authority or permission to disregard or violate legal requirements. The Contractor shall immediately draw the attention of the Architect to any such conflicts noted in the Contract Documents.

1.11 DESCRIPTION OF BID DOCUMENTS

- A. Specifications:
1. Specifications, in general, describe quality and character of materials and equipment.
 2. Specifications are of simplified form and include incomplete sentences.
- B. Drawings:
1. Drawings in general are diagrammatic and indicate scope, sizes, routing, locations, connections to equipment and methods of installation, but not necessarily offsets, obstructions or structural conditions. Locations on drawings may be distorted for purposes of clearness and legibility.
 2. Contractor to provide additional offsets, fittings, hangers, supports, valves, drains as required for construction and coordination with work of other trades.

3. Scaled and figured dimensions are approximate and are for estimating purposes only, but shall be followed with sufficient accuracy to coordinate with other work and structural limitations.
 4. Before proceeding with work, check and verify all dimensions and carefully check space requirements with other Work to ensure that all equipment and materials can be installed in spaces allotted.
 5. Assume all responsibility for fitting of materials and equipment to other parts of equipment and structure.
 6. The Contractor is responsible for installing the work in such a manner that it will conform to the structure and architectural elements, avoid obstructions, maintain headroom, leave adequate clearance for proper maintenance and repairs, and provide clearances and access required by codes.
 7. Make adjustments that may be necessary or requested in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.
 8. Above items to be performed at no additional cost to the Owner.
- C. If any part of Specifications or Drawings appears unclear or contradictory, consult with Architect and/or Engineer for interpretation and decision as early as possible during bidding period. Do not proceed with such work without Architect's and or Engineer's decision.
- D. Typical details, where shown on the drawings, apply to each and every item of the project where such items are applicable. Typical details are not repeated in full on the plans, and are diagrammatic only, but with the intention that such details shall be incorporated in full.

1.12 TEMPORARY FACILITIES

- A. Provide dust control to prevent dust from migrating out of the work areas. Use fans to create a negative air condition in the working area, use HEPA filters and temporarily discharge the air outdoors. Provide makeup air. Seal air tight.
- B. See division 1 for temporary facilities required.
1. Temporary water supply for construction per Specifications for Plumbing Work..
 2. Temporary toilet facilities:
 - a. Provide, where directed by Architect, temporary toilet facilities for use of all workman on project.
 - b. Conform to requirements of all authorities having jurisdiction.
 - c. Connect water to temporary water lines and drainage to sewer.
 - d. Temporary toilets will be maintained by General Contractor who will pay for water consumed.
 - e. At completion of job, or when directed by Architect, remove temporary toilet facilities and piping.

1.13 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured in place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces.

1.14 SPECIAL TOOLS

- A. Furnish to Owner at completion of work:
 - 1. One set of any special tools required to operate, adjust, dismantle or repair equipment furnished under any section of this Division.
 - 2. "Special tools": those not normally found in possession of mechanics or maintenance personnel.
 - 3. One pressure grease gun for each type of grease required.
 - a. With adapters to fit all lubricating fittings on equipment.
 - b. Include lubricant for lubricated plug valves.
 - 4. Tag each item and cross reference in Maintenance Manual.
 - 5. Turn over to Owner's representative or temporarily secure to unit at Architect's instruction.

1.15 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
- C. Check dimensions of access route through the site from delivery point to final location. Where necessary, ship in crated sections of size to permit passing through available space. Dismantle and/or reassemble, re-provision and retest equipment too large to pass through available access route to final location in one piece.
- D. Ship equipment in original packages, to prevent damaging or entrance of foreign matter.
- E. Handle and ship in accordance with manufacturer's recommendations.
- F. Provide protective coverings during construction.

- G. Replace at no expense to Owner, equipment or material damaged during storage or handling, as directed by Architect.
- H. Tag all items with weatherproof tag, identifying equipment by name and purchase order number.
- I. Include packing and shipping lists.
- J. Special requirements as specified in individual sections.

1.16 PROTECTION OF MATERIALS

- A. Protect from damage, water, dust, etc., material, equipment and apparatus provided under this Division, both in storage and installed, until Notice of Completion has been filed.
- B. Provide temporary storage facilities for material and equipment.
- C. Arrange with Owner for storage facilities for materials and equipment.
- D. Material, equipment or apparatus damaged because of improper storage or protection will be rejected.
 - 1. Remove from site and provide new, duplicate, material equipment or apparatus in replacement of that rejected.
- E. Cover motors and other moving machinery to protect from dirt and water during construction.
- F. Protect premises and work of other Divisions from damage arising out of installation of work of this Division.
 - 1. Repair or replace, as directed by Architect, materials and parts of premises which become damaged as result of installation of work of this Division.
 - 2. Remove replaced parts from premises.

1.17 REVIEW OF CONSTRUCTION

- A. Work may be reviewed at any time by representatives of Architect.
- B. Advise Architect in writing that work is ready for review at following times:
 - 1. Prior to concealment of work in walls and above ceilings.
 - 2. When all requirements of Contract have been completed.

1.18 SCHEDULE OF WORK

- A. Arrange work to conform to schedule of construction established or required to comply with Contract Documents.
- B. In scheduling, anticipate means of installing equipment through available openings in structure.
- C. Confirm in writing to Architect, within 30 days of signing of contract, anticipated number of days required to perform test, balance, and acceptance testing of mechanical systems:
 - 1. This phase must occur after completion of mechanical systems, including all control calibration and adjustment, and requires substantial completion of the building, including closure, ceilings, lighting, partitioning, etc.
 - 2. Submit for approval at this time, names and qualifications of test and balancing agencies to be used.
- D. Arrange with Owner schedule for work in each area.
- E. Unless otherwise directed by Owner perform work during normal working hours.
- F. Work delays:
 - 1. In case noisy work interferes with Owner's operations, Owner may require work to be stopped and performed at some other time, or after normal working hours.
 - 2. Lost time and overtime will be compensated for by Owner.
 - 3. Submit, with bid proposal, schedule of hourly rates and overtime premiums.

1.19 NOISE REDUCTION

- A. Cooperate in reducing objectionable noise or vibration caused by mechanical systems.
 - 1. To extent of adjustments to specified and installed equipment and appurtenances.
- B. Correct noise problems caused by failure to install work in accordance with Contract Documents. Include labor and materials required as result of such failure.

1.20 PERMITS, LICENSES, AND INSPECTIONS

- A. Permits and Licenses:
 - 1. Secure required permits and licenses including payments of all charges and fees.
- B. Inspections:
 - 1. Obtain certificates of final inspection approval from authorities having jurisdiction, and submit to Architect before acceptance of the Work.
 - 2. Obtain inspections during the Work as required to allow timely progress of these and other trades.

1.21 GUARANTEE

- A. Guarantee all materials, equipment, apparatus and workmanship to be free of defective materials and faulty workmanship for period of one year from date of filing of Notice of Completion, unless extended guarantee periods are specified in individual sections.
- B. Furnish guarantee covering all work in accordance with general requirements of the Contract.
- C. Provide new materials, equipment, apparatus and labor to replace that determined by Architect to be defective or faulty.
- D. This guarantee also applies to services such as Instructions, Adjusting, Testing, Noise, Balancing, etc.
- E. Equipment manufacturers shall include extended warranty to give full coverage during warranty period, unless longer period is specified.

1.22 PRELIMINARY OPERATION

- A. Any portion of the system or equipment shall be placed in operation at the request of the Owner prior to the final completion and acceptance of the work. Such operation shall be under the direct supervision of the Contractor, but the expense thereof will be paid separately and distinct from any money paid on account of the Contract.
- B. Preliminary operation or payment thereof shall not be construed as acceptance of any part of the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Division 23 Sections where articles and subparagraphs introduce lists, the following requirements apply for product selection:
 - 1. Contractor's Options:
 - a. For products specified by naming several products or manufacturers, select any one of products and manufacturers named which complies with Specifications.
- B. Submission of equipment of manufacturers' other than those specified shall detail equality and difference, item by item.

2.2 GROUT

- A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic cement.
 - 1. Characteristics: Post-hardening, volume adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000psi, 28day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

2.3 ACCESS DOORS

- A. Size for proper access, adjusting and maintenance:
 - 1. 12 in. x 12 in. minimum for valves, trap primers, shock absorbers, etc.
 - 2. 24 in. x 24 in. for man access to concealed fans, coils, etc., unless indicated otherwise.

2.4 ACCESS TILE IDENTIFICATION

- A. Buttons, tabs, and markers: to identify location of concealed work.
- B. Submit for review.

2.5 PAINTING

- A. Manufacturers:
 - 1. SherwinWilliams.
 - 2. Pittsburgh Plate Glass Co.
 - 3. Pratt and Lambert.
 - 4. RustOleum.
- B. Materials:
 - 1. Best grade for its purpose.
 - 2. Deliver in original sealed containers.
 - 3. Apply in accordance with manufacturers instructions.
 - 4. Heat resistant paint for hot piping, equipment and materials.
 - 5. Colors as selected.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
 - 1. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - 2. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 EQUIPMENT INSTALLATION COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.
- E. Access to Valves and Equipment.
 - 1. Access shall be possible where valves, expansion joints, fire dampers, motors, filters, control devices, and any other equipment requiring access for servicing, repairs, or maintenance are located in walls, chases, and/or above ceilings.
 - 2. Definition of Accessible:
 - a. Valves and dampers may be operated.
 - b. Control devices may be adjusted.
 - c. Fire dampers may be reset.
 - d. Equipment access panels may be opened.
 - e. Normal maintenance work such as replacement of filters, lubrication of bearings, etc., may be performed readily within arm's reach of access opening.
 - f. It shall not be necessary to crawl through furred ceiling space to perform such operations.

3. Group concealed valves, expansion joints, controls, dampers and equipment requiring service access, so as to be freely accessible through access doors and to minimize the number of access doors required.
4. Relocate piping equipment and accessories as required, at no extra cost to afford proper maintenance access.
5. For access into ductwork see Section 233300: Air Duct Accessories.
6. Coordinate location of access panels with applicable trades installing walls or ceiling.
 - a. Coordinate panel locations with lights and other architectural features.
 - b. Submit proposed panel locations to Architect for review.
7. Access doors or panels will be installed by the trade furnishing surface on which panels are installed.
8. Arrange for location and marking of removable tiles in splined ceilings where access panels are not installed.
9. Existing Structures:
 - a. When installation requires access openings through existing construction, provide necessary panels, and arrange for respective trades to provide openings and framing which may be required.
 - b. Restore adjoining existing surfaces to original condition after new access panels have been installed.

3.3 PAINTING

- A. Painting of exposed rooftop equipment.
- B. Finish painting under Division 09 Sections "Interior Painting" and "Exterior Painting."
 1. Colors coordinated by Mechanical Contractor as directed by Architect.
- C. Painting under this Division:
 1. Interior of ductwork as far back as visible from outside: flat black.
 2. Uncoated hangers, supports, rods and inserts: dip in zinc chromate primer.
 3. Factory prime coat for following except as noted.
 - a. Fans.
 - b. Motors.
 - c. Equipment.
 - d. Air outlets.
 4. Marred surfaces of prime coated equipment and piping: spot prime coat to match adjacent coat.
- D. General:
 1. Labor, materials and equipment necessary for field painting.
 2. Protect flooring and equipment with drip cloths.
 3. Paint and materials stored in location where directed.
 4. Oily rags and waste removed from building every night.
 5. Furnish each space containing stored painting materials with approved 2½ gallon fire extinguisher.

6. Wire brush and clean off all oil, dirt and grease areas to be painted before paint is applied.
 7. Mixing:
 - a. Mixed and strained as required by manufacturer.
 - b. Use thinners only in accordance with manufacturers recommendation.
 - c. Follow printed instructions on paint containers. If none are available, instructions shall be obtained in writing from manufacturer.
 8. Workmanship:
 - a. No painting or finishing shall be done with:
 - 1) Dust laden air.
 - 2) Unsuitable weather conditions.
 - 3) Space temperature below 60°F.
 - b. Pipes being painted: containing no heat and to remain cold until paint is dried.
 - c. Paint spread: uniform and proper film thickness showing no runs, sags, crawls or other defects.
 - d. Finished surfaces shall be uniform in sheen, color, and texture.
 - e. All coats to be thoroughly dry before succeeding coats are applied, minimum 24 hrs. between coats.
 - f. Priming undercoat: slightly different color for inspection purposes.
 9. Exposed, un-insulated, un-galvanized sheet metal other than stainless steel and aluminum: Two coats of aluminum paint or alkyd paint color as directed.
 10. Exposed, un-insulated, galvanized sheet metal in finished space including mechanical equipment rooms:
 - a. One coat galvanized iron primer.
 - b. Two coats alkyd oil paint, color as directed.
 11. Exposed equipment covering:
 - a. One coat primer sealer.
 - b. Two coats alkyd oil paint, color as directed.
 12. Paint following with two coats alkyd oil paint, color as directed:
 - a. Exposed steel and metal work not furnished with factory painted finish.
 - b. Structural steel supports for piping ductwork and equipment.
 - c. Exposed, un-insulated piping.
 13. Exposed, un-insulated aluminum sheet metal in finished space:
 - a. One coat zinc chromate primer.
 14. No paint on exposed, un-insulated stainless steel sheet metal in finished space.
- E. Finish painting:
1. Consisting of two finished coats of high gloss medium or long alkyd paint over prime coat.
 2. Submit color shade for approval.
 3. Piping continuously painted in all exposed areas.
 4. Color coding per Section 230553: Mechanical Identification for HVAC piping and equipment
- F. Interior of ductwork as far back as visible from outside: flat black.
- G. Uncoated hangers, supports, rods and inserts: dip in zinc chromate primer.

- H. Factory finish:
 - 1. Steel air outlets in acoustical tile ceilings: baked white enamel.
 - 2. Aluminum air outlets: anodized.
 - 3. Exposed fan coil units: baked enamel.
 - 4. Unit ventilators and unit heaters: baked enamel.
- I. Factory prime coat, except as noted:
 - 1. Fans.
 - 2. Motors.
 - 3. Equipment.
 - 4. Registers.
 - 5. Diffusers.
 - 6. Grilles.
- J. Marred surfaces of prime coated equipment and piping: spot prime coat to match adjacent coat.
- K. Shop prime coat for following except as noted:
 - 1. Structural frames.
 - 2. Platforms.
 - 3. Ladders.
 - 4. Railings.
 - 5. Tanks.

3.4 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

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

3.5 CUTTING AND PATCHING

- A. All carpentry, cutting and patching to be done under trades doing that work.
- B. Provide all carpentry, cutting and patching required for proper installation of material and equipment specified in this Division.
- C. Do not cut or drill structural members without consent of Architect.

3.6 WATER PROOFING

- A. Under General Construction Work.
- B. Where any work pierces waterproofing, installation shall be subject to review.
 - 1. Provide all necessary sleeves, caulking, flashing and flashing fittings required to make openings absolutely watertight.
- C. Flashing:
 - 1. 6 lb. lead.
 - 2. 16 oz. lead coated copper.
 - 3. No.22 USSG aluminum.
 - 4. Fittings for piping through roof:
 - a. Galvanized cast iron bottom recess roof type.
 - b. Similar to Josam No. 26440 or No. 26450.
- D. Provide weather protection canopies, hoods or enclosures over equipment which could be damaged by exposure to weather.
 - 1. This requirement applies to:
 - a. Damper operators.
 - b. Damper bearings.
 - c. Controls.
 - d. Instruments.
 - 2. See other sections in this Division for application of this requirement to motors, drives, ducts, and fans, etc.
 - 3. Identify items under such covers if entirely enclosed.

3.7 CLEANING AND ADJUSTING

- A. Brush and clean work prior to concealing, painting and acceptance. Perform in stages if directed.
- B. Painted or exposed work soiled or damaged: clean and repair to match adjoining work before final acceptance.
- C. Remove debris from inside and outside of materials and equipment.
- D. Flush out piping after installation.
- E. Clean piping systems as described in Division 23, Section Hydronic Piping.
- F. Adjust valves and automatic control devices.
- G. Traps, wastes and supplies: unobstructed.

3.8 FIELD QUALITY CONTROL

- A. Tests:
 - 1. Perform as specified in individual sections, and as required by authorities having jurisdiction.
 - 2. Duration as noted.
- B. Provide required labor, material, equipment, and connections.
- C. Furnish written report and certification that tests have been satisfactorily completed.
- D. Repair or replace defective work, as directed.
- E. Pay for restoring or replacing damaged work due to tests, as directed.
- F. Pay for restoring or replacing damaged work of others, due to tests, as directed.

3.9 TRAINING

- A. Provide training by qualified manufacturers' representatives for equipment as specified in this Division.
- B. Each training session to be scheduled with Owner at least 30 days in advance.

END OF SECTION 230500

SECTION 230513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE OF WORK

- A. Contractor to furnish all electric motors as indicated and specified. Motors shall be of the energy efficient type as hereinafter specified.

1.3 SECTION INCLUDES

- A. Single phase electric motors.
- B. Three phase electric motors.

1.4 REFERENCES

- A. AFBMA 9 Load Ratings and Fatigue Life for Ball Bearings.
- B. AFBMA 11 Load Ratings and Fatigue Life for Roller Bearings.
- C. ANSI/IEEE 112 Test Procedure for Polyphase Induction Motors and Generators.
- D. ANSI/NEMA MG 1 Motors and Generators.
- E. ANSI/NFPA 70 National Electrical Code.

1.5 SUBMITTALS

- A. Submit product data under provisions of Division 1.
- B. Submit test results verifying nominal efficiency and power factor for three phase motors larger than 20 horsepower.
- C. Submit manufacturer's installation instructions under provisions of Division 1.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Division 1.
- B. Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacture of electric motors for specified use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.

1.8 REGULATORY REQUIREMENTS

- A. Conform to applicable electrical code ANSI/NFPA 70 National Electrical Code.
- B. Conform to local energy code.
- C. Refer to Paragraph 3.1C.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 01600.
- B. Store and protect products under provisions of Section 01600.
- C. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof covering. For extended outdoor storage, remove motor from equipment and store separately.

1.10 WARRANTY

- A. Provide manufacturer's warranty under provisions of Division 1.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Electrical Service: Refer to Sections 260519, 260526 & 260553 for required electrical characteristics.

- B. Motors: Design for continuous operation in 40 degrees C environment and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, Service Factor, and motor enclosure type.
- C. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.
- D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, Service Factor, Power Factor and efficiency.
- E. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide screwed conduit connection in end frame.
- F. Motors up to and including 1/3 horsepower shall be wired for 120 volts, single phase, 60 hz power. Motors 1/2 horsepower and larger shall be wired for volts, three phase, 60 hz power.
- G. Motors: Built in accordance with latest standards of NEMA and as specified.
- H. Tested in accordance with standards of ASA C50 and conforming thereto for insulation resistance and dielectric strength.
- I. Provided with adequate starting and protective equipment as specified or required and conduit terminal box.
- J. Capacity: Sufficient to operate associated driven devices under all conditions of operation at load and without overload at horsepower indicated or specified.
- K. All motors 5 HP and larger shall be of the premium efficiency type.
- L. All motors shall meet acoustical requirements of OSHA. Motors shall operate with sound level not exceeding 85 DBA, 3 feet from motor when tested according to I.E.E.E. Standard #85 test procedure.

2.2 SINGLE PHASE POWER SPLIT PHASE MOTORS

- A. Starting Torque: Less than 150 percent of full load torque.
- B. Starting Current: Up to seven times full load current.
- C. Breakdown Torque: Approximately 200 percent of full load torque.
- D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, pre-lubricated sleeve or ball bearings.
- E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.15 Service Factor, pre-lubricated ball bearings.

2.3 SINGLE PHASE POWER PERMANENT SPLIT CAPACITOR MOTORS

- A. Starting Torque: Exceeding one fourth of full load torque.
- B. Starting Current: Up to six times full load current.
- C. Multiple Speed: Through tapped windings.
- D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.15 Service Factor, pre-lubricated sleeve or ball bearings, automatic reset overload protector.

2.4 SINGLE PHASE POWER CAPACITOR START MOTORS

- A. Starting Torque: Three times full load torque.
- B. Starting Current: Less than five times full load current.
- C. Pull-up Torque: Up to 350 percent of full load torque.
- D. Breakdown Torque: Approximately 250 percent of full load torque.
- E. Motors: Capacitor in series with starting winding; capacitor start/capacitor run motors shall have two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, pre-lubricated ball bearings.
- G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.15 Service Factor, pre-lubricated ball bearings.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Motors drawing less than 250 Watts and intended for intermittent service may be germane to equipment manufacturer and need not conform to these specifications.
- B. Motors shall be open dripproof type, except where specifically noted otherwise.
- C. Motors five (5) horsepower and larger shall be premium energy efficient type.
- D. Single phase motors for shaft mounted fans, oil burners, centrifugal pumps shall be split phase type.
- E. Single phase motors for shaft mounted fans or blowers shall be permanent split capacitor type.

- F. Single phase motors for fans, pumps, blowers, air compressors shall be capacitor start type.
- G. Single phase motors for fans, blowers, pumps shall be capacitor start, capacitor run type.
- H. Motors located in exterior locations wet air streams downstream of sprayed coil dehumidifiers, draw thru cooling towers, air cooled condensers, humidifiers, direct drive axial fans, roll filters, explosion proof environments, dust collection systems shall be totally enclosed type. Refer to Paragraph 2.5L.
- I. Motors located in exterior locations, shall be totally enclosed weatherproof epoxytreated type. Refer to Paragraph 2.5L.

3.2 ACCEPTABLE MANUFACTURERS

- A. General Electric
- B. Baldor
- C. Reliance
- D. Substitutions: Under provisions of Division 1.

END OF SECTION 230513

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SECTION 230548

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Isolation mounts.
 - 3. Restrained vibration isolation roof-curb rails.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 - 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.
 - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
4. Seismic Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 - d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.
- B. Qualification Data: For professional engineer.
- C. Welding certificates.
- D. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.

- E. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
 - 1. Kinetics Noise Control.
 - 2. Mason Industries.
 - 3. Vibration Eliminator Co., Inc.
 - 4. Vibration Isolation.
 - 5. Vibration Mountings & Controls, Inc.

- D. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - 1. Resilient Material: Oil- and water-resistant neoprene.
- E. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- F. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
 - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 - 2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
 - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 - 1. Kinetics Noise Control.
 - 2. Mason Industries.
 - 3. Thybar Corporation.
 - 4. Vibration Eliminator Co., Inc.
 - 5. Vibration Isolation.

6. Vibration Mountings & Controls, Inc.

- D. General Requirements for Restrained Vibration Isolation Roof-Curb Rails: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic forces.
- E. Lower Support Assembly: Formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.
- F. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
 - 1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
 - a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
 - b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 2. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - a. Resilient Material: Oil- and water-resistant standard neoprene.
- G. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
- H. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

2.3 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- B. Equipment Restraints:
 - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES providing required submittals for component.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES providing required submittals for component.
- E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- H. Drilled-in Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 232113 "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 - 5. Test to 90 percent of rated proof load of device.
 - 6. Measure isolator restraint clearance.
 - 7. Measure isolator deflection.
 - 8. Verify snubber minimum clearances.
 - 9. Air-Mounting System Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 10. Air-Mounting System Operational Test: Test the compressed-air leveling system.
 - 11. Test and adjust air-mounting system controls and safeties.
 - 12. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust air-spring leveling mechanism.
- D. Adjust active height of spring isolators.
- E. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 230548

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SECTION 230553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Duct labels.
 - 4. Stencils.
 - 5. Access Tile Identification.
 - 6. Warning tags.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Comply with ASME A 13.1 "Scheme for the Identification of Piping Systems."

1.5 COORDINATION

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 - 2. Letter Color: Black.
 - 3. Background Color: Yellow.
 - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2 1/2 by 3/4 inch.
 - 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 7. Fasteners: Stainless steel rivets or self-tapping screws.
 - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Yellow.

- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 DUCT LABELS

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

2.4 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1 1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
 - 1. Stencil Material: Aluminum or brass.
 - 2. Stencil Paint: Exterior, gloss, alkyd enamel or acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray can form.
 - 3. Identification Paint: Exterior, alkyd enamel or acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 3 by 5-1/4 inches minimum.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

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

3.3 DUCT LABEL INSTALLATION

- A. Install plastic laminated duct labels with permanent adhesive on air ducts in the following color codes:
 - 1. Blue: For cold air supply ducts.
 - 2. Yellow: For hot air supply ducts.
 - 3. Green: For exhaust, outside, relief, return, and mixed air ducts.
 - 4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

- B. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction may be provided instead of plastic laminated duct labels, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.
- C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.4 WARNINGTAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

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SECTION 230593

TESTING, ADJUSTING, BALANCING AND SPECIAL INSPECTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

- A. Attention is directed to the applicable requirements of the various sections of the heating, ventilating and air conditioning work and the specific tests required or normally furnished as part of the Contractor's responsibility.
- B. The following tests and balancing procedures are in addition to those previously called for.
- C. Balancing shall include complete rebalancing of existing air handling unit presently serving the adjacent space. Final balance report for this project shall include this information.

1.3 QUALIFICATIONS

- A. The controlled inspection shall be performed by an independent registered professional engineer who is covered by both professional liability insurance and general comprehensive liability insurance acceptable to the Architect.
- B. Upon award of contract, contractor shall submit From TR 1 listing person designated to perform controlled inspection so as not to impede the obtaining of required building permits.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 AIR BALANCING

A. Scope

1. The Contractor shall procure the services of an independent air balance and testing agency approved by the Engineer, which specializes in the balancing and testing of Heating, Ventilating and Air Conditioning Systems, to balance, adjust, and test air moving equipment and air distribution or exhaust systems as herein specified. All work by this agency shall be done under direct supervision of a qualified heating and ventilating engineer employed by the agency. All instruments used by this agency shall be accurately calibrated and maintained in good working order. If required, the tests shall be conducted in the presence of Mechanical Engineer responsible for the project and/or his representative. Air balancing and testing shall not begin until the system has been completed and is in full working order. The contractor shall put all heating, ventilating and air conditioning systems and equipment into full operation and shall continue the operation of same during each working day of testing and balancing. The air balance and testing agency shall provide proof of having successfully completed at least five projects of similar size and scope.
2. The Contractor shall award the test and balance contract to the approved agency upon receipt of his contract to proceed with the air conditioning installation, to allow the air balance and testing agency to schedule this work in cooperation with other contractors involved and comply with completion date.
3. The balancing agency supervising engineer shall be Licensed Professional Engineer approved by New York State.

B. Air Balance Procedure:

1. Upon completion of the heating, ventilating and air conditioning systems, the Air Balance and Testing Agency shall perform the following tests, compile the test data and submit six (6) copies of the complete test data to the Contractor for forwarding to the General Contractor for evaluation and approval. The independent Air Balance and Testing Agency shall be qualified and certified member of Associated Air Balance Council.
2. Air Balance and Testing Agency shall perform the following tests and balance the system with flow measuring hood in accordance with the following requirements:
 - a. Test and adjust blower rpm to design requirements.

- b. Test and record full load amperes.
 - c. Make Pitot tube traverse of main supply and obtain design cfm at fans.
 - d. Test and record system static pressure, suction and discharge.
 - e. Test and adjust system for design cfm outside air.
 - f. Test and record entering air temperatures (db heating).
 - g. Test and record leaving air temperatures (wb heating).
 - h. Test and record leaving air temperatures (db cooling).
 - i. Test and record leaving air temperatures (wb cooling).
 - j. Adjust all main supply and exhaust air ducts to design cfm. Record CFM and static pressure at traverses.
 - k. Adjust all zones to design cfm, supply and exhaust.
 - l. Test and adjust each diffuser, grille, and register to within 5% of design requirements.
 - m. Submit plan identifying each diffuser, grille, and register. Plan shall indicate name and room number.
 - n. Identify and list size, type and manufacturer of diffusers, grilles, registers, and all testing equipment. Use manufacturers rating on all equipment to make required calculations.
 - o. In readings and tests of diffusers, grilles, and registers, include required fpm velocity and test fpm velocity and required cfm and test cfm after adjustments.
 - p. In cooperation with the control manufacturer's representative set adjustments of automatically operated dampers to operate as specified, indicated, and/or noted.
 - q. Adjust all diffusers, grilles, and registers to minimize drafts in all areas.
 - r. Check rotation of fan.
- 3. As part of this Contract, the Contractor shall make any changes in or replace the pulleys, belts, and dampers or add any dampers as required for correct balance as recommended by the Air Balance and Testing Agency or Engineer at no additional cost to the Owner.
 - 4. The final data in Report Form shall be submitted under signature of a Professional Engineer registered in the State.

3.2 WATER BALANCING

A. Scope

- 1. The Contractor shall procure the services of an independent Balance and Testing Agency, approved by the Engineer, which specializes in the balancing and testing of heating, ventilating and air conditioning systems, to balance, adjust and test all water systems and equipment as herein specified. This agency must have the same experience and qualifications detailed in Paragraph 3.01A.
- 2. All work by this Agency shall be done under direct supervision of a qualified heating and ventilating engineer employed by the Agency. All instruments used by this agency shall be accurately calibrated and maintained in good working order. If requested, the tests shall be conducted in the presence of the Mechanical Engineer responsible for the project and/or his representative.

3. All testing and balancing shall be performed in conjunction within the subcontractor for the automatic temperature controls and the manufacturer of refrigeration chillers.

B. Water Balancing Procedure:

1. The Balance and Testing Agency must provide the technicians with the following instruments for field use:
 - a. One set of pressure gauges and fittings.
 - b. Dry bulb thermometer.
 - c. Wet bulb thermometer.
 - d. Thermocouple unit and thermocouples.
 - e. Set of balancing cock adjustment wrenches.
 - f. Portable field flowmeter.
2. Preparation of System Phase I - The balance engineer or technicians must prepare the water systems for balancing in the following manner:
 - a. Open all valves to full position, including coil stop valves, close bypass valves, and return line balancing cocks.
 - b. Remove and clean all strainers.
 - c. Set all temperature controls so that all coils are calling for full cooling. This should close all automatic bypass valves at chiller.
 - d. Check and set operating temperature of chillers and bleed valves to design requirements.
 - e. Complete air balance must have been accomplished before water balance is begun.
3. Upon completion, the balancing engineer shall prepare on a neatly typed sheet a listing of all items required by specifications. This shall be included in the complete test and balance report.
4. Methods of balancing at each coil shall be as outlined in specifications, but the procedure outlines here shall be followed in each case.

3.3 CONTROLLED INSPECTION

- A. The following items are to be inspected and tested in accordance with the applicable sections of the New York City Building code but shall not be limited to items described.

<u>Item</u>	<u>Code Section</u>
Final Inspection	Directive 14

- B. Test all smoke and fire protection devices* and systems related to the ventilating systems to verify that they are functioning properly. Where possible this test shall be carried out at the same time as the Fire Department Inspector's inspection.

*(In case of fusible link fire dampers, spot check as many dampers as necessary to be fully convinced of the acceptability of the installation.)

3.4 SAMPLE FORMATS

- A. Air and water balancing reports shall be submitted using the sample formats.

END OF SECTION 230593

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SECTION 230713
DUCTWORK INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE OF WORK

- A. The work described in this Section is intended to provide both thermal and acoustic treatment to duct systems.

1.3 RELATED WORK

- A. Section 09900 Painting: Painting insulation jackets.
- B. Section 230529 Support and Anchors.
- C. Section 230553 Mechanical Identification.
- D. Section 233300 Ductwork and Ductwork Accessories.

1.4 REFERENCES

- A. ANSI/ASTM C553 Mineral Fiber Blanket and Felt Insulation.
- B. ANSI/ASTM C612 Mineral Fiber Block and Board Thermal Insulation.
- C. ASTM E84 Surface Burning Characteristics of Building Materials.
- D. NFPA 255 Surface Burning Characteristics of Building Materials.
- E. UL 723 Surface Burning Characteristics of Building Materials.

1.5 QUALITY ASSURANCE

- A. All insulation materials, including jackets, facings, adhesives, coatings, and accessories, shall be fire hazard rated and listed by Underwriters' Laboratory, Inc., using

the Steiner Tunnel Test Method for Fire Hazard Classification of Building Materials, Standard UL 723 (ASTM E-84) and NFPA 255.

1. The Underwriters' Laboratory, Inc. listed Class I flamespread rating shall be a maximum of 25 and the fuel contributed and smoke developed rating shall be a maximum of 50.
 2. Flame-proofing treatments which are subject to deterioration from moisture or humidity are not acceptable.
- B. Refer to Section GENERAL PROVISIONS FOR HEATING, VENTILATION AND AIR CONDITIONING WORK for Guarantee and other Quality Assurance requirements.
- C. All insulation materials, thickness and densities shall meet the New York State Energy Conservation Code as minimum requirements.

1.6 SUBMITTALS

- A. Submit shop drawings for insulation materials, vapor barrier materials, adhesives, fastening devices and finishes and jacketing.
- B. Submit a schedule listing the work that will be insulated and a description of insulation materials and finishing procedures and a certificate indicating compliance with code.

PART 2 - PRODUCTS

2.1 BASE BID MANUFACTURERS

- A. Fiberglass insulation: Certain Teed Corp., Manville Corp., Owens-Corning Fiberglas Corp. and Knauf Fiber Glass.
- B. Calcium silicate insulation: Manville Corp. and Owens-Corning Fiberglas Corp.
- C. Finishes, adhesives and sealants: Foster Products Div., H.B. Fuller Co., Epolux Mfg. Co., Childers Products Co. and Armstrong World Industries.
- D. Weld pins: AGM Industries, Inc. and Duro-Dyne Corp.
- E. Weatherproof aluminum jacket: Epolux Mfg. Corp., Manville Corp., Pabco, Inc., Premetco, Inc. and Childers Products Co.
- F. Insulating tapes: Compac Corp., Nashua Tapes, Nashua Corp. and Fasson.

2.2 DUCTWORK AND EQUIPMENT INSULATION

- A. Type D-1: Fiberglass blanket. The maximum K factor shall be 0.28 at 75°F mean temperature with a minimum density of 0.75 pounds per cubic foot. Insulation shall be provided with a factory-applied foil-scrim-kraft (FSK) facing. Insulation shall be equal to Johns Manville Microlite Type 75 FSK.
- B. Type D-2: Fiberglass board. The maximum K factor shall be 0.23 at 75°F mean temperature with a minimum density of 3 pounds per cubic foot. Insulation shall be provided with a factory-applied all purpose (AP) facing. Insulation shall be equal to Johns Manville Type 814 Spin-Glass AP.
- C. Type D-4: Weatherproof fiberglass board. The maximum K factor shall be 0.22 at 75°F mean temperature, with a minimum density of 6 pounds per cubic foot and a factory-applied all purpose or all service jacket facing. Insulation shall be similar to Johns Manville Type 817 Spin-Glass AP.
- D. Type D-5: Acrylic coated fiberglass rigid board duct-liner. The maximum K factor shall be 0.23 at 75 F mean temperature with a minimum density of 3 lbs. Per cubic foot. The acrylic coating shall be located on the air stream side. Insulation shall be similar to Johns Manville Permacote R-300 and be in compliance with NFPA 90A and 90B.
- E. Type D-6: Acrylic coated fiberglass flexible duct liner. The maximum K factor shall be 0.23 at 75 F mean temperature with a minimum density of 3 lbs. Per cubic foot. The acrylic coating shall be located on the air stream side. Insulation shall be similar to Johns Manville Permacote Linacoustic 1 in. high performance plenum liner and be in compliance with NFPA 90A and 90B.
- F. Type D-7: Calcium silicate block. The maximum K factor shall be 0.44 at 300°F mean temperature with a minimum density of 12 pounds per cubic foot. Deflection at 200 PSIG shall be less than 5 percent. The block shall be scored as required to fit round ducts. Insulation shall be asbestos free and similar to Johns Manville Thermo-12 Gold.
- G. Type D-8: Vermiculite fireproof plaster. The plaster shall contain mineral wool binders, be asbestos free, and similar to International Vermiculite Co. Therm-O-Seal.
- H. Type D-9: Fire resistive duct wrap. Thermal conductivity value shall be 0.44 at 500°F. Ceramic fiber blanket shall be manufactured from refractory inorganic oxides, with foiled face, and rated for 2300°F. Insulation shall be similar to Premier Pyroscat FP.

2.3 FINISHES, ADHESIVES, SEALANTS AND JACKETS

- A. Type F-2: Aluminum jacketing. The jacketing shall have a minimum 0.016 inch wall thickness and have longitudinal joints with lock seams.
- B. Type F-3: Elastomeric vapor barrier mastic. The elastomer based vapor barrier mastic shall be applied over 10 x 10 or 20 x 20 glass, polyester or nylon cloth reinforcing

membrane. It shall have a 50 mil dry film thickness. The mastic shall be similar to Foster Monolar 60-38 or 60-56.

- C. Type F-5: Off-white vapor seal adhesive. The adhesive shall be non flammable, solvent based, quick setting and with a maximum permeance of 0.05. The adhesive shall be equal to Foster Spark-Fas 8520.
- D. Type F-6: Flexible vapor barrier sealant and bedding compound. The compound shall be equal to Foster Foamseal 30-45.

2.4 WIRE, BANDING AND FASTENING DEVICES

- A. The wire shall be a minimum 16 gauge copper clad annealed steel wire. The bands shall be 3/4 inch nominal width with wing seals, of minimum thickness as follows:
 - 1. Aluminum: 0.007 inches where exposed to weather, 0.020 inches.
 - 2. Galvanized steel: 0.005 inches
 - 3. Stainless steel: 0.005 inches
- B. The staples shall be the outward clinching type of corrosion resistant steel. The weld pins which support and fasten the duct insulation shall be a minimum 1/8 inch diameter with speed washer or integral flange of minimum 1 3/8 inch diameter. The metal lathe shall consist of galvanized steel.
- C. Insulation tape: the tape shall be UL rated with all service or foil-scrim jacket to match insulation and of width as noted. The tape shall be similar to Compac Corp. UL ASJ or UL FKJ PS Tape.

2.5 DUCTWORK

- A. Insulate ductwork in the following systems:
 - 1. All air conditioning supply.
 - 2. Air conditioning return, except ductwork exposed in air-conditioned spaces, and ductwork installed in hung ceiling where spaces immediately above and below are both air-conditioned. All return ductwork in mechanical equipment room shall be insulated.
 - 3. All outdoor exposed to weather supply and return ductwork and all ductwork shown.
 - 4. Exhaust air ductwork between automatic dampers and louvers, outdoor air intake duct from louvers to air-handling unit, outside air-intake duct from plenum to air-handling unit, exhaust duct passing through air-conditioned spaces, wet exhaust duct passing through air-conditioned space, and any system where temperature may exceed 85 deg F.
- B. Thickness shall be equal to the depth of the steel angles, except that the thickness shall be not less than 1 inch and not more than 2 inches. Insulation is not required where sound-lining is of minimum thickness specified for insulation

- C. Insulation schedule - rectangular ductwork except outdoor air intake duct:

	Concealed	Exposed	Outdoor
Type:	D-1	D-2	D-4
Finish:	-	-	F-3
Thickness:	1½ in.	1½ in.	2 in.
Vaporseal Req'd.	Yes	Yes	Yes

- D.

Insulation schedule - round ductwork except outdoor air-intake duct:

	Concealed	Exposed
Type:	D-1	D-2
Finish:	-	F-2
Thickness:	1½ in.	1½ in.
Vaporseal Req'd.	Yes	Yes

- E. Insulation schedule rectangular duct - for outside air-intake duct:

	Concealed	Exposed
Type:	D-4	D-4
Finish:	-	F-5
Thickness:	2½ in.	2½ in.
Vaporseal Req'd.	Yes	Yes

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: before applying insulation, complete and approve the required pressure and leakage tests of joints and connections. In addition, clean surfaces of dust, grease and foreign matter and dry before application of insulation. Insulation shall not be installed on pipe and black metal until the surface has received a prime coat of paint. All insulation joints shall be butted firmly together and all jackets shall be smoothly and securely installed. Insulate each pipe and duct individually. Do not use scrap pieces of insulation where a full length section will fit. Except for specific exceptions, insulate entire specified equipment, piping and duct systems.
- B. Ducts, plenums, casings, housing and equipment:

1. Fiberglass blanket: install 2 inch lap strip at one end; peel insulation for 2 inch and lap strip along longitudinal joints. Secure bottom of rectangular ducts over 24 inches wide with two (2) rows of weld pins 12 inches on center. Secure joints with outward clinching staples 6 inches on center. Seal all strips with foil vapor barrier tape and Type F-7 vaporseal adhesive.
 2. Fiberglass board: seal joints and breaks in facings with 3 inch wide tape to match facing and adhere with vapor seal adhesive. Apply 5 inch wide tape at corners. Weld pins on top, sides and bottom.
- C. Weld pins and anchors: spacing shall be minimum 12 inch centers and minimum two (2) rows per side of duct. Maximum permissible load shall be 5lb. for 2 inch x 2 inch base-plate and 10lb. for 2 3/4 inch x 2 3/4 inch base-plate. Clip off pin penetrations flush with insulation surface or facing. Seal pins and washers with 4 inch square pieces of Type F-9 vapor barrier tape to match facing and adhere with vaporseal adhesive.
- D. Adhesives and coatings:
1. Apply at following rates, in accordance with the manufacturer's recommendations
 - a. Type F-2 vapor barrier coating shall be 50 sq. ft./gal.
 - b. Type F-9 vaporseal adhesive shall be 100 sq. ft./gal.
 - c. Type F-6 outdoor mastic (vinyl acrylic) shall be 12 sq. ft./gal.
 2. Adhere jackets and facing with wet coat of Type F-9 adhesive. Lap sealing for full width of lap. Surfaces which will be adhered shall be completely coated with adhesive.

END OF SECTION 23 07 13

SECTION 230719

PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE OF WORK

- A. Furnish insulation and specified finishes for all piping hereinafter specified and/or indicated.

1.3 RELATED WORK

- A. Section 09900 Painting: Painting insulation jacket.
- B. Section 230529 Support and Anchors
- C. Section 230553 Mechanical Identification
- D. Section 232113 Hydronic Piping and Specialties
- E. Section 232213 Steam and Steam Condensate Piping
- F. Section 232214 Steam and Steam Condensate

1.4 REFERENCES

- A. ANSI/ASTM C195 Mineral Fiber Thermal Insulation Cement.
- B. ANSI/ASTM C533 Calcium Silicate Block and Pipe Thermal Insulation.
- C. ANSI/ASTM C547 Mineral Fiber Preformed Pipe Insulation.
- D. ANSI/ASTM C552 Cellular Glass Block and Pipe Thermal Insulation.
- E. ANSI/ASTM C578 Preformed, Block Type Cellular Polystyrene Thermal Insulation.
- F. ASTM B209 Aluminum and Aluminum alloy Sheet and Plate.

- G. ASTM C449 Mineral Fiber Hydraulic setting Thermal Insulating and Finishing Cement.
- H. ASTM C610 Expanded Perlite Block and Pipe Thermal Insulation.
- I. ASTM E84 Surface Burning Characteristics of Building Materials.
- J. NFPA 255 Surface Burning Characteristics of Building Materials.
- K. UL 723 Surface Burning Characteristics of Building Materials.

1.5 QUALITY ASSURANCE

- A. All insulation materials, including jackets, facings, adhesives, coatings, and accessories, shall be fire hazard rated and listed by Underwriters' Laboratory, Inc., using the Steiner Tunnel Test Method for Fire Hazard Classification of Building Materials, Standard UL 723 (ASTM E-84) and NFPA 255.
 - 1. The Underwriters' Laboratory, Inc. listed Class I flame spread rating shall be a maximum of 25 and the fuel contributed and smoke developed rating shall be a maximum of 50.
 - 2. Flame-proofing treatments which are subject to deterioration from moisture or humidity are not acceptable.
- B. Refer to Section GENERAL PROVISIONS FOR HEATING, VENTILATION AND AIR CONDITIONING WORK for Guarantee and other Quality Assurance requirements.
- C. All insulation materials, thickness and densities shall meet the New York State Energy Conservation Code as minimum requirements.

1.6 SUBMITTALS

- A. Submit shop drawings for insulation materials, vapor barrier materials, adhesives, fastening devices and finishes and jacketing.
- B. Submit a schedule listing the work that will be insulated and a description of insulation materials and finishing procedures and a certificate indicating compliance with code.

PART 2 - PRODUCT

2.1 BASE BID MANUFACTURERS

- A. Fiberglass insulation: Certain Teed Corp., Manville Corp., Owens-Corning Fiberglas Corp. and Knauf Fiber Glass.

- B. Calcium silicate insulation: Manville Corp. and Owens-Corning Fiberglas Corp.
- C. Finishes, adhesives and sealants: Foster Products Div., H.B. Fuller Co., Epolux Mfg. Co., Childers Products Co. and Armstrong World Industries.
- D. Weld pins: AGM Industries, Inc. and Duro-Dyne Corp.
- E. Weatherproof aluminum jacket: Epolux Mfg. Corp., Manville Corp., Pabco, Inc., Premetco, Inc. and Childers Products Co.
- F. Insulating tapes: Compac Corp., Nashua Tapes, Nashua Corp. and Fasson.

2.2 PIPE INSULATION

- A. Type P-1: molded fiberglass. The maximum K factor shall be 0.23 at 75 deg F mean temperature with a minimum density of 4lb. The insulation shall be provided with a factory-applied all service or all purpose jacket consisting of fire retardant laminate of white kraft facing, glass scrim reinforcing and aluminum foil. The insulation shall be similar to Owens-Corning 650 ASJ.
- B. Type P-2: molded calcium silicate. The maximum K factor shall be 0.44 at 300 deg F mean temperature with a minimum density of 12lb. The insulation shall be furnished without a factory applied jacket. The insulations shall be similar to Owens - Corning Kaylo - 10.
- C. Type P-3: molded fiberglass fittings. The maximum K factor shall be 0.23 at 75 deg F mean temperature with a minimum density of 4lb. The insulation shall be similar to Epolux Hamfab Molded Fittings.
- D. Type P-4: fiberglass fitting inserts. The maximum K factor shall be 0.28 at 75 deg F mean temperature with a minimum density of 1lb. The insulation shall be similar to Manville Hi-Lo Temp Insulation Inserts.

2.3 FINISHES, ADHESIVES, SEALANTS AND JACKETS

- A. Type F-2: Aluminum jacketing. The jacketing shall have a minimum 0.016 inch wall thickness and have longitudinal joints with lock seams.
- B. Type F-3: Elastomeric vapor barrier mastic. The elastomer based vapor barrier mastic shall be applied over 10 x 10 or 20 x 20 glass, polyester or nylon cloth reinforcing membrane. It shall have a 50 mil dry film thickness. The mastic shall be similar to Foster Monolar 60-38 or 60-56.
- C. Type F-5: Off-white vapor seal adhesive. The adhesive shall be non flammable, solvent based, quick setting and with a maximum permeance of 0.05. The adhesive shall be equal to Foster Spark-Fas 8520.

- D. Type F-6: Flexible vapor barrier sealant and bedding compound. The compound shall be equal to Foster Foamseal 30-45.

2.4 WIRE, BANDING AND FASTENING DEVICES

- A. The wire shall be a minimum 16 gauge copper clad annealed steel wire. The bands shall be 3/4 inch nominal width with wing seals, of minimum thickness as follows:
1. Aluminum: 0.007 inches where exposed to weather, 0.020 inches.
 2. Galvanized steel: 0.005 inches
 3. Stainless steel: 0.005 inches
- B. The staples shall be the outward clinching type of corrosion resistant steel. The weld pins which support and fasten the duct insulation shall be a minimum 1/8 inch diameter with speed washer or integral flange of minimum 1 3/8 inch diameter. The metal lathe shall consist of galvanized steel.
- C. Insulation tape: the tape shall be UL rated with all service or foil-scrim jacket to match insulation and of width as noted. The tape shall be similar to Compac Corp. UL ASJ or UL FKJ PS Tape.

2.5 PIPING, VALVES AND FITTING

- A. Low temperature hot piping systems - 100 deg F to 250 deg including:
1. Hot water supply and return.
- B. Insulation schedule:

INSULATION SCHEDULE – LOW TEMPERATURE HOT PIPING SYSTEMS			
		INDOOR	OUTDOOR
Pipe	Type	P-1	P-1
	Finish	-	F-4
Fittings and Valves	Type	P-3 or P-4	P-3
	Finish	-	F-4
Thickness	Up to 2½ in IPS	1 ½ inch	2 inch
	2½ to 4 in in IPS	2 inch	3 inch
	Over 4 in IPS	2 ½ inch	3 ½ inch
Vaporseal Req'd		NO	NO

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: before applying insulation, complete and approve the required pressure and leakage tests of joints and connections. In addition, clean surfaces of dust, grease and foreign matter and dry before application of insulation. Insulation shall not be installed on pipe and black metal until the surface has received a prime coat of paint. All insulation joints shall be butted firmly together and all jackets shall be smoothly and securely installed. Insulate each pipe and duct individually. Do not use scrap pieces of insulation where a full length section will fit. Except for specific exceptions, insulate entire specified equipment, piping and duct systems.
- B. Piping: on longitudinal overlaps, provide 2 inch minimum. For exposed work, install toward ceiling or wall. For weatherproof aluminum jackets, install on side to shed water. For underground piping, install on side, turned down. Use circumferential overlaps on weatherproof aluminum jackets. Insulation passing through sleeves or other openings shall be continuous. Install metal frames to protect edges of openings in insulation. Oversize insulation to accommodate heat tracing on piping. At penetration of fire or smoke barriers, wrap pipe with rock-wool insulation, seal jacket seam and seal end joints to adjacent sections of insulation.
 - 1. Except as noted, the insulation for frost-proofed piping shall be the same as specified for the particular service, except that the insulation thickness shall be two (2) times the thickness indicated and oversized to fit over pipe and heating element. Outdoor piping shall be provided with F4 or F10 jacket.
 - 2. Where specified thickness of insulation exceeds available single layer thickness, install insulation in two (2) layers with joints staggered.
 - 3. Fill voids with Type F-6 insulating cement.
 - 4. For valves, fittings, flanges and accessories insulation, insulation type shall be as noted above. Unless otherwise noted, insulate valves including bonnets, flanges, fittings, strainers, expansion joints and specialties. Insulation for strainers, expansion joints, fittings and accessories requiring servicing or inspection. Insulation shall be removable and replaceable without damage, and enclosed within two-piece, No. 18 gauge aluminum covers fastened with cadmium-plated bolts and nuts. Insulation shall be of the same thickness as adjacent piping insulation.
 - a. In piping systems insulated with fiberglass, secure insulation with wire. Under 3 inch pipe size, built-up coating of Type F-6 insulating and finishing cement to match the thickness of adjoining pipe insulation may be used.
 - 1) Finishes, Type F-1: apply factory pre-molded cover and seal edges with Type F-9 vapor barrier sealer and fiberglass tape as recommended by the manufacturer.
 - 2) Finishes Types F-2 and F-3: apply uniform layer of finish coating to cover the entire surface of fitting insulation and embed layer of

- fiberglass tape into wet coating, extending 2 inches over adjoining pipe covering. Apply finish layer of coating over the entire surface.
- b. For above ground piping systems insulated with calcium silicate, wire on pre-molded sections of calcium silicate fitting covers or mitered segments of pipe insulation. Under 3 inch IPS, built-up coating of insulating and finishing cement to match the thickness of adjoining pipe insulation may be used, with Type F-2 finish on exposed pipes. For exposed locations only, apply a skim coat of Type F-6 finishing cement to smooth out the surface of the fitting insulation and a coat of type F-2 finish.
 - c. Flanges: insulation sleeve shall be of the same material as the pipe insulation, to cover the flange and overlap the insulation on the adjacent piping. For calcium silicate insulation, provide calcium silicate rings between the sleeve and the pipe insulation. Finish for outdoor locations only: a weatherproof aluminum jacket compatible with the weatherproof jacket on the adjoining pipe insulation.
5. Wiring, banding and fastening devices: secure the insulation to the piping in accordance with the following minimum requirements.
- a. Piping insulation section 3 ft long:
 - 1) Type P-1 molded fiberglass: self-sealing laps may be used. Staples are not permitted on vaporesealed piping.
 - 2) Type P-2 calcium silicate: secured with wire at ends and center.
 - 3) Type P-5 insulation: banded per the manufacturer's recommendations.
 - 4) Other Types: per the manufacturer's recommendations.
 - b. For pipe fitting insulation, loops or wire shall be installed to secure mitered segments of insulation. The wire shall be spiraled from end to end on blanket insulation. Outdoor piping weatherproof aluminum jackets shall be banded at circumferential joints and at the center of each section.
6. At Pipe Hangers: for fiberglass insulated piping, provide an 18 inch long calcium silicate section continuous with the adjoining pipe insulation and jacket. Insulation protection saddles and shields shall be as specified in Section "PIPING." No hangers shall be embedded in insulation. Saddles shall be filled with insulation of type specified for the service, or filled with insulating cement.
7. Jackets and facings: all staples shall be sealed with Type F-9 vapor barrier sealant. Prior to sealing jackets on services below 35 deg F, apply 1/16 inch minimum thickness F-9 vapor barrier coating to ends of pipe insulation at butt joints, overlapping inside surface of insulation a minimum of 2 inches every 21 ft on straight runs. Adhere longitudinal laps if self-sealing laps are not used and as necessary to maintain integrity of the vaporeseal. Adhere 3 inch wide joint strip, of same material as facing, at center of each butt joint, if self-sealing butt strips are not used.
- a. Adhesives: indoor shall be Type F-9. Weatherproof aluminum jacket shall be Type F-4.
8. Contractor shall provide and install PVC covering on all outdoor insulated pipes. Similar to Zeston 2000 PVC as manufactured by John Manville.

END OF SECTION 230719

SECTION 232113

HYDRONIC PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 General

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

1.2 SCOPE OF WORK

- A. Furnish all piping and hydronic specialties required to make apparatus connected complete and ready for regular operation. Unless otherwise noted connect all apparatus and equipment in accordance with manufacturers' standard details, as approved.

1.3 WORK INCLUDED

- A. Pipe and pipe fittings.
- B. Valves.
- C. Reheat Hot water piping system.
- D. Air vents.

1.4 RELATED WORK

- A. Section 08305 Access Doors.
- B. Section 09900 Painting.
- C. Section 230529 Supports and Anchors
- D. Section 230553 Mechanical Identification
- E. Section 230548 Vibration Isolation
- F. Section 230719 Piping Insulation
- G. Section 230566 Testing, Adjusting, Balancing and Controlled Inspection

1.5 REFERENCES

- A. ANSI/ASME Boiler and Pressure Vessel Code.
- B. ANSI/ASME Sec 9 Welding and Brazing Qualifications.
- C. ANSI/ASME B16.3 Malleable Iron Threaded Fittings Class 150 and 300.
- D. ANSI/ASME B16.23 Cast Copper Alloy Solder Joint Drainage Fittings DWV.
- E. ANSI/ASME B16.29 Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings DWV.
- F. ANSI/ASME B31.9 Building Services Piping.
- G. ANSI/AWS A5.8 Brazing Filler Metal.
- H. ANSI/AWS D1.1 Structural Welding Code.
- I. ASTM A53 Pipe, Steel, Black and HotDipped Zinc Coated, Welded and Seamless.
- J. ASTM A120 Pipe, Steel, Black and HotDipped Zinc Coated (Galvanized), Welded and Seamless, for Ordinary Uses.
- K. ASTM A234 Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- L. ASTM B32 Solder Metal.
- M. ASTM B88 Seamless Copper Water Tube.
- N. ANSI/AWWA C606 Grooved and Shouldered Joints.
- O. ASTM A395 Ferritic Ductile Iron Pressure Retaining Castings.
- P. ASTM A536 Ductile Iron Castings.
- Q. ASTM B75 Seamless Copper Tube.
- R. ASTM D2235 Solvent Cement for AcrylonitrileButadieneStyrene (ABS) Plastic Pipe and Fittings.

1.6 REGULATORY REQUIREMENTS

- A. Conform to ANSI/ASME B31.9.
- B. Conform to ANSI/ASME Boilers and Pressure Vessels Code Section 8D for manufacture of tanks.

1.7 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Welding Materials and Procedures: Conform to ANSI/ASME SEC and applicable state labor regulations.
- C. Welders Certification: In accordance with ANSI/ASME SEC 9.

1.8 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Division 1.
- B. Include data on pipe materials, pipe fittings, valves, and accessories.
- C. Include welders certification of compliance with ANSI/ASME SEC 9.
- D. Submit shop drawings and product data for manufactured products and assemblies required for this project.
- E. Include component sizes, roughin requirements, service sizes and finishes. Include product description, model and dimensions.
- F. Submit inspection certificates for pressure vessels from ASME authority having jurisdiction.
- G. Submit manufacturer's installation instructions under provisions of Division 1.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 01600.
- B. Store and protect products under provisions of Section 01600.
- C. Deliver and store valves in shipping containers with labeling in place.

1.10 MINIMUM PIPE SIZES

- A. Minimum pipe sizes shall be 1/2" on vents 3/4" on all water piping.

PART 2 - PRODUCTS

2.1 MATERIALS FOR PIPING

- A. Pipe Service Classification

1. Piping up to and including 2½" to be screwed. Piping 3" and larger to be welded or grooved.

Service	Size	Material	Type	Weight
Hot Water Heating and Reheat Branch Piping	3" and under	Steel ASTM A-53	Black Welded	Schedule 40
Vents (Atmos.)	Up to 6"	Steel ASTM A-120	Galv.	Schedule 40
Vents (Atmos.)	Up to 6"	Steel ASTM A-120	Black Seamless	Schedule 40

2. Fittings to be ANSI/ASTM B16.3 malleable iron or ASTM A234 forged steel welding type fittings.
3. Joints: Screwed or ANSI/AWS D1.1 welded.
4. Piping 12"20" OD wall thickness shall be 0.375".

B. Copper Tubing: ASTM B88, Type L, hard drawn.

1. Fittings: ANSI/ASME B16.23 cast brass or ANSI/ASME B16.29 solder wrought copper.
2. Joints: ASTM B32, solder, Grade 95TA.

2.2 FLANGES, UNIONS, AND COUPLINGS

- A. Pipe Size up to 2 1/2" Inches and Under: 150 psig malleable iron unions for threaded ferrous piping; bronze unions for copper pipe, soldered joints.
- B. Pipe Size Over 2 1/2 Inches: 150 psig forged steel slipon flanges for ferrous piping; bronze flanges for copper piping; 1/16 inch thick preformed gasket.
- C. Pipe flanges for welding piping shall be forged steel welding neck type, with raised face, conforming to ASA B16.5 dimensions, and pressure/temperature ratings and ASTM, A181 Grade 1 for 150 lb. class flanges and A105 Grade 1 for 400 lb. and 600 lb. class flanges. Flanges shall be faced and drilled and shall be bored to the exact inside diameter of the pipe to which they are connected. Pipe flanges shall be as manufactured by TubeTurn, Midwest, Grinnell, or as approved.
- D. Gaskets: Unless otherwise specified, makeup flanged joints with one piece gaskets, ring or full face as required, 1/16" thick. For water piping, rubber composition.

2.3 GATE VALVES

- A. Low pressure piping: (Up to 100 PSI) Valves, unless otherwise specified.
 1. Standard weight, 150 psi WSP Class.
 2. 3" and larger, flanged: smaller sizes, screwed.
 3. Figure numbers indicated refer to Stockham valves.
 - a. Up to 21/2": bronze gate, solid wedge, inside screw, non traveling spindle. Fig. B120

- b. 3" to 16": iron body bronze mounted gate, solid wedge, O.S. & Y., rising spindle. Fig. G623

2.4 GLOBE VALVES

- A. Low Pressure Piping (Up to 100 PSI)
 - 1. Figure numbers indicated refer to Stockham valves.
 - a. Up to 2": Bronze globe, regrinding seat, ring and plug, union bonnet, Fig. B37.
 - b. 2 1/2": Bronze globe composition disc. Fig. B22T.
 - c. 3" to 8": Iron body bronze mounted globe, regrinding disc and seat ring. O.S. & Y. Fig. G512.

2.5 LUBRICATED PLUG VALVES

- A. Low Pressure Piping (Up to 80 PSI)
 - 1. Up to 2 1/2" Fig. 114
 - 2. 3" and 4" Fig. 115
 - 3. 5" Fig. 189 (with worm gear operator)
 - 4. 6" TO 12" Fig. 149 (with worm gear operator)
 - 5. 14"20" Fig. 1169 (with worm gear operator)
 - 6. Furnish indicator arc on each valve.
 - 7. Figure numbers indicated refer to Rockwell.

2.6 CHECK VALVES

- A. General requirements, same as for stop valve. Furnish where specified or indicated, and at discharge of every pump. Except where otherwise specified, same manufacturer as stop valves, similar to Stockham valves of figure numbers specified.
- B. Water Piping: Low pressure swing check valves:
 - 1. 125 psi WSP class
 - 2. 2 1/2" and larger, flanged: smaller sizes, screwed
 - 3. Up to 2": Bronze regrinding bronze disc, screw in cap. Fig. B319.
 - 4. 2 1/2" to 6": Iron body bronze fitted renewable bronze seat ring and composition disc. Fig. G931.
- C. Silent Check Valves: Provide on discharge of each water pump, silent spring loaded check valve, iron body, bronze trim: 125 psi WSP class, globe type. Similar to Williams Hager, Fig. 636, Smolensky, or Mueller. Provide valved bypass for each check valve installed in a vertical pipe, of same pressure rating. Where 250 WSP rating is required, silent check valves shall have 250 lb. WSP rating, cast steel body similar to Mueller Model 109DT, globe type.
- D. Provide valve bypass around all check valves installed in vertical pipes. Bypass valve of same pressure rating as bypassed valve.

2.7 BUTTERFLY VALVES (WATER SYSTEM ONLY)

- A. Shutoff and balancing valves 4" and larger for water systems that operate at temperature of 210 degrees F. or below may be of the butterfly type, as hereinafter specified at Contractors option.
- B. Valves shall be flame cut carbon steel body, lugged type drilled and tapped for bolting to 150 lb. or 300 lb. ANSI flanges as required with standard drilling. Valves shall be provided for bubbletight dead end shutoff in either direction at the test pressures called for in the specification for the system in which installed. Valves 8" and larger shall be provided with totally enclosed gear operators. Chain wheels and chains shall be provided for valves installed 8'0" or more above floor. All other valves shall have lever operators with spring loaded stops. Valve pressure rating shall be as specified in Paragraph 2.07 to 2.09 of this section.
- C. Materials:
1. Body: Flame cut, carbon steel of lugged type (wafer type shall not be acceptable).
 2. Shaft: One piece 174 PH stainless steel.
 3. Shaft bearings: 316 SS sleeve with armalon insert.
 4. Shaft seals: Teflon chevron rings. Minimum of 5 independent rings with outside yoke.
 5. Disc seal: Teflon encapsulated silicon rubber "O" ring, or one piece molded reinforced teflon. Seal shall not be penetrated by shaft.
 6. Disc material: 316 stainless steel or chrome plated carbon steel with A16RMF finish.
- D. Valves shall be constructed and rated in accordance with ANSI Standards.
- E. Minimum shaft diameters for valves shall be as follows:

Valve Size	Min. Shaft Diameter (inch) 150 lb. Class	Min. Shaft Diameter (inch) 300 lb. Class
4	5/8	3/4
6	1	1
8	1	1

2.8 BALL VALVES

- A. Throttling and hand control valves in sizes up to 2" on water systems can be at the Contractors option ball valves.
- B. Valves shall be suitable for the pressure rating called for (i.e., 250 WSP or 150 WSP) and shall be of a type that allow complete maintenance and removal of the ball and other inner parts without removal of the valve body from the line. Valves shall have 316

stainless steel ball, teflon seat rings and 188 stem. Body shall be bronze for 150 WSP and steel for 250 WSP.

- C. Valves shall be Crane "ACCESSO", NIBCO Fig. 595Y66 (150 #WSP only) or Jamesbury "Clincher".

2.9 STRAINERS

- A. Furnish approved valved and capped, self-cleaning blow-off type strainer ahead of each pump and each automatic control valve except where otherwise specified or indicated.
- B. Total open area of basket perforations, in accordance with manufacturer's recommendations, but not less than 5 times pipe area.

Body	Baskets	Perforations
Water CI	Stainless Steel	1/16" up to 4" 1/8": 6" and larger

- C. Strainers: "Y" type, except where otherwise specified. Baskets, readily removable for cleaning. Strainers at discharge of chilled water pumps shall be basket type located close to floor.
- D. Equip all strainers with blow-off valves with hose end.
- E. All strainers installed upstream of automatic control valves and pumps shall be installed line size, which shall mean the size of the inlet pipe shown on the drawings, not the reduced size serving the control valve, or the pump inlet.

2.10 UNIONS

- A. Make final connections to all equipment, automatic control valves, and pressure reducing valves with union. Up to 2" screwed: 2 1/2" and larger flanged.
- B. Screwed unions on steel pipe, 300 psi WSP class, malleable iron with bronze seat rings; on brass pipe, copper pipe and copper tubing 200 psi WSP class, all bronze with ground joints.

2.11 PIPE SLEEVES

- A. Furnish sleeves built into place for all pipes, passing through walls, floors, or other building construction. Sleeves not less than 1/2" larger in diameter than piping and its covering, if any, extending full depth of construction pierced. Pack space between

sleeves and pipe with non combustible material in accordance with Underwriters' requirements and shall be closed off with close fitting metal escutcheons. Caulk air tight with non hardening mastic. Pipes piercing exterior walls shall be packed with Oakum and lead and made watertight. This Contractor shall close all unused sleeves which have been installed by him.

- B. Sleeves piercing beams, foundations walls or floors of Mechanical Equipment Room(s) containing plumbing, heating, ventilating or air conditioning equipment: Standard weight steel pipe. Extend sleeves in Mechanical Equipment Room floors not less than 2" above finished floor. All other sleeves: Galvanized sheet steel with lock seam joints, not less than #22 USSG, except sleeves for piping 4" and larger, #18 USSG.
- C. For piping extending through roof, provide galvanized cast iron bottom recess roof flashing fittings, Zurn Fig. Z1983 or Z190, with 6 lb. lead flashing extending at least 10" around pipe and up as high as other flashing on roof.
- D. For pipes passing through interior membrane waterproofed floors furnish special cast iron flashing sleeve extending 2" above finished floor with integral flashing flange and clamping roof Josam Series #1880. Adjust sleeves to floor construction with steel or wrought iron pipe nipples top and bottom.

2.12 ESCUTCHEONS

- A. Furnish pipe escutcheons at all surfaces where exposed piping bare or covered, passes through walls, ceiling, floors or partitions. Escutcheons: Cast brass or cast iron. In toilet rooms, at tile walls, and in connection with chromium plated piping: CP finish. Fasten escutcheons securely to pipe sleeves or to extensions of sleeves without any part of sleeve or extension being visible; on bare pipe held in place by set screws, and on covered pipe held in place by internal spring tension. Escutcheons: Ritter Casting and Pat Co.

2.13 BALANCING VALVES

- A. Manual valves for precision balancing of water flow shall be Ypattern globe type, with numerical position indicator on handwheel, tamperproof adjustable memory stop, and gauge ports.
- B. Valves, unless otherwise specified:
 - 1. 250 psi at 300 degrees F.
 - 2. Model numbers indicated refer to Tour & Anderson:
 - 3/4 to 2": T&A Model STAD
 - 2 1/2" to 12": T&A Model STAF

2.14 AIR VENTS

- A. Manual Type

1. Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
 2. Float Type: Brass or semisteel body, copper float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
 3. Washer Type: Brass with hydroscopic fiber discs, vent ports, adjustable cap for manual shutoff, and integral spring loaded ball check valve.
- B. Automatic Type
1. Automatic float operated. Furnish where indicated or required, and at all high points to expel air from system and to prevent air binding at the tops of all risers, etc.
 2. Each automatic air vent shall be provided with 1/2" shutoff valve and overflow of soft copper tubing extended to nearest open drain or sink (janitors closet).

2.15 AUTOMATIC FLOW CONTROL VALVES

- A. General: The contractor shall install automatic pressure compensating flow control valves where indicated on the drawings and herein after specified. Valves shall have the capacities and pressure differential characteristics as indicated and conform to the following specifications.
- B. Valves shall be factory set and shall automatically limit the rate of flow to required engineered capacity within plus or minus 5% accuracy over an operating pressure differential of at least 14 times the minimum required for control.
- C. The control mechanism of the valve shall consist of a self-contained, open chamber assembly with unobstructed flow passages that eliminate accumulation of particles and debris. All internal working parts shall be passivated stainless steel.
- D. The cartridge assembly shall consist of a spring loaded cup. The cup shall be guided at two points and shall utilize the full available differential pressure across the valve to actuate the cup and thereby reduce friction and hysteresis and eliminate binding. It shall have thin orifice plate for self cleaning of the variable inlet ports over the full control range.
- E. Valves shall be available in four pressure differential ranges, with the minimum range requiring less than 2 psid to control flow. Cast iron valve bodies shall be provided with inlet and outlet tappings suitable for connection of instruments for verification of flow rates. Valve bodies shall be rated for use at not less than 150% of system designed operating pressures.
- F. Certified performance data for the flow control valve, based on independent laboratory tests, supervised and witnessed by a registered professional engineer, shall be available.
- G. All flow control valves shall be supplied by a single source responsibility.
- H. Each automatic flow control valve shall be furnished with a valve kit consisting of 1/4 inch x 2 inch minimum size nipples quick disconnect valves (to be located outside of insulation), and fittings suitable for use with the measuring instruments specified.

- I. Provide a metal identification tag, with chain, for each installed valve. The tag to be metal stamped with zone identification, valve model number, rated flow in GPM and differential pressure range.
- J. Provide in the following systems:
 - 1. Each hot water reheat coil.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. After completion, fill, clean, and treat systems. Refer to Section 15545 Chemical Water Treatment.

3.2 INSTALLATION

- A. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.
- B. Install piping to conserve building space, and not interfere with use of space and other work.
- C. Group piping whenever practical at common elevations.
- D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 15121 Piping Expansion Compensation.
- E. Provide clearance for installation of insulation, and access to valves and fittings.
- F. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Division 8.
- G. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- H. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- I. Prepare pipe, fittings, supports, and accessories for finish painting. Refer to Division 9.
- J. Install valves with stems upright or horizontal, not inverted.

- K. Provide manual air vents at system high points and as indicated.
- L. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- M. Provide valved drain and hose connection on strainer blow down connection.

3.3 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install brass male adapters at each side of valves in copper piped system. Sweat solder adapters to pipe.
- C. Install gate valves for shutoff and to isolate equipment, part of systems, or vertical risers.
- D. Install ball or butterfly valves for throttling, bypass, or manual flow control services.
- E. Provide spring loaded check valves on discharge of water pumps.
- F. Use butterfly valves in heating and chilled water systems interchangeably with gate and globe valves.
- G. Use only lubricated plug or butterfly valves in chilled and condenser water systems for throttling and isolation service.
- H. Use lug end butterfly valves to isolate equipment.
- I. Provide 3/4 inch ball drain valves at main shutoff valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest drain.

3.4 WELDING PROCEDURE FOR PIPING

- A. All welding shall be done in accordance with applicable provisions of the ASME Code for Pressure Piping B31.1 by the metallic arc welding process using electrodes of proper quality for the base metal being welded.
- B. Pipe with wall thickness of 3/4 inch or less shall be beveled $37\frac{1}{2}$ degrees plus or minus $2\frac{1}{2}$ degrees with a 1/16 inch land at the root. Pipe shall be mill beveled or machine beveled under this clause of the Specification.
- C. Material to be welded shall be preheated as required by ambient temperature conditions and the grade of material involved.
- D. Split-type backings rings shall be used for all welded joints where required and for all piping having wall thickness of 1/2 inch or more. Welding ring shall be low carbon steel of good weldability and compatible with the base metal being welded. The

machining of the inside diameter of pipe or fitting to accept backing rings shall not be permitted.

- E. Pipe length shall be lined up straight with abutting pipes concentric. All scale and oxide shall be removed with hammer, chisel or file and bevel left clean and smooth for welding.
- F. Both conductors from the welding machine shall be extended to locations at which welding work is being done. The leads from welding machine to location of welding work shall be held together with tape or other approved means so as to prevent induced current in structure steel, in piping or in other metals within the building. The ground lead shall be connected to length of pipe with suitable clamp in such manner that welding current will not flow through joints in pipe, structural steel of building or steel pipe supports.
- G. Weld metal thoroughly fused with base metal at all sections. Welds shall be of sound metal, free from laps, slag inclusion, excessive porosity or other defects, and without excessive reinforcement.
- H. All welders shall be certified for the service for which they are employed and on which they work by the National Certified Pipe Welding Bureau of the Mechanical Contractor's Association of America.

3.5 TESTING

- A. Furnish all materials, supplies, labor and power required for testing. Make preliminary tests and prove work satisfactory. Test before insulating or concealing any piping. Repair defects disclosed by tests or if required replace defective work with new work without additional cost to Owner. Make test in stages if so ordered to facilitate work of others. Peening or wicking in tightening leaking joints, not permitted.
- B. Contractor shall be responsible for work of other trades disturbed or damaged by tests and/or repair and replacement of his work, and shall cause work so disturbed or damaged to be restored to its original condition at his expense.
- C. Unless otherwise specified, all piping: Hydrostatically tested to two (2) times operating pressure, or 150 psi whichever is greater. Test: Two (2) hours duration, during which time piping shall show no leaks and during which time no sealing of leaks will be permitted.
- D. Perform such additional or alternate tests as may be required under Testing, Adjusting, Balancing and Controlled Inspection Section 15990 of this Specification.

3.6 ACCEPTABLE MANUFACTURERS

- A. Gate Valves
 - 1. Stockham
 - 2. Walworth

3. NIBCO
 4. Substitutions: Under provisions of Division 1.
- B. Globe Valves
1. Stockham
 2. Walworth
 3. NIBCO
 4. Substitutions: Under provisions of Division 1.
- C. Butterfly Valves
1. McCannalok High Performance
 2. Jamesbury Series 8000
 3. StockhamLC915
 4. Substitutions: Under provisions of Division 1.
- D. Ball Valves
1. NIBCO
 2. Jamesbury Clincher
 3. Crane Accesso
 4. Substitutions: Under provisions of Division 1.
- E. Swing Check Valves
1. Stockham
 2. Walworth
 3. NIBCO
 4. Substitutions: Under provisions of Division 1.
- F. Spring Loaded Check Valves
1. Williams Hager
 2. Smolensky
 3. Mueller
 4. Substitutions: Under provisions of Division 1.
- G. Lubricated Plug Valves
1. Rockwell
 2. Walworth
 3. Substitutions: Under provisions of Division 1.
- H. Balancing Valves
1. Tour & Andersson
- I. Valve Schedule:

Valve Type	Systems
Gate	Hot Water
Globe	Hot Water
Butterfly	Hot Water

Ball	All Systems
Swing Check	All Systems
Spring Loaded	All Systems
Check Valve	
Lubricated Plug	Chilled Water, Dual Temperature, Condenser Water Hot Water and Glycol

J. Vents

1. Bell & Gossett
2. Taco
3. Hoffman
4. Substitutions: Under provisions of Division 1.

K. Automatic Flow Control Valves

1. Griswold
2. BIF
3. Autoflow
4. Substitutions: Under provisions of Division 1.

END OF SECTION 23 21 13

SECTION 233300

DUCTWORK AND DUCTWORK ACCESSORIES

PART 1 – GENERAL

1.1 General

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

1.2 SCOPE OF WORK

- A. Contractor shall furnish and install, except as otherwise specified under various Sections, all sheet metal ductwork, and related items in accordance with this Section.
- B. Make every duct bend with centerline radius not less than its width. Make every change in size or shape of duct with taper not exceeding 1 in. in 4 in. Unless otherwise indicated provide throats with volume dampers at all branches. Throat velocity shall be same as main duct velocity. Construct square throat elbows, indicated or required with internal turning vanes in accordance with standard details.
- C. Joints in all ductwork shall form smooth interior surface. Air leakage shall be in accordance with specifications.
- D. Support duct work on galvanized iron hangers not less than 1" x 1/8" spaced not more than 8 feet on centers for ducts under 8 sq. ft. in area and not more than 4 ft. on centers for larger ductwork. For ducts 61" wide and over, furnish 1-3/8" x 1/8" hangers. Ducts shall be individually supported from slab above, structural steel and shall not be supported from other ducts.
- E. Furnish dampers indicated or required to balance distribution of air through various parts of duct system to obtain air deliveries indicated at all registers, inlets and outlets.
- F. "Ductwork" shall mean all ducts, dampers, access doors, louvers, joints, stiffeners and hangers, wire mesh screens.
- G. All ductwork, UNLESS OTHERWISE SPECIFIED, fabricated in accordance with recommendations of ASHRAE, and SMACNA standards and in compliance with the regulations of the State and Local Authorities having jurisdiction.
- H. Soundproofing of ductwork in accordance with the "Acoustic Performance" Section 21 33 19 of the specifications.

- I. Testing and Balancing in accordance with "Testing and Balancing" Section 23 05 66 of the specifications.
- J. Contractor shall make final connections to equipment hoods, laboratory hoods, cart washers, etc.

1.3 DEFINITIONS

- A. Seam: locks or weld applied longitudinally to close section of duct, e.g.: longitudinal seam, spiral seam.
- B. Joint: abutting connection between duct sections for continuity of air passage, e.g.: cross joint, transverse joint, coupling.
- C. Reinforcement: hardware applied to strengthen duct, e.g.: girth angles, tie rods, fasteners (not connectors), etc.
- D. Stiffening: folding, bending, beading, cross-breaking or corrugating of sheets to achieve strength through shape, e.g.: pocket lock secures joint and is transverse stiffener, with girth angle and/or fasteners applied (not connectors), joint or stiffener is reinforced.
- E. Static pressure classifications:

- 1. Except as noted:

PRESSURE CLASS	OPERATING PRESSURE
2 IN. W.G.	UP TO 2 IN. W.G.
6 IN. W.G.	OVER 2 IN. UP TO 6 IN. W.G.

- 2. Based on the following:

- a. Single duct systems: static pressure at respective point in ductwork during normal operation.

- 3. Extent of ductwork at 6 in. w.g. pressure class and equipment.

- a. Single duct constant volume systems with duct reheat coils: from fan discharge to re-heat coils (constant volume unit) or as noted.
- b. Exhaust system over 2 in. operating pressure: from 50 feet, upstream of fan.

- 4. Extent of ductwork up to 2 in. w.g.:

- a. Supply ductwork from reheat coil to air outlets.
- b. Exhaust and return air ductwork.

1.4 REFERENCE STANDARDS

- A. All work shall conform with the following:
 - 1. Sheet Metal and Air Conditioning Contractors National Association, Inc. manuals (SMACNA) except where details or notes on drawings indicate otherwise.
 - a. HVAC Construction Standards Metal and Flexible.
 - b. Fire Smoke and Radiation Damper Installation Guide for HVAC Systems.
 - 2. Associated Air Balance Council Manual: National Standards for Total System Balance; referred to as AABC Manual.
- B. The most recent edition of all references shall be used.
- C. The aforementioned references shall be superseded by notes and details on drawings and in the Specification.
- D. American National Standard Institute (ANSI).
- E. National Fire Protection Association Standards: referred to NFPA 90A, NFPA90B etc.
- F. Underwriters Laboratories (UL) Standard for Safety: referred an UL 181, UL555, etc.
- G. Underwriter Laboratory (UL) Standard UL 723 (ASTM-E-04): Maximum 25 flamespread rating and maximum 50 fuel contributed and smoke developed rating.
- H. Published Specifications' standards, tests or recommended methods of trade, industry or governmental organizations apply to work in this Section.
- I. Where two or more references conflict, the most stringent, as determined by the Engineer, shall take precedence.
- J. Comply with all applicable national, state and local codes and refer to Section GENERAL PROVISIONS FOR HEATING, VENTILATING, AND AIR CONDITIONING WORK for additional Reference Standards.

1.5 SUBMITTALS

- A. Submit ductwork shop drawings for approval:
 - 1. Coordinated layout duct drawings that differ from ductwork shown on contract drawings.

2. Mechanical equipment room plans and sections showing all equipment, curbs, and accessories.
 3. Minimum 3/8 inch scale, double line, showing sizes, transverse joints, seismic restraints, transitions, elevations, clearances and accessories; sections where required.
- B. Submit shop details and catalog cuts of:
1. Ductwork construction, including gauge and bracing schedule.
 2. Casing and plenum construction.
 3. Supports.
 4. Seismic restraints.
 5. Dampers.
 6. Turning vanes.
 7. Fire dampers.
 8. Smoke damper installation.
 9. Access doors.
 10. Flexible connections.
 11. Other accessories.
 12. Submit each set of details and catalog cuts submitted in a 8-1/2 inch x 11 inch binder.

PART 2 – products

2.1 MATERIAL

- A. Metal sheets shall be as follows:
1. Galvanized steel shall be in accordance with ASTM A527; black or galvanized as herein after specified.
 2. Aluminum shall be in accordance with ASTM B209-64,2,1.4

2.2 Ductwork

- A. Ductwork shall be galvanized steel, except as noted, in accordance with

SMACNA HVAC Duct Construction Standard, 1995, except as noted. Provide gauges, construction and reinforcement as follows:

1. Pressure class 2 inch w.g.
 - a. Sheet metal gauge and reinforcement shall be in accordance with SMACNA Table 1-5 and 1-10 thru 1-13 and based on a minimum of 2 inch w.g. duct pressure class regardless of possible lower pressures. Round ductwork shall be spiral or longitudinal seam. Beading or cross breaking shall be required for all unlined ductwork.
 2. Pressure classes 6 inch w.g.
 - a. Rectangular ductwork: For pressure above 2 inch w.g. up to 6 inch w.g. Sheet metal gauges and reinforcement in accordance with Pressure Class 6 inch w.g.-SMACNA Table 1-8; based on 6 inch pressure, regardless of possible lower pressure. Ducts to 60 inch wide and within 30 ft from fan discharge shall be next heavier listed gauge thickness to that indicated in SMACNA's. Duct Construction Standard. Use Tables 1-10 thru 1-13 for reinforcements. Beading or cross breaking shall be required for all unlined ductwork.
 - (1) Joints shall be welded flange, flanged joint and companion angle flanged joint only. Inside slip (Fig T9), double S slip (Fig T8 & T8A), standing seam (Fig T-15 and T-16) and pocket lock (Figs T17, 8A and T19) will not be permitted. Fittings and/or joints of two different gauges, connected joint rating shall meet more stringent conditions.
 - b. Round ductwork shall be spiral seam construction only. Gauges shall be in accordance with SMACNA Duct Construction Standard and fittings in accordance with SMACNA Duct Construction Standard, except as noted.
 - (1) Joints: Interior slip coupling beaded at center, fastened to duct with screws and with sealing compound applied continuously around joint before assembling and after fastening. Wrap joints with 3 inch wide duct tape.
- B. Watertight construction where noted with edges bent 1/2 inch for watertight seal. Longitudinal seam sealant shall be similar to 3M Brand No. 800; Alcoa, Aluminastic Type C, or solder. Stiffeners shall be plug or spot welded. Transverse joints shall be bolted companion angles with 1/4 inch cadmium plated bolts with 6 inch minimum on centers and gasket.
- C. Airtight construction where noted with longitudinal seams soldered. Stiffeners

shall be plug or spot welded. Transverse joints shall be bolted companion angle with 1/4 inch cadmium plated bolts with 6 inch minimum on centers and gasket. Exposed, uninsulated ductwork shall be flush flat seam.

D. Ductwork exposed to weather and located in existing penthouse MER, except as noted shall be as follows:

1. Aluminum.
2. Watertight.

E. Outside air, exhaust and relief duct shall be as follows:

1. Aluminum.
2. Extent:
 - a. Within 10 ft of louvers.
 - b. Louvers to casings.
3. Watertight.

F. Shower and Combination Toilet/Shower Exhaust Duct:

1. Aluminum.
2. Watertight.

G. Wet exhausts duct shall be as follows:

1. Aluminum
 - a. Extent:
 - (1) 20'-0" from register or equipment.
 - (2) Pitch duct towards register or equipment.
2. Watertight.

H. Duct Fittings:

1. Full radius elbows shall be used in ducts with velocity over 2000 fpm and wherever possible in other ducts. Square elbows shall not be used in high velocity ducts.
2. Where square elbows are used in low velocity ducts (below 2000 fpm) provide turning vanes.

- I. Manufactured transverse joints (Ductmate TDC, TDF, etc.) shall be installed as per manufacturer's standards. Submit manufacturer's standards for installation and construction.

2.3 FIRE DAMPERS

- A. Fire Dampers shall be UL listed and rated for 1-1/2 hour fire rating and 3 hour ratings where required, in conformance with NFPA 90A and authorities having jurisdiction. Horizontal ducts shall be gravity drop type and vertical ducts shall be spring loaded type.
 1. Dampers shall be approved by New York City Board of Standard and Appeals.
 2. Dampers multibladed, equipped with fusible link with blade housing out of air stream where noted.
 3. Dampers shall be multi-bladed, with blade housing out of air stream and equipped with fusible link.
 4. Fusible link shall be UL listed, with temperature rating not greater than 50 deg F above highest air temperature in duct.
 5. Fire Dampers shall be similar to Air Balance, Inc. Model 119 (319 for 3 hour rated).
 6. Stainless steel construction shall be Type 304 where installed in stainless steel or aluminum ductwork.
- B. Install in accordance with U.L. 55S, NFPA 90A and local authority requirements.
 1. Installation details in SMACNA Smoke, Fire and Radiation Dampers Installation Guide for HVAC, 1992 shall apply unless noted otherwise. Details on drawings are intended to superseded similar details in the Guide. Provide break-away connection.
- C. Provide fire dampers as noted and in ducts and openings in the following:
 1. Shafts.
 2. Floors.
 3. Fire walls.
 4. Fire-Resistance partitions.
 5. Fire rated ceilings.

- D. Provide access door in duct adjacent to each fire damper.

2.4 SMOKE DETECTORS

- A. Contractor to mount smoke detectors in exhaust air and supply air ductwork, supply fan discharge and where indicated on plans and in accordance with NFPA 90A. Detectors shall be mounted on the side or bottom of ductwork so as to be visible from floor or through removed ceiling tile or access door.
- B. Smoke detectors shall be furnished and wired by the Electrical Contractor and shall be installed by the Contractor.
- C. Provide labor and smoke bombs for testing and adjusting of smoke detector.

2.5 SMOKE DAMPERS

- A. Install smoke dampers supplied by Automatic Control System manufacturer (Division 17) in accordance with U.L. 55S, NFPA 90A and local authority requirements.
 - 1. Installation details in SMACNA Smoke, Fire and Radiation Dampers Installation Guide for HVAC, 1992 shall apply unless noted otherwise. Details on drawings are intended to supersede similar details in the Guide. Provide break-away connection.
- B. Provide smoke dampers as noted and in ducts and openings (in 2-hour construction and smoke rated partitions) in the following:
 - 1. Shafts.
 - 2. Floors.
 - 3. Fire walls.
 - 4. Fire-Resistance partitions.
 - 5. Fire rated ceilings.
 - 6. Smoke rated partitions.
- C. Provide access door in duct adjacent to each smoke damper.

2.6 COMBINATION FIRE AND SMOKE DAMPERS

- A. Install combination fire and smoke dampers in accordance with UL 555S NFPA90A and local authority requirements and Class I leakage rating (4 cfm/sq ft at 1.0" w.g. and 8 cfm/sq ft. at 4" w.g.).
 - 1. Install in accordance to details in SMACNA Smoke, Fire and Radiation

Damper Installation Guide for HVAC 1992 shall apply unless noted otherwise, details on drawings are intended to supersede similar details in the Guide. Provide break-away connection.

- B. Provide combination fire and smoke dampers as noted and in ducts and openings (in 2-hour fire partitions, 2 hour fire/smoke partitions).
- C. Unit shall be equivalent to FSD-60 Series fire/smoke dampers with electric actuator as manufactured by Ruskin.
- D. Smoke detection:
 - 1. Each combination fire/smoke damper shall be equipped with a controlled 7 to 15 second heat actuated release device and the pneumatic PFL shall close and lock the fire/smoke damper during smoke detection with manual reset from fire alarm panel.
- E. Fire operation:
 - 1. When temperatures in excess of 165 deg F are detected, the damper will close and lock. At no time shall the damper be disengaged from actuator. Upon cessation of the fire conditions, the damper be manually reset and the fusible link on the damper assembly be replaced.
- F. For smoke dampers in smoke partitions only refer to this section for the specification "Smoke Dampers".

2.7 VOLUME DAMPERS

- A. Volume dampers shall be single and multi-blade as specified. For galvanized steel ductwork, provide galvanized steel dampers except as noted. For other ductwork, provide dampers same material as ductwork. Provide single bladed dampers up to 6 inch width and opposed blade multi-blade dampers above 6 inch width.
 - 1. Single and multiblade volume dampers shall be in accordance with SMACNA HVAC. Duct construction with blades of the same material as ductwork, end bearings, and dial regulator. Provide single bladed damper up to 6 inch width and multi-opposed blade above 6 inch. Damper end bearings shall be similar to Ventlock 609 dial regulator, with locking device shall be similar to Ventlock 635. For insulated ducts dial regulator with locking device shall be on collar to clear insulation similar to Ventlock No's 637, 638 or 639 as required to meet insulation thickness.
 - 2. For internally lined ductwork: Provide 2 internal saddles to protect lining.
 - 3. For low pressure duct, provide opposed blade on branch ducts as noted.

For high pressure duct provide opposed blade, factory fabricated. Refer to Section "AIR DISTRIBUTION SYSTEM EQUIPMENT". Damper levers shall be accessible.

4. Provide volume dampers at following locations:
 - a. In all duct splits and branch connections of supply, return, and exhaust systems.
 - b. At duct splits above 36 inch depth.
 - c. Ducts connecting to common plenums.
 - d. Ducts serving single outlet (supply, return and exhaust).
 - e. At open return duct in hung ceiling.
 - f. And as noted.

2.8 RELIEF DAMPERS

- A. Relief dampers shall be 16 gauge galvanized steel frames with minimum 0.05 gauge aluminum blades integral stiffening ribs, stainless steel ball bearings, adjustable counter weight and concealed linkage.

2.9 AUTOMATIC DAMPERS

- A. Install automatic dampers supplied by automatic control system manufacturer (Division 17). Notch end of rod and label duct or casing to indicate open and closed position.

2.10 ACCESS DOORS

- A. Access doors shall be in accordance with SMACNA HVAC Duct Construction Standards, except as noted. In ductwork doors shall be insulated or noninsulated the same as duct. Two 2 inch x 2 inch butt hinges, except where sliding or 4 latch removable type is required. Latch shall be similar to Ventlock No. 100. Provide 20 inch x 14 inch access doors except for ducts less than 16 inch: one dimension 20 inch and the other dimension 2 inch less than duct width. Provide larger sizes where required for access. For non-hinged door, provide chain to secure door to either duct or frame.

1. Provide access doors in following locations:
 - a. Coils in ducts: entering and leaving side.
 - b. Automatic dampers: linkage side.

- c. Main balancing dampers.
- d. Fire dampers.
- e. Smoke dampers.
- f. Smoke detection heads.

2.11 FLEXIBLE CONNECTIONS

- A. Flexible connections for ductwork shall be in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, except as noted. Flexible connections with metal collars shall be installed with 2 inch slack in fabric and minimum movement of 1 inch. Provide flexible at connections to fans, building expansion joints, at connection between copper and stainless steel ductwork.
 - 1. Provide neoprene coated glass fabric, 30 oz per sq yd with sewn and cemented seams, similar to Vent Fabrics, Inc.
 - 2. Provide flex connection in ductwork passing through expansion walls.

2.12 TURNING VANES

- A. For galvanized steel ductwork, provide galvanized steel or painted black steel, except as noted. For other ductwork, provide same material as ductwork. Turning vanes shall be in accordance with SMACNA HVAC Duct Construction Standards, except as noted.
 - 1. Install at square duct elbows and as noted on drawings. Max unsupported vane length shall not exceed 48 inches. Provide separate equal size sections for greater lengths. Refer to turning vane detail. Single vane and short radius vanes are not acceptable.

2.13 ACCESSORIES

- A. Provide the following in accordance with SMACNA Duct Manual, except as noted.
 - 1. Belt guards: Frames shall be minimum No. 18 USSG steel with heavy gauge expanded metal; painted and shall be in conformance with OSHA regulations. Provide openings for tachometer measurements.
 - 2. Cap flashing shall be the same material as duct; where copper, use 24 oz minimum.
- B. Open ducts in hung ceiling: Provide No. 16 USSG, 3/4 inch square mesh, screen over each opening; with 1 inch wide galvanized steel enclosing frame and

flanged duct opening to receive frame. In lieu of screen and volume damper, provide register or grille plus opposed blade volume damper.

- C. Provide duct sleeves. Sleeves shall be minimum 20 gauge USSG galvanized sheet steel unless otherwise indicated. Round sleeves through bearing walls or partitions shall be black steel pipe, Schedule 30, or 40.
 - 1. Clearances:
 - a. Non-insulated duct: Provide 1 inch between duct and sleeve on all sides.
 - b. Insulated duct: Provide 1 inch between insulation and sleeve on all sides.
 - c. Grilles, registers and diffusers: Provide no clearance.
 - 2. Provide closure collars for exposed ducts on each side of wall or floor opening. Collars shall be galvanized sheet metal, minimum 4 inch wide, and fit tight against surface and around duct or insulation. Install with nails 6 inch on center.
 - 3. Provide sleeves for ductwork passing through one-hour rated walls and partitions which do not contain fire or smoke dampers (electric closets, soiled utility rooms, etc.)
- D. Framed openings: Provide clearances and closure collars the same as for Duct Sleeves.
- E. Duct-mounted automatic controls and monitoring devices: Mount on mechanical equipment all devices related to automatic controls, monitoring and fire protection work. Coordinate to obtain such devices from other contractors when they are not provided under Mechanical Work. Devices shall include, but not be limited to:
 - 1. Automatic dampers.
 - 2. Smoke dampers.
 - 3. Duct-mounted smoke detectors.
 - 4. All equipment in Division 17 - Automated Monitoring and Control Systems.
- F. Angles, tie rods and shapes for reinforcing joints shall be in accordance with SMACNA HVAC Duct Construction Standards, except for the following:
 - 1. Reinforcing angle spacing shall not exceed 24 inch spacing and applied

to four sides for following distances from fan inlet and outlet for each system.

- a. Ten feet for fans with wheel diameter to 27 inches.
 - b. Twenty feet for fans with wheel diameters exceeding 27 inches.
2. Galvanized and aluminum sheets: Provide galvanized steel.
 3. Stainless steel sheets: Provide stainless steel.
- G. Screws and rivets: Provide the same material as sheet, except as noted. On aluminum sheets, provide cadmium plated or stainless steel. Zinc or cadmium plated will be permitted on galvanized sheets. Minimum screw size shall be No. 10; maximum spacing shall be 10 inch. Minimum rivet size shall be 4 lb; maximum spacing shall be 6 inch.
- H. Duct sealants:
1. Provide sealing compound for brush applications, similar to 3M Brand No. 800 and other applications, similar to 3M Brand No. 900. Provide tape, similar to 3M No. 474. For gaskets, provide continuous, reinforced, inert self-conforming type, 1/8 inch thick and width to match angle connection, similar to 3M Weatherban 1202-T ribbon sealer.
- I. Refer to Installation for supports, hangers, inserts and attachments and the following special construction.
1. Stainless steel ductwork.
 2. Spiral seam round or flat oval ductwork.
 3. Lead shielding for ductwork.

PART 3- EXECUTION

3.1 INSTALLATION

- A. Install in accordance with SMACNA HVAC Duct Construction Standards, except as noted. Unequal elbows are not permitted. Rectangular duct sections may be joined by use of acceptable mechanical coupling systems and installation shall be in accordance with manufacturer's recommendations, except use metal clips only (PVC will not be permitted). Provide system similar to the Ductmate System.
1. Sealing:
 - a. Pressure class 2 inch w.g. shall be in accordance with

SMACNA HVAC Duct Construction Standards except that tape shall not be used. Longitudinal seams caulked.

- b. Pressure class 2 inch w.g. (isolation room supply and exhaust): Seal all longitudinal seams, transverse joints, fastener penetrations and fitting connections. Tape shall not be used. SMACNA duct standards reference 'Class C.'
- c. Pressure class 6 inch w.g. to 10 inch w.g.: Seal all longitudinal seams, transverse joints, fastener penetrations, fitting connections and duct wall penetrations.
- d. The installer shall verify in writing that the shelf life of all sealants products have not been exceeded.

2. Inserts and attachments:

- a. Locate and set inserts prior to the pouring of concrete floor slab. Subsequent attachments to concrete floor slabs and beams shall be made with expansion shields with a safety factor of four, based on manufacturers listed capacities.
- b. Overhead supports shall be from bottom flanges of steel beams and sides of concrete beam, with bolts in shear rather than in tension. Attachment of hangers to bottom of overhead slab shall be limited to ducts with a maximum side dimension of 18 inches.
- c. Provide anchors, similar to Phillips Drill Co. "Red Head". Beam clamps shall be used on exposed steel beam construction.

3. Hangers, Horizontal Duct:

- a. Up to 4 sq ft in area: maximum 60 inches duct width, galvanized steel strap hangers, minimum 1 inch x 1/8 inch, maximum 8 ft 0 inch spacing.
- b. Strap hangers shall be bent 2 inch under the bottom corner of rectangular ducts. One screw shall secure 2 inch portion of hanger to bottom of duct. Straps shall be secured to side of duct with a minimum of two screws and more, as necessary, to provide a maximum screw spacing of 12 inch. Side-of-duct screws shall be located not more than 2 inch from top and bottom of duct.
- c. 4 to 10 sq ft in area: provide galvanized steel trapeze angles from steel threaded rods with a maximum 6 ft – 0 inch spacing.
- d. Over 10 sq ft in area: provide galvanized steel trapeze angles

from steel threaded rods with a maximum 4 ft - 0 inch spacing.

- e. Provide stronger supports to match larger and heavier ducts; provide cross-bracing, angle iron hangers, as required for rigid and adequate supports.
- f. In mechanical rooms: provide black steel painted or galvanized, vertical angles or rods and horizontal angles across ductwork.

4. Hangers, Vertical Ducts

- a. Vertical Ducts : At each floor, provide minimum 2 supports per duct fastened to duct and spanning shaft opening. Fasten supports to floor or structural construction. Maximum screw spacing shall be 12 inch on center and maximum four screws per riser.
- b. Angles and channels: Provide painted black steel or galvanized. Where angles are specified, channels of equivalent strength, material and protective coating will be permitted. Where more than one duct is supported by a common set of angles, support size shall be determined by sum of width dimensions.
- c. Supports: Provide as follows, except increase supports as required for load and span where span of angles exceed 6 ft or floor-to-floor height exceeds 14 ft.
 - (1) Duct width to 30 inch: Provide angle size: 1-1/4 inch x 1-1/4 inch x 1/8 inch.
 - (2) Duct width, 31 inch to 54 inch: Angle size shall be 2 inch x 2 inch x 3/16 inch.
 - (3) Duct width, 55 inch to 90 inch: Angle size shall be 2 inch x 2 inch x 1/4 inch.

B. Special materials and construction.

- 1. Aluminum ductwork: Provide as specified for respective pressure classification and in accordance with SMACNA recommendations on aluminum duct, except as noted. Construction shall be of equivalent Brown & Sharpe (B&S) gauges. Seal all seams watertight. Separate aluminum ducts, casings, plenums, housings and louvers from direct contact with concrete by resilient gasketing or caulking compound.

3.2 FIELD QUALITY CONTROL

- A. Refer to Section "Balancing Air and Water Systems".

END OF SECTION 233100

SECTION 233416
CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: For each product.
 - 1. Airfoil centrifugal fans.
 - 2. Backward-inclined centrifugal fans.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Include rated capacities, furnished specialties, and accessories for each fan.
 - 2. Certified fan performance curves with system operating conditions indicated.
 - 3. Certified fan sound-power ratings.
 - 4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 5. Material thickness and finishes, including color charts.
 - 6. Dampers, including housings, linkages, and operators.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Belts: Two sets for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. AMCA Compliance:
 - 1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
 - 2. Operating Limits: Classify according to AMCA 99.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Capacities and Characteristics:
 - 1. Vibration Isolators: Spring isolators having a static deflection of 1 inch.

2.2 AIRFOIL CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide by one of the following:
 - 1. Greenheck
 - 2. Twin City
 - 3. New York Blower Company (The).

- C. Description:

Lincoln Medical and
Mental Health Center
New Clinic Renovation

233416- 2

Centrifugal HVAC Fans

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
 2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
 3. Factory-installed and -wired disconnect switch.
- D. Housings:
1. Formed panels to make curved-scroll housings with shaped cutoff.
 2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 3. Horizontally split, bolted-flange housing.
 4. Spun inlet cone with flange.
 5. Outlet flange.
- E. Airfoil Wheels:
1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange.
 2. Heavy backplate.
 3. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
 4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
- F. Shafts:
1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
 2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- G. Grease-Lubricated Shaft Bearings:
1. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
 2. Ball-Bearing Rating Life: ABMA 9, L10 at 200,000 hours.
 3. Roller-Bearing Rating Life: ABMA 11, L10 at 200,000 hours.
- H. Grease-Lubricated Shaft Bearings:
1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 2. Ball-Bearing Rating Life: ABMA 9, L10 at 200,000 hours.
 3. Roller-Bearing Rating Life: ABMA 11, L10 at 200,000 hours.
- I. Belt Drives:
1. Factory mounted, with adjustable alignment and belt tensioning.

2. Service Factor Based on Fan Motor Size: 1.5
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

J. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
5. Discharge Dampers: Assembly with parallel blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
6. Inlet Screens: Grid screen of same material as housing.
7. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
8. Spark-Resistant Construction: AMCA 99.
9. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
10. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

2.3 BACKWARD-INCLINED CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide by one of the following:
 1. Greenheck
 2. Twin City
 3. Loren Cook Company.
 4. New York Blower Company (The).
- C. Description:
 1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.

2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
 3. Factory-installed and -wired disconnect switch.
- D. Housings:
1. Formed panels to make curved-scroll housings with shaped cutoff.
 2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 3. Horizontally split, bolted-flange housing.
 4. Spun inlet cone with flange.
 5. Outlet flange.
- E. Backward-Inclined Wheels:
1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades, and fastened to shaft with set screws.
 2. Welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate.
- F. Shafts:
1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
 2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- G. Grease-Lubricated Shaft Bearings:
1. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
 2. Ball-Bearing Rating Life: ABMA 9, L10 at 200,000 hours.
 3. Roller-Bearing Rating Life: ABMA 11, L10 at 200,000 hours.
- H. Grease-Lubricated Shaft Bearings:
1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
 2. Ball-Bearing Rating Life: ABMA 9, L10 at 200,000 hours.
 3. Roller-Bearing Rating Life: ABMA 11, L10 at 200,000 hours.
- I. Belt Drives:
1. Factory mounted, with adjustable alignment and belt tensioning.
 2. Service Factor Based on Fan Motor Size: 1.5
 3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

J. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
5. Discharge Dampers: Assembly with parallel blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
6. Inlet Screens: Grid screen of same material as housing.
7. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
8. Spark-Resistant Construction: AMCA 99.
9. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
10. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

2.4 IN-LINE CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
 1. Greenheck Fan Corporation.
 2. Loren Cook Company.
 3. PennBarry.
 4. Twin City Fan Company
- C. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- D. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
- E. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

F. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

G. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
3. Companion Flanges: For inlet and outlet duct connections.
4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.5 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.6 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install centrifugal fans level and plumb.
- B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Equipment Mounting: Install centrifugal fans using restrained spring isolators. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
1. Minimum Deflection: 1 inch.

- E. Equipment Mounting: Install centrifugal fans on vibration isolation equipment base. Comply with requirements specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- F. Equipment Mounting: Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- G. Equipment Mounting: Install continuous-thread hanger rods and spring hangers with vertical-limit stop of size required to support weight of dehumidification unit.
 - 1. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- H. Curb Support: Install roof curb on roof structure, level and secure, according to "The NRCA Roofing and Waterproofing Manual," Low-Slope Membrane Roofing Construction Details Section, Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure centrifugal fans on curbs, and coordinate roof penetrations and flashing with roof construction.
- I. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install flexible duct connectors and vibration isolation and seismic-control devices.
 - 1. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.
 - 2. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation and seismic-control devices.
- J. Install units with clearances for service and maintenance.
- K. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."
- B. Install ducts adjacent to fans to allow service and maintenance.
- C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
 - 6. Adjust damper linkages for proper damper operation.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 9. See Section 230593 "Testing, Adjusting, and Balancing For HVAC" for testing, adjusting, and balancing procedures.
 - 10. Remove and replace malfunctioning units and retest as specified above.
- D. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233416

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SECTION 233600

AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Shutoff, single-duct air terminal units.

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

1.4 SUBMITTALS

- A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
 - 1. Air terminal units.
 - 2. Liners and adhesives.
 - 3. Sealants and gaskets.
- B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
 - 3. Hangers and supports, including methods for duct and building attachment and vibration isolation.
- C. Delegated-Design Submittal:
 - 1. Materials, fabrication, assembly, and spacing of hangers and supports.

- 2. Design Calculations: Calculations for selecting hangers and supports.
- D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Size and location of initial access modules for acoustic tile.
 - 3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- E. Field quality-control reports.
- F. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Instructions for resetting minimum and maximum air volumes.
 - 2. Instructions for adjusting software set points.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 - PRODUCTS

2.1 SINGLE-DUCT VARIABLE AND CONSTANT AIR TERMINAL UNITS

- A. Configuration: Single duct, pressure independent type variable air volume terminals with integral electric coil.
- B. Casing: Minimum 22-gauge galvanized steel, single wall.
 - 1. Casing Lining: Mechanically attached, 1-inch thick, 1½ lb. density, fiber-free engineered hospital grade polymer foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84. Exposed fiberglass is not acceptable.
 - 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 - 3. Air Outlet: S-slip and drive connections.
 - 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
 - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
 - 6. Provide access door upstream and downstream of coil.

- C. Control motors and controllers shall be factory installed on unit by unit manufacturer. Controller shall be supplied by approved control manufacturer.
- D. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
- E. At an inlet velocity of 2,000 fpm, the minimum static pressure required to operate any terminal size shall not exceed 0.13-inch wg for the basic terminal.
- F. Maximum Sound Power Levels: Sound performance shall be ARI certified and tested in accordance with ASHRAE Standard 36-72 or ADC Code 1062R4 with ratings tabulated for upstream of 4 inch W.G. and minimum static pressure. Maximum permissible radiated sound-power levels in octave bands of terminal boxes when operated at the scheduled maximum inlet pressure and air quantity in an installed condition over occupied spaces shall be as follows:

TERMINAL BOX RADIATED SOUND POWER (dB re 10 ⁻¹² WATT)		
Octave Band	Where Units will be located above Conf. Room Ceiling (NC-35)	Where Units will be exposed in open plan areas (NC-40)
1	72	62
2	70	60
3	61	54
4	60	51
5	57	48
6	56	47
7	66	46
8	65	45

- G. Factory Mounted Electronic Controls:
 - 1. The units shall be provided with a factory mounted analog electronic controller.
 - 2. Provide inlet air velocity sensors. The sensor shall be multi-point center averaging type, with a minimum of four measuring ports parallel to the take-off point from the sensor. Sensors with measuring ports in series are not acceptable. The sensor shall provide a minimum differential pressure signal of 0.03 inch wg. at an inlet velocity of 500 fpm.
 - 3. Controller shall be capable of performing the following functions, at minimum:
 - a. Remote space temperature sensing and control.
 - b. Airflow measurement.

4. Wall thermostats / temperature sensors (factory calibrated for design flow) shall be provided by the air terminal unit Vendor.

2.2 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electro galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- D. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.3 SOURCE QUALITY CONTROL

- A. Factory Tests: Test assembled air terminal units according to ARI 880.
 1. Terminals shall be certified under the ARI Standard 880 Certification Program and carry the ARI Seal.
 2. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows and ARI certification seal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal unit's level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. Install wall-mounted thermostats.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Comply with latest SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts or structural-steel fasteners appropriate for construction materials to which hangers are being attached. Do not use powder-actuated concrete fasteners.

- C. Hangers Exposed to View: Threaded rod and angle or channel supports. Install plumb and level, subject to Architect's approval on an individual basis.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 CONNECTIONS

- A. Connect ducts to air terminal units according to [Division 23 Section "Metal Ducts."] [Division 23 Section "Nonmetal Ducts."]

3.4 IDENTIFICATION

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections. Owner will engage a commissioning agent to commission all systems. Testing agency shall cooperate fully with commissioning agent throughout testing and commissioning period.
- B. Tests and Inspections:
 - 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Air terminal unit will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 233600

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SECTION 233713

DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE OF WORK

- A. The work included in this Section comprises the furnishing of ceiling diffusers, ceiling diffuser returns, ceiling registers, ceiling grilles, top registers, bottom registers, transfer grilles, linear diffusers, and non aspirating diffusers.

1.3 RELATED WORK

- A. Section 09511 - Suspended Acoustical Ceilings
- B. Section 09900 - Painting
- C. Section 233300 - Ductwork and Ductwork Accessories
- D. Section 233900 - Acoustical Performance
- E. Section 230566 - Testing, Adjusting, Balancing and Controlled Inspection.

1.4 REFERENCES

- A. ADC 1062 - Certification, Rating and Test Manual.
- B. AMCA 500 - Test Method for Louvers, Dampers and Shutters.
- C. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- D. ARI 650 - Air Outlets and Inlets.
- E. ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.

- F. SMACNA - Low Pressure Duct Construction Standard.

1.5 QUALITY ASSURANCE

- A. Test and rate performance of air outlets and inlets in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.

1.6 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 90A.

1.7 MOCKUP

- A. Provide mockup of typical interior ceiling module with supply and return air outlets under provisions of Division 1.

1.8 SUBMITTALS

- A. Submit product data under provisions of Division 1.
- B. Provide product data for items required for this project.
- C. Submit schedule of outlets and inlets indicating type, size, location, application, and noise level.
- D. Review, requirements of outlets and inlets as to size, finish, and type of mounting prior to submitting product data and schedules of outlets and inlets.
- E. Submit one sample of each required air outlet and inlet type under provisions of Division 1 as required.
- F. Submit manufacturer's installation instructions under provisions of Division 1.

PART 2 - PRODUCTS

2.1 BASE BID MANUFACTURERS

- A. Diffusers, registers and grilles: Anemostat Products Div., Dynamics Corp. of America, Titus Products Div., Carnes Co. and Krueger Manufacturing Co.
- B. Perforated laminar flow diffusers: Titus Mfg. Div., Anemostat Products Div., Krueger Manufacturing Co., and Carnes Co.

- C. Terminal units: Buensod/Agitair Div., Anemostat Products Div., Dynamics Corp. of America, and Titus Mfg. Div.
- D. Humidifiers:
 - 1. Steam jet type: Armstrong Machine Works, Sarco Company and Dri-Steam Humidifier Company.

2.2 AIR DIFFUSERS

- A. Diffusers shall be with volume damper adjustable from diffuser face except as noted, without removal of face louvers or panel. Provide supply air diffusers with air-equalizing deflectors. Diffusers in same room shall be the same size and type, except as otherwise approved. Diffusers shall have removable core, unless otherwise noted. Supply plaster frames for diffusers without removable cores installed in plaster for setting under General Construction Work.
 - 1. Provide diffusers suitable for the following ceiling construction, as required.
 - a. Lay-in acoustical tile ceiling with inverted tee-bar shall have lay-in type frame for setting on tee-bars.
 - b. Plaster ceilings shall be flanged for surface mounting, or plaster frames as indicated.
 - 2. Noise level at noted capacities shall not exceed criteria specified in Section NOISE CONTROL. Diffusers shall be suitable for operation at 5 percent excess and 75 percent less than noted capacity, for variable air volume operation. Provide blanking for proper coverage and blow without producing objectionable noise or air motion at occupied level. Finish shall match color sample as approved.
 - a. Baked enamel
 - b. Anodized
- B. Perforated supply diffuser shall have a nominal 24" x 24" drawn back pan with a square or round neck for supply duct connection. Pattern control vanes shall be attached to the back pan and shall be configurable in the field for a 1, 2, 3, or 4 way air patterns. Deflectors or vanes attached directly to the perforated face are not approved. Pattern adjustment shall be made by removing, rotating and reattaching the vanes to the back pan. Diffusers requiring closure of louvers/vanes or utilizing blank-off for pattern adjustment are not approved. Volume dampers shall be located in the neck of the diffuser for balancing. The perforated face plate shall be constructed of minimum 22 gauge steel with not less than a 50% free area pattern, and shall have an unperforated visible margin around the perimeter. Face plates of expanded metal or directional louvers formed out of the face material are not approved. The face plate shall be removable from the back pan by concealed spring clips. The face shall lie in the same plane as the bottom surface of the ceiling in which it is mounted. The face plate finish shall be white, with the back pan and pattern control vanes painted flat black for masking. All white diffuser assemblies are not approved.
 - 1. Types:
 - a. For lay-on T-bar, diffuser shall be similar to Anemostat Type PLD or Titus PSS.
 - b. For surface mounted, diffuser shall be similar to Anemostat Type PFD.

- c. For concealed spline, diffuser shall be similar to Anemostat Type PCD.
- C. Perforated return diffuser shall match perforated supply diffusers. Construction and finish shall be identical to the perforated supply diffusers, but without pattern control vanes.

2.3 REGISTERS AND GRILLES

- A. The manufacturer shall be responsible for examining the application of each outlet and shall guarantee that each outlet will provide comfort space conditions at noted capacity without drafts. Noise level at noted capacities shall not exceed criteria specified in Section NOISE CONTROL. Provide registers with key-operated, opposed-blade volume control. Refer to Architectural Drawings for mounting details. Finish shall match color sample as approved.
 - 1. Baked enamel
 - 2. Supply plaster frames for grilles and registers without removable cores installed in plaster for setting under General Construction Work. Grilles and registers in aluminum ductwork or plenums shall be anodized aluminum. Grilles and registers in stainless steel ductwork or plenums shall be stainless steel.
- B. Supply registers: provide adjustable, double-deflection, formed bar type
 - 1. Face bars shall be horizontal, 3/4 inch bar spacing. Rear bars shall be vertical.
 - 2. Behind registers installed on side of duct, provide air-equalizing deflector, similar to Titus AG-25. Registers shall be similar to Titus Series 300RS5, or Anemostat type S2VD.
- C. Return and exhaust registers:
 - 1. Fixed curved or tilted blades between 30 and 45 deg for return high on wall or ceiling, 30 deg for returns below 4 ft and depth shall be 1 inch. Blades spacing shall be 3/4 inch and parallel to long dimension. Net effective free area shall be not less than 75 percent. Registers shall be similar to Titus Series 350RL5, or Anemostat type S3HOD.

2.4 RETURN AIR SCREENS

- A. 3/4 inch square pattern mesh, constructed of interwoven No. 16 galvanized wire and welded or secured to frame. Frame shall be 1 inch x 1 inch x 1/8 inch galvanized steel angles frames, continuous around perimeter of screen.

2.5 TERMINAL UNITS: CONSTANT VOLUME TERMINAL UNIT/ VARIABLE AIR VOLUME (CV/VAV)

- A. Casings shall be minimum No. 22 USSG steel, galvanized steel or 0.040 inch thick aluminum

- B. Acoustic lining shall consist of thermal/acoustical glass fiber with an aluminum laminate facing, minimum 1" thick, with a density not less than 4-1/4 pounds per cubic foot. The aluminum facing shall be exposed to the air stream to prevent airborne fibers and suitable for hospital or clean room application. The edges of the insulation shall be sealed by zinc coated steel channels that interlock the adjacent edges of the insulation. Tapes or adhesives are not acceptable. The insulation shall conform to NFPA 90A, UL 181, and ASTM C665.
- C. Control motors and controllers shall be factory-installed on units by unit manufacturer. Motors shall be supplied by approved automatic control system manufacturer.
- D. Controllers shall be factory calibrated and preset for minimum and maximum air volumes noted. Air quantities shall be clearly indicated with pressure taps to permit field change of air quantities without special tools or replacement components. Units shall maintain pressure independence within plus or minus 5 percent, up to 6 inch w.g. inlet air pressure. Maximum static differential pressure 0.15 inch w.g. at inlet air velocity of 2000 fpm. Damper blades shall be aluminum set in self lubricating bearings. Leakage shall be 2 percent of maximum flow against 6 in. w.g. static pressure rated by Air Diffusion Council Standards. For units with reheat coils, regulators shall be sequenced with reheat controls. Provide air flow sensor piped to controller for each box.
- E. Noise level at noted capacities shall not exceed criteria specified in Section NOISE CONTROL. Provide sound absorbers for units where noted or to conform to requirements of Section NOISE CONTROL. Units shall be tested in accordance with ASHRAE Standard 36-72 or ADC Code 1062R4, with ratings tabulated for upstream pressure of 4 inch wg. and minimum static pressure.
- F. Depth of units shall not exceed allowable space allocation. Moving parts shall be suitable for minimum of 300,000 cycles. Units shall be in compliance with U.L. 181 and NFPA 90A.
- G. Constant volume units: Units shall be pressure independent and capable of N.O., N.C., direct action, or reverse acting as required to meet control requirements. Maximum pressure drop shall not exceed 0.4 inch w.g. pressure differential across terminal.
 - 1. Hot water reheat coils: refer to Section AIR HANDLING EQUIPMENT. Provide factory mounted access panel for coil inspection and cleaning.
 - 2. Units shall be similar to Titus DESV or Approved Equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Return and exhaust registers: for wall installations, mount on upper portion of wall with upward deflection. Mount on lower portion of wall with downward deflection.

- B. Examine areas where diffusers, registers and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Install diffusers, registers and grilles level and plumb.
- E. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw and pressure drop. Make final locations where indicated, as much practical. For unit installed in lay-in ceiling panel, locate units in center of panel. Where architectural features or other items conflict with installation, notify Architect for determination of final location.
- F. Install diffusers, registers and grilles with airtight connections to ducts and allow service and maintenance of dampers, air extractors and fire dampers.
- G. After installation, adjust diffusers, registers and grilles to air pattern indicated or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 233900
ACOUSTIC PERFORMANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

- A. The Contractor shall provide all materials, labor and equipment necessary to furnish, deliver and install all acoustical material and equipment related work required by the drawings and/or herein specified.
- B. It is the intent of this Specification that noise levels due to air conditioning and/or ventilating equipment, ducts, grilles, registers, diffusers, VAV and single duct terminals will permit attaining specified sound pressure levels within occupied spaces in the 8 octave bands from 63 to 8000 hertz.

1.3 SECTION INCLUDES

- A. Sound traps
- B. Grilles, registers and diffuser sound power levels.

1.4 REFERENCES

- A. AMCA 300 Test Code for Sound Rating
- B. AMCA 301 Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- C. AMCA 302 Application of Sound Loudness Ratings for Non-Ducted Air Moving Devices.
- D. AMCA 303 Application of Sound Power Level Ratings for Ducted Air Moving Devices Recommended Typical dBa Calculation.
- E. ANSI S1.1 Acoustical Terminology (Including Mechanical Shock and Vibration).
- F. ANSI S1.8 Preferred Reference Quantities for Acoustical Levels.

- G. ANSI S1.13 Methods for Measurement of Sound Pressure Levels.
- H. ARI 270 Sound Rating of Outdoor Unitary Equipment.
- I. ARI 575 Measuring Machinery Sound Within Equipment Rooms.
- J. ASA 16 (ANSI S1.36) Survey Methods for Determination of Sound Power Levels of Noise Sources.
- K. ASA 29 (ANSI S1.29) Measurement and Designation of Noise Emitted by Computer and Business Equipment.
- L. ASA 47 (ANSI S1.4) Specification for Sound Level Meters.
- M. ASA 49 (ANSI S12.1) Preparation of Standard Procedures to Determine the Noise Emission from Sources.
- N. ASHRAE 68 Method of Testing InDuct Sound Power Measurement Procedure for Fans.
- O. ASHRAE Handbook Systems Volume, Chapter "Sound and Vibration Control".
- P. ASTM E90 Method for Laboratory Measurement of Airborne Sound Transmission of Building Partitions.
- Q. ASTM E477 Method of Testing Duct Liner Materials and Prefabricated Silencers for Acoustical and Airflow Performance.
- R. ASTM E596 Method for Laboratory Measurement of the Noise Reduction of Sound Isolating Enclosures.
- S. NEBB Procedural Standards for Measuring Sound and Vibration.
- T. SMACNA HVAC Duct Construction Standards Metal and Flexible.
- U. ANSI/ASTM C553 Mineral Fiber Blanket and Felt Insulation.
- V. ANSI/ASTM C612 Mineral Fiber Blanket and Board Thermal Insulation.
- W. ASTM E84 Surface Burning Characteristics of Building Materials.
- X. NFPA 255 Surface Burning Characteristics of Building Materials.
- Y. UL 723 Surface Burning Characteristics of Building Materials.
- Z. ASTM C423 Standard test method for sound absorption and sound absorption coefficients by the reverberant room method.

1.5 DEFINITIONS

- A. Submittals, and Report: Conform to ANSI S1.1.

1.6 PERFORMANCE REQUIREMENTS

- A. Maintain sound level of spaces at levels not to exceed those listed below by utilizing acoustical devices as required to achieve specified sound levels.
- B. Maintain rooms at following maximum sound levels, in Noise Criteria (NC) as defined by ASHRAE Handbook.
 - 1. Hospitals and Clinics
 - a. Private rooms 30
 - b. Corridors (Hospital) 35
 - c. Public areas 40
 - d. Utility rooms 40
 - e. Nurses station 35
 - f. Storage and service spaces 40
 - g. Lockers 45
 - h. Toilets (Other Than Patients) 40
 - i. Administration Areas 35

1.7 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Shop Drawings: Indicate assembly, materials, thicknesses, dimensional data, pressure losses, acoustical performance, layout, and connection details.
- C. Product Data: Provide catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance.
- D. Test Reports: Indicate dynamic insertion loss and noise generation values of silencers.
- E. Manufacturer's Installation Instructions: Indicate installation requirements which maintain integrity of sound isolation.
- F. Manufacturer's Field Reports: Submit under provisions of Division 1.
- G. Manufacturer's Field Reports: Indicate installation is complete and in accordance with instructions.

1.8 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 1.

1.9 QUALITY ASSURANCE

- A. Perform Work in accordance with standards and recommendations of ASHRAE 68.

1.10 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience.

1.11 REGULATORY REQUIREMENTS

- A. Conform to applicable codes for sound levels.

PART 2 - PRODUCTS

2.1 BASE BID MANUFACTURERS

- A. Sound attenuators: Industrial Acoustics Co., Environmental Elements Corp., and Aeroacoustic Corp.
- B. Soundlinings: CertainTeed Products Corp., JohnsManville Corp. and OwensCorning Fiberglas Corp.

2.2 SOUND LININGS (RETURN AIR AND EXHAUST AIR DUCTWORK ONLY)

- A. Soundlinings shall be fibrous glass, minimum 11/2 lb per cu ft. Flamespread shall be a maximum of 25 and fuel contributed and smoke developed shall be a maximum of 30. Lining shall be suitable for duct velocities up to 4000 fpm. Lining shall meet erosion test method described in UL Publication No. 181. The dynamic loss coefficient shall be a maximum of 1.2. The K factor shall be a maximum of 0.25 Btu/hr/deg F/inch. The noise reduction coefficient for 1 inch thick lining shall be a minimum of 0.70.
 - 1. The facing for low pressure duct liner shall have a neoprene coated finish and stenciled in accordance with NFPA 90. Downstream of supply terminal units shall be provided with tedlar sheathing.
 - 2. The facing for circular medium and high pressure duct liner shall be perforated, 28 percent minimum open area, and 24 gauge galvanized steel.
 - 3. In ductwork, provide a minimum thickness of 1 inch. In plenums, provide a minimum thickness of 2 inches. For soundlining used as thermal insulation, the minimum thickness shall conform to the requirements as specified in Section 230713 "DUCTWORK INSULATION."
 - 4. The lining shall be similar to JohnsManville LinaCoustic.

- B. Provide adhesive and sealer in conformance with NFPA 90A with material specified in Section "INSULATION". Adhesive and sealer shall be similar to Benjamin Foster 85-20.
- C. Nonhardening caulking shall be designed to be permanently elastic and shall be similar to Tremco Polybutene.
- D. Sound lining shall be used for return air and exhaust ductwork only where required per specification.

2.3 SOUND ATTENUATORS AND SOUND LININGS

- A. Sound attenuators shall be factory prefabricated with galvanized steel shell of a minimum No. 22 USSG and leak proof at a pressure differential of 8 inches wg.
 - 1. Acoustic fill shall inorganic glass fiber with a density sufficient to achieve the specified acoustic performance and packed under 5 percent compression to eliminate voids due to vibration and setting. Material shall be inert, vermin and moisture proof. Filler material shall be totally encapsulated and sealed on the polymer film of an approximate thickness of 1.5 mils. The encapsulated fill material shall be separated from the perforated baffles by means of non-combustible, erosion resistant, acoustic stand off. The flame spread shall be a maximum of 25 and the fuel contributed and smoke developed shall be a maximum of 30. The fill shall meet the erosion test method described in UL Publication No. 181. The filler shall be inert, vermin and moisture proof.
 - 2. Provide minimum 26 gauge galvanized perforated steel baffles.
 - 3. The net insertion ratings shall be determined by the duct-to-reverberant room test method at the design airflow.

Dynamic Net Insertion Loss (db)						
Band Center	Sound Trap Types					
Frequency -Hz	3HS	5HS	7HS	3HL	5HL	7HL
125	9	13	14	4	6	9
250	14	19	23	4	7	11
500	19	26	36	7	14	15
1000	22	35	50	9	14	21
2000	28	44	51	19	37	42

Dynamic Net Insertion Loss (db)							
Band Center	Sound Trap Types						
Frequency -Hz	3MS	5MS	7MS	3LFS	3S	5S	7S
125	7	10	14	13	12	18	20
250	12	18	24	23	16	24	35
500	19	30	36	27	28	40	45
1000	23	42	48	26	35	45	50
2000	23	34	44	22	35	46	48

4. The maximum self-generated noise at 2000 ft per minute face velocity shall be as follows:

Sound Power Level (db)						
	Sound Trap Types					
Frequency -Hz	3HS	5HS	7HS	3HL	5HL	7HL
125		69				51
250		63				51
500		64				49
1000		61				47
2000		63				50

Sound Power Level (db)						
	Sound Trap Types					
Frequency -Hz	5MS	7MS	3LFS	3S	5S	7S
125	54		42			49
250	52		45			49
500	50		43			47
1000	47		45			46
2000	48		49			49

5. Submit certified test data from an approved laboratory for pressure drop and insertion loss ratings as follows:
- For square or rectangular attenuators, provide minimum 24 inches x 24 inches cross-section attenuator.
 - For round attenuators, provide minimum 24 inches diameter conical attenuator.
 - Certification data for pressure drop and net insertion loss shall be based on tests of same attenuator.
 - Attenuators and tests shall be subject to inspection upon request.
6. All sound attenuators shall be clean flow type silencer suitable for hospital and clean room applications except for return and exhaust fans.
7. Attenuators shall be similar to Industrial Acoustics, Inc.
8. Sound attenuators shall be installed down stream of VAV/CV box serving all medical related areas (i.e. Patient Rooms, Exam Rooms, Emergency Department, OR's, LOR's, Simulations, Linac, Spec. Procedure Rooms, etc).
9. Sound attenuators shall be similar to Industrial Acoustics Co.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install sound attenuators in supply ductwork from existing AC unit on roof and at supply C.V. terminal unit serving isolation room in accordance with the manufacturer's

recommendations to obtain noted performance. For maximum allowable static pressure loss, refer to tests in this Section allowable.

- B. Adhere sound linings with 6 inches wide strips of adhesive, 12 inches on centers and at joints in lining. In addition, secure with weld pins and 2 inch diameter washers on maximum 16 inch centers. Coat all edges with sealer. Provide continuous sheet metal edge protectors at entering and leaving edges of all lined duct sections and all joints. Dimensions of lined ductwork are clear inside dimensions after lining has been installed.
 - 1. The extent of ductwork sound linings for air conditioning systems shall be as follows:
 - a. Provide sound lining on all return ducts in mechanical equipment room and exposed ductwork on the roof upstream of return to HVAC units.
 - b. Upstream and downstream of exhaust fans for minimum distance of 20'0" (6m).
 - c. All toilet exhaust branch ducts. Lining can be deleted if ductwork configuration has at least two 90° elbows between the closest air outlets of the men's and women's toilet rooms.

3.2 FIELD QUALITY CONTROL

- A. Tests: after installation, measure the total system pressure before and after each attenuator. If the pressure loss at any attenuator exceeds the maximum static pressure scheduled on the drawings, replace the attenuator(s) at no charge, and/or modify entrance and/or discharge aerodynamic flow to obtain the specified performance.

END OF SECTION 233900

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SECTION 238216

AIR COILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following types of air coils that are not an integral part of air-handling units:
 - 1. Hot-water.
- B. Related sections:
 - 1. Section 233300 – Ductwork and Ductwork Accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil. Include rated capacity and pressure drop for each air coil.
- B. Shop Drawings: Diagram power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.
- B. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance:
 - 1. Comply with ASHRAE 15 for refrigeration system safety.
 - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
 - 3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

PART 2 - PRODUCTS

2.1 HOT WATER RE-HEAT COILS

- A. Hot water re-heat coils shall be ¾" inch O.D. trombone type or aluminum 5/8" straight type. Similar to Aerofin MP Type or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install coils level and plumb.
- B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
- C. Install stainless-steel drain pan under each cooling coil.
 - 1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
 - 2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
 - 3. Extend drain pan upstream and downstream from coil face.

- 4. Extend drain pan under coil headers and exposed supply piping.
- D. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.
- E. Straighten bent fins on air coils.
- F. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to coils to allow service and maintenance.
- C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Section 230900 "Instrumentation and Control for HVAC," and other piping specialties are specified in Section 232113 "Hydronic Piping."
- D. Connect steam piping with gate valve and union and steam condensate piping with union, strainer, trap, and gate valve to allow coils to be disconnected without draining piping. Control valves are specified in Section 230900 "Instrumentation and Control for HVAC," and other piping specialties are specified in Section 232213 "Steam and Condensate Heating Piping."
- E. Connect refrigerant piping according to Section 232300 "Refrigerant Piping."

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 238216