DIVISION 15 - MECHANICAL

SECTION 15010 - GENERAL PROVISIONS

PART 1 - GENERAL

1.01 SUMMARY OF ITEMS INCLUDED

A. This Section contains General Provisions related specifically to the Mechanical Work.

1. Quality Assurance.
2. Terminology.
3. Protection.
4. Coordination and Sequencing.
5. General Completion.
6. Demolition.
7. Cutting and Patching.
8. Excavation for Mechanical Work.
9. Concrete for Mechanical Work.

B. Drawings and General Provisions of Contract, including General and Supplementary Conditions, apply to this section.

1.02 QUALITY ASSURANCE

A. Laws, Permits, Inspections.

1. Comply with latest revisions of New York State Uniform Fire Protection and Construction Code, NYSED Manual of Planning Standards, any Local Codes or Regulations that apply.
2. Underwriters Laboratories label required for all electrical materials carrying 50 volts or more.
3. Comply with New York State Energy Conservation Construction Code.
4. Comply to requirements of drawings and specifications that are in excess of governing codes.
5. Comply with section 1621 of the New York State Building Code for seismic requirements.
6. Do not install work as specified or shown if in conflict with governing code. Notify Engineer and request direction.
7. Pay all Inspection and Permit fees.
8. Provide Certificate of Inspection from all governing authorities.

B. Reference to technical society, organization, body or section made in accordance with the following abbreviations:

1. AIA American Institute of Architects
2. AMCA Air Moving and Conditioning Association, Inc.
3. ANSI American National Standards Institute.
4. ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers
5. ASME American Society of Mechanical Engineers
6. ASTM American Society of Testing Materials
7. AWSC American Welding Society Code
8. AWWA American Water Works Association
9. IEEE Institute of Electric and Electronics Engineers

10. NEC National Electric Code
11. NEMA National Electrical Manufacturer's Association
12. NFPA National Fire Protection Association
13. NYBFU New York Board of Fire Underwriters
14. NYCRR - Codes, Rules and Regulations of the State of New York.
15. NSF - National Sanitation Foundation
16. PDI - Plumbing and Drainage Institute.
17. SMACNA Sheet Metal and Air Conditioning Contractors National Association
18. UL Underwriters' Laboratories, Inc.

C. Contractor submission of equivalent or substitute items other than those specified is at Contractor convenience only. If a substitution or equivalent is accepted, the Contractor shall coordinate the installation of the substitute or equivalent and make all associated changes required. The Contractor also waives any claim for additional costs associated with the substitute / equivalent which becomes apparent before, during or after installation. The Contractor agrees to bear any and all additional costs to all other contractors or subcontractors which are caused by the incorporation of the substitution / equivalent.

D. The Contractor shall, as part of his contract, furnish and install all equipment, materials, wiring accessories, and on-site installation of equipment as required by current standards of good practice.

E. All materials and equipment to be furnished and installed shall be new and of first quality and be free from all defects.

1.03 TERMINOLOGY

A. The following terminology and definitions are used on this project as related to the Mechanical Work.

1. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces and tunnels.
2. Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
3. Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
4. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
5. 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.

6. Sewers: Refer to underground connections from building to street mains. Sewers begin at points 5 feet outside building wall.
7. Service Connections: Refer to underground connections from 5 feet outside building wall to street mains.
8. Underground Lines: Refer to piping buried in earth inside and within 5 feet outside building.
9. Building Lines: Refer to all other lines.
10. For other definitions refer to latest issue of New York State Plumbing Code, and all revisions.

1.04 PROTECTION

A. Protect equipment from damage, including water, chemical, mechanical injury and theft.

B. Replace damaged equipment or components.

C. Close and waterproof between sleeves, openings, pipes and voids in walls, floors and foundations to prevent entrance of water or moisture.

D. Holes made in fire walls, partitions, fire stops, shall be patched to maintain fire rating integrity.

E. Deliver pipes and tubes with factory-applied end-caps. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris and moisture.

F. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.

G. Protect flanges, fittings, and piping specialties from moisture and dirt.

H. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

I. If permanently installed air handler equipment/systems are used during construction, filtration media with a Minimum Efficiency Reporting Value (MERV) of 8 shall be used in each unit and at each return air grille/opening, as determined by ASHRAE 52.2 Replace all unit filtration media with a Minimum Efficiency Reporting Value (MERV) of 13 immediately prior to occupancy and verify ductwork cleanliness; if ductwork is found contaminated, clean ductwork and associated air handling equipment and replace filtration media.

1.05 COORDINATION AND SEQUENCING

A. Coordinate mechanical equipment installation with other building components.

B. Arrange for chases, slots and openings in building structure during progress of construction, to allow for mechanical installations.

C. Coordinate the installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.

D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning prior to closing in the building.

E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

F. Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces. Access panels and doors shall be submitted and approved by the engineer.

G. Coordinate installation of identifying devices after completion of covering and painting, where devices are applied to surfaces. Install identifying devices prior to installation of acoustical ceilings and similar concealment.

H. Coordination with other trades: Right-of-Way as follows:

1. Light Fixtures.
2. Drain Pipes and Vents.
3. Ductwork.
4. HVAC Piping.
5. Domestic Water Piping.
6. Electrical Conduit.

I. Work in existing building.

1. Verify existing locations of pipe, ductwork equipment and conduit in field.
2. Extend existing systems as required for proper tie-in to new systems.
3. Leave existing equipment to be reused in satisfactory working order.
4. Remove from building all existing piping, ductwork, equipment and similar items which do not conform to new layout. Before disposing of these items, determine if Owner wishes to retain them.

J. Changeovers and continuity of services.

1. Make changeovers, tie-ins, removal, and perform similar work that affect operation of present building at times approved by Owner.
2. Make temporary connections required to keep present building systems and equipment in operation.
3. Prior to any shutdown of present building, have necessary materials at site.

1.06 GENERAL COMPLETION

A. Oiling Equipment.

1. Lubricate equipment and motors in accordance with manufacturer's requirements.

B. Instructions to Owner's Representative.

1. Give notice to Engineer when all systems are installed and operating.
2. Obtain name of Owner's Representative to receive instructions.
3. Schedule instructions of Owner's Representative by manufacturer's representative and instruct Owner in system installation and operation for:

a. Heating, Ventilating & Air Conditioning Equipment.
b. Fan equipment.
c. Pumps.
d. Temperature control.
e. Equipment lubrication.
f. Packaged systems.

C. Provide Operation and Maintenance manuals in accordance with the requirements of Division 1 "Project Closeout" Section. Provide an instructional video to the owner of the training / maintenance instruction sessions with the owner.

1.07 PAINTING AND FINISHING

A. Refer to "Painting" Section 09900 for field painting requirements.

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

1.08 DEMOLITION

A. Disconnect, demolish, and remove work specified under Division 15 and as indicated.

B. Where pipe, ductwork, insulation or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.

C. Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.

D. Abandoned Work: Cut and remove buried pipe abandoned in place, 2 inches beyond the face of adjacent construction. Cap and patch surface to match existing finish.

E. Removal: Remove indicated equipment from the project site.

F. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation. Add cap off and pressure test prior to putting back in service.

1.09 CUTTING AND PATCHING

A. All cutting required to facilitate the proper installation of all work to be installed under Div. 15, shall be done by Div. 15 contractor.

B. Cut, channel, chase and drill floors, walls, partitions, ceilings and other surfaces necessary for mechanical installations in the maner specified and approved by the architect. Perform cutting by skilled mechanics of the trades involved.

C. Repair cut surfaces to match adjacent surfaces.

1.10 EXCAVATION FOR MECHANICAL WORK

A. Description of Work: Types of excavation for mechanical related work specified in this section include:

1. Underground mechanical utilities and services.
2. Underground tanks, casings and equipment enclosures.
3. Exterior water circulation and distribution systems.

B. Project Conditions.

1. Locate and protect existing utilities and other underground work in manner which will ensure that no damage or service interruption will result from excavating and backfilling. Liabilities arising out of performance of work is responsibility of Contractor doing excavation.
2. Protect persons from injury at excavations by barricades, warnings, and illumination.
3. Provide temporary covering or enclosure and temporary heat as necessary to protect bottoms of excavations from freezing and frost action. Do not install mechanical work on frozen excavation bases or subbases.

1.11 CONCRETE FOR MECHANICAL WORK.

A. Types of concrete for mechanical related work specified in this section include:

1. Lean concrete backfill to support mechanical work.
2. Encasement of mechanical work.
3. Mechanical equipment foundations and housekeeping pads.
4. Inertia bases for isolation of mechanical work.
5. Rough grouting in and around mechanical work.
6. Patching concrete cuts to accommodate mechanical work.
7. Thrust block.

1.12 REBATES

A. The Division 15 Contractor shall assist the Owner in applying for any available rebates from manufacturer's, utility companies, etc. on equipment or materials installed under the contract. Provide all required documentation and assist in the completion of applications as required to complete the rebate process. All proceeds from rebates remain the property of the Owner.

PART 2 – PRODUCTS

Reference Section 03300.

PART 3 - EXECUTION

3.01 EXCAVATION - GENERAL

A. Do not excavate for mechanical work until work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimum.

B. Excavate with vertical sided excavations to greatest extent possible, except where otherwise indicated. Where necessary, provide sheeting and cross bracing to sustain sides of excavation. Remove sheeting and cross bracing during backfilling wherever such removal would not endanger work or other property. Where not removed, cut sheeting off at sufficient distance below finished grade to not interfere with other work.

C. Width: Excavate for piping with 6" to 9" clearance on both sides of pipe, except where otherwise shown or required for proper installation of pipe joints, fittings, valves and other work. Excavate for other mechanical work to provide minimum practical but adequate working clearances.

D. Depth for direct support: For work to be supported directly on undisturbed soil, do not excavate beyond indicated depths, and hand excavate bottom cut to accurate elevations, undercut at pipe hubs.

E. Depth for subbase support: For large piping (6" pipe size and larger), tanks, and where indicated for other mechanical work, excavate for installation of subbase material in depth indicated or, if not otherwise indicated, 6" below bottom of work to be supported.

F. Depth for unsatisfactory soil or rock conditions: Where directed, (because of unsatisfactory conditions at bottom of indicated excavation), excavate additional depth as directed to reach satisfactory conditions. Backfill with subbase material, compacted as directed, to indicated excavation depth.

G. Store excavated material (temporarily) near excavation, in manner which will not interfere with or damage excavation or other work. Do not store under trees (within drip line).

1. Dispose of excavated material which is either in excess of quantity needed for backfilling, or does not comply with requirements for backfill material.

    a. Remove unused material from project site, and dispose of in lawful manner.

3.02 WATER CONTROL

A. Maintain dry excavations for mechanical work, by removing water. Protect excavations from inflow of surface water. Pump inflow of ground water from excavations, protect excavations from inflow of ground water, by installing temporary sheeting and waterproofing as well as dewatering as required. Provide adequate barriers which will protect other excavations and below grade property from being damaged by water, sediment or erosion from or through mechanical work excavations. Need permit for dewatering – contractor to obtain and pay for.

3.03 BACKFILLING(REFERENCE 02200)

A. Do not backfill until installed mechanical work has been tested and accepted, wherever testing is indicated.

B. Install drainage fill where indicated, and tamp to uniform firm density.

C. Backfill with finely graded subbase material to 6" above wrapped, coated and plastic piping and tanks, and to centerline of other tanks.

D. Condition backfill material by either drying or adding water uniformly, to whatever extent may be necessary to facilitate compaction to required densities. Do not backfill with frozen soil materials.

E. Backfill simultaneously on opposite sides of mechanical work, and compact simultaneously, do not dislocate work from installed positions.

F. Backfill excavations in 8" high courses of backfill material, uniformly compacted to the following densities (% of maximum density, ASTM D1557), using power-driven hand operated compaction equipment.

    1. Lawn and landscaped areas: 85% for cohesive soils, 90% for cohesionless soil.
    2. Paved areas and roadways: 90% for cohesive soils, 95% for cohesionless soils.

G. Backfill to elevations matching adjacent grades, at time of backfilling excavations for mechanical work. Return surfaces to original condition.

H. After covering piping with 6" layer of approved fill, employ General Contractor to backfill, compact excavations beneath:

1. New foundations.
2. Slabs on grade.
3. Areas to be paved by General Contractor.

3.04 CONCRETE BASES

A. Construct concrete equipment bases of dimensions required, but not less than 4 inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations.

3.05 CONCRETE GENERAL

Reference Section 03300.

3.06 CONCRETE CURING AND PROTECTION

Reference Section 03300.

3.07 MISCELLANEOUS CONCRETE ITEMS

A. Fill in holes and openings left in concrete structures for passage of work by trade unless otherwise shown or directed, after work of other trades is in place. Mix, place and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.

3.08 CONCRETE SURFACE REPAIRS(REFERENCE 03300)

A. Repair and patch areas with epoxy or non-shrink grout immediately after removal of forms, when acceptable to Architect/Engineer.

B. Repair areas, except single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4" clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

C. Use epoxy-based mortar for structural repairs, where directed by Architect/Engineer.

D. Repair methods not specified above may be used, subject to acceptance of Engineer.

3.09 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. Quality Control: Owner's acceptable testing laboratory will perform sampling and testing during concrete placement, which may include the following, as directed by Engineer. This testing

does not relieve Contractor of responsibility of providing concrete in compliance with specifications. Contractor shall perform additional testing as necessary, at no expense to Owner, to ensure quality of concrete.

1. Sampling Fresh Concrete: ASTM.
2. Slump: ASTM, one test for each load at point of discharge.
3. Air Content: ASTM C 173, one for each set of compressive strength (specimens of freshly mixed concrete).
4. Compressive Strength: ASTM, one set for each 50 cu. yds. or fraction thereof of each class and type of concrete; 2 specimens tested at 7 days, 3 specimens tested at 28 days, and one retained for later testing if required.
5. Laboratory Cured Test Cylinders: ASTM.

END OF SECTION

DIVISION 15 - MECHANICAL

SECTION 15014 - CODES, STANDARDS, AND PERMITS

1.01 GENERAL

The entire installation shall be made in accordance with State rules and regulations and shall also conform with the Standards of the National Board of Fire Underwriters for this installation and the local Board of Fire Underwriters having jurisdiction. The installation shall also comply with air pollution requirements of the State of New York and Industrial Code Rule 4 of the State of New York Department of Labor, Board of Standards and Appeals, dated March 31, 1965, and all other ordinances having jurisdiction.

The Contractor shall submit to all authorities having jurisdiction all required applications and shall secure all necessary permits, tests, and inspections required for final approval.

Certain standard and staple materials are described by reference to standard specifications. These standards are as follows:

ASA-B9	Safety Code for Mechanical Refrigeration
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing Materials
AWWA	American Water Works Association
CS	Commercial Standard
FS	Federal Specification
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
NSF	National Sanitation Foundation
PDI	Plumbing and Drainage Institute
SMACNA	Sheet Metal and Air Conditioning Contractors Association
USASI	United States of America Standards Institute
UL	Underwriters' Laboratories
	New York State Uniform Fire Prevention and Building Code dated January 1, 1989
A.A.B.C.	Associated Air Balance Council
N.E.B.B.	National Environmental Balancing Bureau

All new equipment shall bear U.L. label and conform to the latest edition of the National Electric code.

END OF SECTION

DIVISION 15 - MECHANICAL

SECTION 15018 - MOTORS AND ELECTRICAL WORK

1. Internal electrical control devices that operate starters, controllers, etc. shall be furnished, installed, and wired under Division 15. Such devices shall be included but not necessarily limited to, devices connected to ducts, damper switches, float switches, electric thermostats, safety devices, limit switches, relays, push button controllers, selector switches, pilot lights, extra interlock contacts, etc.

2. Equipment starters and disconnects shall be provided by the mechanical contractor completely mounted and wired to internal controls and shall be wired to incoming and outgoing control connections. Should integral equipment starters, disconnects or control panels be shipped separately, the mechanical contractor shall be responsible for the proper installation and connections from equipment to same. Incoming and outgoing (line and load) power wiring to starters / disconnect switches shall be performed by the electrical contractor.

3. The integration of the existing temperature control system wiring and controls shall be the responsibility of the Contractor under Division 15. The Contractor shall be fully responsible for the satisfactory operation of new equipment with the temperature control system.

4. All control transformers, control devices, starters, and control wiring furnished shall be properly protected with fuse cutouts and fuses or circuit breakers to conform to the National Electric Code, latest edition. All work shall be performed by a licensed electrician.

5. Each piece of equipment shall be provided with permanent type laminated, black finish, white core, phenolic nameplate. Nameplates should indicate the name and number of the unit, voltage, and any interlock reference. Each starter furnished by the Contractor shall be provided with a permanent type laminated, black finish, white core phenolic nameplate. Nameplate shall indicate the name of the unit controlled and the voltage rating. Nameplate shall be secured with adhesives. Plastic tape type labels will not be accepted.

6. All equipment shall be provided with disconnect means (by Mechanical Contractor).

7. All wiring furnished and installed by the mechanical contractor shall be in strict accordance with the latest edition of the National Electrical Code and all State and Municipal Agencies having jurisdiction. Except as specified otherwise, minimum size wire shall be #14 AWG (control) and #12 AWG (power) and shall be run in rigid galvanized steel conduit except as noted hereinafter. All wire shall be Type THHN or as required by code. All conduit connections to motors shall be made with short lengths of neoprene jacketed galvanized flexible metallic conduit (liquitite).

8. All wire and cable shall be new, manufactured of soft drawn copper of not less than 98% conductivity, conforming to ASTM Specifications and the latest requirements of N.E.C. Wire, and cable shall have 600 volt insulation (unless otherwise noted or specified) of the type specified and shall be of the standard AWG sizes as called for on Drawings or specified.

9. The Contractor shall furnish all labor and material required for the installation of the systems. A brief description of the work is as follows:

   a. Furnish all electrical control wiring for the new equipment and controls.

   b. Contractor shall apply final finish to insure uniformity.

   c. All cutting, patching, and painting as required.

   d. All controls for units as hereinbefore specified and disconnect switches.

   e. Testing of all mechanical contractor installed wiring as directed.

   f. Contractor shall perform all work as stated on the documents for fire alarm fan shutdown for all new applicable equipment, unless noted otherwise.

   g. Contractor shall obtain an approved independent electrical inspection certificate, covering all work performed by an electrical inspection agency serving the locality of the project.

END OF SECTION

DIVISION 15 - MECHANICAL

SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY OF ITEMS INCLUDED

A. This Section includes the following basic mechanical materials and methods to complement other Division 15 Sections.

1. Submittals.
2. Welder certification.
3. Pipe joining materials and installation instructions common to piping systems.
4. Piping specialties: Escutcheons, dielectric fittings, sleeves and seals.
5. Identifying devices and labels.
6. Nonshrink grout for equipment installations.
7. Drip pans.
8. Fire stopping.
9. Pipe supports: Hangers, clamps, support spacing, building attachments, shields and saddles, flashing, miscellaneous materials, anchors.
10. Field fabricated metal and wood equipment supports.

B. Pipe and pipe fitting materials are specified in piping system sections.

1.02 RELATED DOCUMENTS

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

1.03 SUBMITTALS

A. General - Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data for following piping specialties:

1. Mechanical sleeve seals.
2. Identification materials and devices.

C. Samples of color, lettering style and other graphic representation required for each identification material and device.

D. Shop drawings detailing fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.

E. Coordination drawings for access panel and door locations.

F. Prepare coordination drawings according to Division 1 Section 01044-"Composite Drawings" to a 1/4 inch equals 1 foot scale or

larger. Detail major elements, components and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Show where sequence and coordination of installations are important to the efficient flow of the Work. Include the following:

1. Proposed locations of piping, ductwork, equipment and materials. Include the following:

    a. Planned piping layout, including valve and specialty locations and valve stem movement.
    b. Planned duct systems layout, including elbows radii and duct accessories.
    c. Clearances for installing and maintaining insulation.
    d. Clearances for servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance.
    e. Equipment service connections and support details.
    f. Exterior wall and foundation penetrations.
    g. Fire-rated wall and floor penetrations.
    h. Sizes and location of required concrete pads and bases.

G. Floor plans, elevations and details to indicate penetrations in floors, walls and ceilings and their relationship to other penetrations and installations.

H. Reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

I. Submit weld proceedure specifications.

1.04 WELD AND WELDER CERTIFICATION

A. Welder certificates signed by Contractor certifying that welders comply with requirements of this Section.

B. Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code - Steel".

1. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".

1. Comply with provisions of ASME B31 Series "Code for Pressure Piping".

1.05 Standards for Materials and Workmanship

A. All materials and workmanship shall, at a minimum be inaccordance with (in no order of precedence):

1. New York State Codes – latest edition as adopted by the Authority Having Jurisdiction, unless otherwise noted.

2. State and municipal Building Codes and related subcodes.

3. Occupational and Safety Act (OSHA) Requirements.

4. Rules and Regulations of the Authority Having Jurisdiction applicable to the work.

5. National Electrical Standards Association Standard for Good Workmanship in Electrical Construction (NECA-1)

6. Serving utility's rules and regulations for providing service.

7. Contract Drawings and Specifications.

8. Manufacturer recommended installation instructions, practices and procedures for the products being utilized or installed.

9. Where conflicts arise between the above, the more stringent requirement shall be adhered to.

PART 2 - PRODUCTS

2.01 PIPE AND PIPE FITTINGS

A. Refer to individual piping system specification Sections for pipe and fitting materials and joining methods. Joining methods and pipe installation shall be performed in complete accordance with section 1613 of the Building Code of New York State for building seismic type II, zone C.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.02 PIPE JOINING MATERIALS

A. Refer to individual piping system specification Sections in Division 15 for special joining materials not listed below.

B. Pipe Flange Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8 inch maximum thickness, except where thickness or specific material is indicated.

a. Full-Face Type: for flat-face, Class 125 cast-iron and cast-bronze flanges.
b. Narrow-Face Type: for raised-face, Class 250 cast-iron and steel flanges.

2. ASME B16.20 for grooved, ring-joint, steel flanges. Note that grooved, ring joint piping / accessories may be used for sprinkler or condenser water piping systems only.
3. AWWA C110, rubber, flat face, 1/8 inch thick, except where other thickness is indicated; and full-face or ring type, except where type is indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, except where other material is indicated.

D. Solder Filler Metal: ASTM B 32.

1. Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent) and silver (approximately 5 percent).
3. Alloy E: Tin (approximately 95 percent) and copper (approximately 5 percent).
4. Allow HA: Tin-antimony-silver-copper-zinc.
5. Alloy HB: Tin-antimony-silver-copper-nickel.
6. Alloy Sb5: Tin (95 percent) and antimony (5 percent).

E. Brazing Filler Metals: AWS A5.8.

1. BCuP Series: Copper-phosphorus alloys.
2. BAg1: Silver alloy.

F. Welding Fill Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Flanged, Ductile-Iron Pipe Gasket, Bolts and Nuts: AWWA C110, rubber gasket, carbon steel bolts and nuts.

H. Couplings: Iron body sleeve assembly, fabricated to match outside diameters of plain-end, pressure pipes.

1. Sleeve: ASTM A 126, Class B, gray iron.
2. Followers: ASTM A 47, Grade 32510 or ASTM A 536 ductile iron.
3. Gaskets: Rubber.
4. Bolts and Nuts: AWWA C111.
5. Finish: Enamel paint.

2.03 PIPING SPECIALTIES

A. Escutcheons: Manufactured wall, ceiling and floor plates; deep-pattern type, where required to conceal protruding fittings and sleeves.

1. Inside Diameter: Closely fit around pipe, tube and insulation of insulated piping.
2. Outside Diameter: Completely cover opening.
3. Cast Brass: One-piece, with set-screw.

    a. Finish: Rough brass.
    b. Finish: Polished chrome plate.

4. Cast Brass: Split casting, with concealed hinge and set-screw.

    a. Finish: Rough brass.
    b. Finish: Polished chrome plate.

5. Stamped Steel: One-piece, with set screw and chrome plated finish.
6. Stamped Steel: One-piece with spring clips and chrome plated finish.
7. Stamped Steel: Split plate with concealed hinge, set-screw, and chrome plated finish.
8. Stamped Steel: Split plate with concealed hinge, spring clips and chrome plated finish.
9. Cast-Iron Floor Plate: One piece casting.

B. Dielectric Fittings: Assembly or fitting having insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.

1. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld neck end types and matching piping system materials.
2. Insulating Material: Suitable for system fluid, pressure and temperature.
3. Dielectric Unions: Factory-fabricated, union assembly, for 250 psig minimum working pressure at 180 deg F temperature.
4. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150 or 300 psig minimum pressure to suit system pressures.
5. Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers and steel backing washers.

    a. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure to suit system pressures.

6. Dielectric Couplings: Galvanized steel coupling, having inert and non-corrosive, thermoplastic lining, with threaded ends and 300 psig minimum working pressure at 225 deg F temperature.
7. Dielectric Nipples: Electroplated steel nipple, having inert and non-corrosive, thermoplastic lining, with combination of plain or threaded end types and 300 psig working pressure at 225 deg F temperature.

C. Mechanical Sleeve Seals: Modular, watertight, mechanical type. Components include interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve. Connecting bolts and pressure plates cause rubber sealing elements to expand when tightened.

D. Sleeves: The following materials are for wall, floor, slab and roof penetrations.

1. Steel Sheet-Metal: 24 gage or heavier, galvanized sheet metal, round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A53, Type E, Grade A, Schedule 40, galvanized, plain ends.
3. Cast-Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, having plain ends and integral water stop, except where other features are specified.
4. Wall Penetration Systems: Wall sleeve assembly, consisting of housing, gaskets and pipe sleeve, with 1 mechanical-joint end conforming to AWWA C110 and 1 plain pipe-sleeve end.

    a. Penetrating Pipe Deflection: In accordance with International Building Code (latest edition), Chapter 16: seismic requirements, without leakage.
    b. Housing: Ductile-iron casting having waterstop and anchor ring, with ductile-iron gland, steel studs and nuts, and rubber gasket conforming to AWWA C111 of housing and gasket size as required to fit penetrating pipe.
    c. Pipe Sleeve: AWWA C151, ductile-iron pipe.
    d. Housing-to-Sleeve Gasket: Rubber or neoprene, push-on type, of manufacturer's design.
5. Cast-Iron Sleeve Fittings: Commercially-made, sleeve having integral clamping flange, with clamping ring, bolts and nuts for membrane flashing.

    a. Underdeck Clamp: Clamping ring with set screws.

2.04 IDENTIFYING DEVICES AND LABELS

A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 15 Sections. Where more than single type is specified for listed application, selection is Installer's option, but provide single selection for each product category.

B. Equipment Nameplates: Metal nameplate with operational data engraved or stamped; permanently fastened to equipment.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.
2. Location: An accessible and visible location.

C. Snap-On Plastic Pipe Markers: Manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, conforming to ASME A13.1.
D. Pressure-Sensitive Pipe Markers: Manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, conforming to ASME A13.1.
E. Plastic Duct Markers: Manufacturer's standard laminated plastic, color coded duct markers. Conform to following color code:

1. Green: Cold air.
2. Yellow: Hot air.
3. Yellow/Green: Supply air.
4. Blue: Exhaust, outside, return and mixed air.
5. For hazardous exhausts, use colors and designs recommended by ASME A13.1.
6. Nomenclature: Include following:

    a. Direction of air flow.
    b. Duct service (supply, return, exhaust, etc.).
    c. Duct origin (from).
    d. Duct destination (to).
    e. Design cfm.

F. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock: Grade ES-2, black surface, black phenolic core, with white (letter color) melamine subcore, except when other colors are indicated.

1. Fabricate in sizes required for message.
2. Engraved with engraver's standard letter style, of sizes and with wording to match equipment identification.
3. Punch for mechanical fastening.
4. Thickness: 1/16 inch, except as otherwise indicated.
5. Thickness: 1/8 inch, except as otherwise indicated.
6. Thickness: 1/16 inch, for units up to 20 square inches or 8-inches long; 1/8 inch for larger units.
7. Fasteners: Self-tapping stainless-steel screws or contact-type permanent adhesive.

G. Plastic Equipment Markers: Laminated-plastic, color-coded equipment markers. Conform to following color code:

1. Green: Cooling equipment and components.
2. Yellow: Heating equipment and components.
3. Yellow/Green: Combination cooling and heating equipment and components.
4. Brown: Energy reclamation equipment and components.
5. Blue: Equipment and components that do not meet any of above criteria.
6. For hazardous equipment, use colors and designs recommended by ASME A13.1.
7. Nomenclature: Include following, matching terminology on schedules as closely as possible:

    a. Name and plan number.
    b. Equipment service.

c. Design capacity.
d. Other design parameters such as pressure drop, entering and leaving conditions, and rpm.

8. Size: Approximately 2-1/2 by 4 inches for control devices, dampers, and valves; and 4-1/2 by 6 inches for equipment.

H. Underground Type Plastic Line Marker.

1. Manufacturer's standard permanent, bright colored, continuous printed plastic tape, intended for direct burial service, not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.

I. Lettering and Graphics: Coordinate names, abbreviations and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, lettering and wording indicated for proper identification and operation/maintenance of mechanical systems and equipment.

1. Multiple Systems: Where multiple systems of same generic name are indicated, provide identification that indicates individual system number as well as service such as "Boiler No. 3", "Air Supply No. 1H", or "Standpipe F12".

2.05 GROUT

A. Nonshrink, Nonmetallic Grout: ASTM C1107, Grade B.

1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000 psi, 28-day compressive strength.
3. Packaging: Premixed and factory-packaged.

2.06 DRIP PANS

A. Provide drip pans fabricated from corrosion resistant sheet metal with watertight joints, and with edges turned up 2-1/2 inches. Reinforce top, either by structural angles or by folding over according to size. Provide hole, gasket, and flange at low point for watertight joint and 1-inch drain line connection.

2.07 FIRE STOPPING

A. Refer to Specification Section 15511 for details.

2.08 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. General: Except as otherwise indicated, provide factory fabricated horizontal piping hangers and supports. Supports and hangers in conformance with International Building Code (latest

edition), Chapter 16: seismic requirements shall be used. Use only one type by one manufacturer for each piping service. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping. Provide copper plated hangers and supports for copper piping systems. Provide spring hangers where piping is subject to vibration movement.

B. Adjustable steel clevises.

1. Material: Carbon steel, copper plated for copper piping.
2. Finish: Black or copper plated.
3. Adjustment: Hanger to be adjustable for vertical height of pipe without removing the pipe.

2.09 VERTICAL PIPING CLAMPS

A. Two bolt riser clamp.

1. Material: Carbon steel copper plated for copper piping.
2. Finish: Black or copper plated.

2.10 HANGER ROD AND SPACING

ROD SIZE AND SPACING SCHEDULE (In accordance with NYSBC 1621)

PIPE SIZE	ROD DIAMETER
2" and smaller	3/8"
2-1/2" thru 3-1/2"	1/2"
4" thru 5"	5/8"
6" and over	3/4"

TYPE	MAXIMUM SPACING
Steel	10’ -0"
Copper	6’- 0"

Note: Cast Iron - support at every hub or coupling 5 ft. maximum spacing.

2.11 BUILDING ATTACHMENTS

A. General: Except as otherwise indicated provide factory fabricated building attachments of one of the following types listed, selected by Installer to suit building substrate conditions. Select size of building attachments to suit hanger rods. Provide copper plated building attachments for copper piping systems. Provide the following where approved by International Building Code (latest edition), Chapter 16:

B. On Structural Steel:

1. For pipes 2" and smaller: C clamps with lock nuts similar to Grinnell figure 86.
2. For pipes 5" and larger: Use beam clamps similar to Grinnell figure 228 or 292.

C. On New Masonry:

1. Use concrete inserts similar to Grinnell figure 281.

D. On Existing Concrete:

1. Use expansion case similar to Grinnell figure 117.

E. On Wood:

1. Use coach screw rods Grinnell figure 111. Ceiling flanges Grinnell figure 153, or fabricated angle clips. Use wood drive screws or lag bolts as fasteners.

2.12 SHIELDS AND SADDLES (Where approved by International Building Code (latest edition), Chapter 16:)

A. General: For insulated piping.

B. Shields: 16 gauge galvanized metal.

Unsul Coustic Corp. "Insul-Shield"

C. Protection saddles:

1. Hardwood block
2. Steel saddle Grinnell 160 series

2.13 FLASHING MATERIALS

A. General: Provide flashings for each penetration of mechanical systems through roofs or waterproof membranes.

B. Molded Pipe Flashing: Compatible with single ply membranes with which it is used and manufactured by membrane manufacturer.

C. Copper flashing: Provide cold-rolled sheet copper (ANSI/ASTM B 370), of proper temper for applications shown and required forming, coated on one side with not less than 0.06 lbs. per sq. ft. of antimony (ANSI/ASTM B 101, Type I, Class A), weighing 1.06 lbs. per sq. ft., except as otherwise indicated.

D. Bituminous coating: FS TT-C-494, or MIL-C-18480, or SSPC-Paint 12, cold applied solvent type bituminous mastic coating for application in dry film thickness of 15 mils per coat.

2.14 MISCELLANEOUS MATERIALS

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

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

C. Heavy duty steel trapezes: Fabricate from steel shapes selected for loads required, weld steel in accordance with AWS standards.

D. Pipe guides: Provide factory fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of a bolted two section outer cylinder and base with a two section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

2.15 ANCHORS

A. Fabricate pipe anchors from 3 x 3 x 1/2" angle.

B. Use pipe protection saddles one size larger than piping.

PART 3 - EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

A. General: All piping systems, components and their installation shall be in conformance with the International Building Code (latest edition), Chapter 16: for seismic requirements. Install piping as described below, except where system Sections specify otherwise. Individual piping system specification Sections in Division 15 specify piping installation requirements unique to the piping system.

B. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing and other design considerations. Install piping as indicated, except where deviations to layout are approved on coordinate drawings.

C. Install piping at indicated slope.

D. Install components having pressure rating equal to or greater than system operating pressure.

E. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.

F. Install piping free of sags and bends.

G. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, except where indicated.

H. Install piping tight to slabs, beams, joists, columns, walls and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.

I. Install piping to allow application of insulation plus 1-inch clearance around insulation.

J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

K. Install fittings for changes in direction and branch connections.

L. Install couplings according to manufacturer's printed instructions.

M. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wallboard partitions and suspended ceilings according to the following:

1. Chrome-Plated Piping: Cast-brass, one-piece, with set-screw and polished chrome-plated finish. Use split-casting escutcheons where required, for existing piping.
2. Uninsulated Piping Wall Escutcheons: Cast-brass or stamped-steel, with set-screw.
3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
4. Insulated Piping: Cast-brass or stamped-steel, with concealed hinge, spring clips and chrome-plated finish.
5. Piping in Utility Areas: Cast-brass or stamped-steel with set-screw or spring clips.

N. Sleeves are required for core drilled holes.

O. Permanent sleeves are not required for holes formed by PE plastic (removable) sleeves.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, concrete floor and roof slabs and where indicated.

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

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring where specified.

2. Build sleeves into new walls and slabs as work progresses.

3. Install large enough sleeves to provide 1/4 inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Sheet-Metal Sleeves: For pipes 6 inches and larger, penetrating gypsum-board partitions.
b. Cast-Iron Sleeve Fittings: For floors having membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Flashing is specified in Division 7 Section "Flashing and Sheet Metal".
c. Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.

4. Except for below-grade wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants specified in Division 7 Section "Joint Sealants".

Q. Above Grade, Exterior Wall, Pipe Penetrations: Seal penetrations using sleeve and mechanical sleeve seals. Size sleeve for 1 inch annular clear space between pipe and sleeve for installation of mechanical seals.

1. Install steel pipe for sleeves smaller than 6 inches.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger.
3. Assemble and install mechanical seals according to manufacturer's printed instructions.

R. Below Grade, Exterior Wall, Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installation of mechanical seals.

S. Below Grade, Exterior Wall, Pipe Penetrations: Install ductile-iron wall penetration system sleeves according to manufacturer's printed installation instructions.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

V. Piping Joint Construction: Joint pipe and fittings as follows and as specifically required in individual piping system specification Sections.

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Soldered Joints: Construct joints according to AWS "Soldering Manual", Chapter 22 "The Soldering of Pipe and Tube".
4. Brazed Joints: Construct joints according to AWS "Brazing Manual", Chapter 28 "Pipe and Tube".

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

    a. Note the internal length of threads in fittings or valve ends and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
    b. Apply appropriate tape or thread compound to external pipe threads (except where dry seal threading is specified).
    c. Align threads at point of assembly.
    d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
    e. Damaged Threads: Do not use pipe or pipe fittings having threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

W. Welded Joints: Construct joints according to AWS D10.12 "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe" using qualified processes and welding operators according to "Quality Assurance" article.

X. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

1. Fitting Heat-Fusion Joints: Prepare pipe and fittings and join with heat-fusion equipment, according to manufacturer's printed instructions.

    a. Plain-End Pipe and Socket-Type Fittings: Socket-joining.

Z. Piping Connections: Except as otherwise indicated, make piping connections as specified below.

1. Install unions, in piping 2 inches and smaller, adjacent to each valve and at final connection to each piece of equipment having 2 inches or smaller threaded pipe connection.
2. Install flanges, in piping 2 1/2 inches and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
3. Dry Piping Systems (Gas, Compressed Air, and Vacuum): Install dielectric unions and flanges to connect piping materials or dissimilar metals.
4. Wet Piping Systems (Water and Steam): Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.02 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to provide the maximum possible headroom, where mounting heights are not indicated. Equipment platforms, vibration isolation and restraints shall be provided and installed where described and shall be in conformance with International Building Code (latest edition), Chapter 16:

B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Architect.

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

D. Install mechanical equipment to facilitate servicing, maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

E. Install equipment giving right-of-way to piping systems installed at a required slope.

3.03 LABELING AND IDENTIFYING

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

1. Plastic markers, with application systems. Install on pipe insulation segment where required for hot non-insulated pipes.

2. Locate pipe markers as follows wherever piping is exposed in finished spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

a. Near each valve and control device.
b. Near each branch, excluding short take-offs for fixtures and terminal units. Mark each pipe at branch, where flow pattern is not obvious.
c. Near locations where pipes pass through walls, floors, ceilings, or enter non-accessible enclosures.
d. At access doors, manholes and similar access points that permit view of concealed piping.
e. Near major equipment items and other points of origination and termination.
f. Spaced at a maximum of 50 feet intervals along each run. Reduce intervals to 25 feet in congested areas of piping and equipment.
g. On piping above removable acoustical ceilings, except omit intermediately spaces markers.

3. During back-filling/top-soiling of each exterior underground piping systems, install continuous underground type plastic line marker, located directly over buried line

at 6-inches to 8-inches below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16-inches, install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

B. Equipment: Install engraved plastic laminate sign or equipment marker on or near each major item of mechanical equipment.

1. Lettering Size: Minimum 1/4 inch high lettering for name of unit where viewing distance is less than 2 feet, 1/2 inch high for distance up to 6 feet, and proportionately larger lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.

2. Text of Signs: Provide text to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to name of identified unit.

C. Duct Systems: Identify air supply, return, exhaust, intake and relief ducts with duct markers, or provide stenciled signs and arrows, showing duct system service and direction of flow.

1. Location: In each space where ducts are exposed or concealed by removable ceiling system, locate signs near points where ducts enter into space and at maximum intervals of 50 feet.

D. Adjusting: Relocate identifying devices which become visually blocked by work of this Division or other Divisions.

3.04 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Provide and install in conformance with International Building Code (latest edition), Chapter 16: Cut, fit and place miscellaneous metal supports accurately in location, alignment and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1 "Structural Welding Code - Steel".

3.05 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish

materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.06 GROUTING

A. Install nonmetallic, nonshrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's printed instructions.

B. Clean surfaces that will come into contact with grout.

C. Provide forms for placement of grout, as required.

D. Avoid air entrapment when placing grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases to provide a smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout according to manufacturer's printed instructions

3.07 DRIP PANS

A. Locate drip pans under piping passing over or within 3 ft. horizontally of electrical equipment, and elsewhere as indicated. Hang from structure with rods and building attachments, and weld rods to sides of drip pan.
Brace to prevent sagging or swaying. Connect 1-inch drain line to drain connection, and run to nearest plumbing drain or elsewhere as indicated.

3.08 FIRESTOPPING

A. See section 15511 for additional fire stopping requirements.

3.09 INSTALLATION OF BUILDING ATTACHMENTS

A. Install building attachments at required locations in concrete, in wood or on structural steel for proper piping support. Space attachments within maximum piping span length indicated. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed, fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through openings at top of inserts.

3.10 INSTALLATION OF HANGERS AND SUPPORTS

A. General: Install hangers, supports, clamps and attachments to support piping properly from building structure. Supports / hangers shall conform to the requirements of International Building Code (latest edition), Chapter 16: Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Install hangers and supports of same type and style for grouped piping runs.

C. Support fire water piping independently of other piping.

D. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated.

E. Provisions for movement: International Building Code (latest edition), Chapter 16:

1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.
2. Load distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
3. Pipe slopes: Install hangers and supports to provide indicated pipe slopes.

F. Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.

3.11 SHIELDS AND SADDLES FOR INSULATED PIPING

A. 4" and below use 16 gauge x 12 inch long shield with oversized hanger outside insulation.

B. 6" and above use hardwood protection saddle with 16 gauge x 18 inch long shield with oversized hanger outside insulation.

C. 6" and above use steel protection saddle. Fill void between shield and pipe with insulation. Cover with vapor barrier. Protect barrier with 16 gauge x 18 inch long shield with oversized hanger outside assembly.

3.12 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

D. Anchor spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.13 FLASHINGS

A. Manufacturer's recommendations: Except as otherwise shown or specified, comply with recommendations and instructions of manufacturer of sheet metal being installed.

B. Coat back side of flashings where in contact with concrete and other cementitious substrates, by painting surface in area of contact with heavy application of bituminous coating, or by other permanent separation as recommended by manufacturer of metal.

C. On vertical surfaces, lap flashings minimum of 3".

D. On sloping surfaces, for slopes of not less than 6" in 12", lap unsealed flashings minimum of 6".

E. For embedment of metal flashing flanges in roofing or composition flashing or stripping, extend flanges minimum of 6" for embedment.

END OF SECTION

DIVISION 15 - MECHANICAL

SECTION 15100 - VALVES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

A. Extent of valves required by this section is indicated on drawings and/or specified in other Division 15 sections.

B. Types of valves specified in this section include the following:

1. Gate valves.
2. Globe valves
3. Drain valves.
4. Ball valves.
5. Butterfly valves (where specifically approved by engineer only).
6. Check valves.

a. Wafer Check (where specifically approved by engineer only).

1.03 QUALITY ASSURANCE

A. Marking of valves - comply with MSS SP-25.

B. Valve dimensions - for face-to-face and end-to-end dimensions of flanged or welding end valve bodies, comply with ANSI B16.10.

C. ASME Compliance: ASME 1331.9 for Building Services Piping.

D. Valve types. Provide valves of same type by same manufacturer.

1.04 SUBMITTALS

A. Product data - submit catalog cuts, specifications, installation instructions, and dimensioned drawings for each type of valve. Include pressure drop curve or chart for each type and size of valve. Submit valve schedule showing manufacturer's figure number, size, location and valve features for each required valve.

B. Maintenance data - submit maintenance data and spare parts lists for each type of valve. Include this data in Maintenance Manual.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle valves and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged valves or components, replace with new.

B. Store valves and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide factory fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated, provide proper selection as determined by installer to comply with installation requirements. Provide sizes as indicated, and connections which properly mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is engineer’s option.

B. Valve Features

1. Bypass- when shown provide manufacturer's standard bypass piping and valving.
2. Drain - when shown provide threaded pipe plugs complying with Division 15 "Hot & Chilled water piping" section.
3. Flanged - valve flanged complying with ANSI B16.1 (cast iron), ANSI B16.5, (steel), or ANSI B16.24 (bronze).
4. Threaded - valve ends complying with ANSI B2.1
5. Solder joint - valve ends complying with ANSI B16.18.
6. Trim - fabricate pressure containing components of valve, including stems (shafts) and seats from brass or bronze materials, of standard alloy recognized in valve manufacturing industry.
7. Renewable seat - design seat of valve with removable disc, and assemble valve so disc can be replaced when worn.
8. Extended stem - increase stem length 2" minimum, to accommodate insulation applied over valve.

C. Valve Definitions

1. Mechanical actuator - factory fabricated gears, gear enclosure, external chain attachment and chain designed to provide mechanical advantage in operating valve.
2. Bonnet - part of gate or globe valve through which stem passes to valve body, and attached to valve body by screws, bolts union, or welding.
3. Solid wedge - one piece tapered disc in gate valve, designed for contact on both sides.
4. Outside screw and yoke (OS&Y) - stem and handwheel designed to rise out of bonnet or yoke as valve is operated from closed to open position.
5. Inside screw, non-rising stem - stem and handwheel designed to rotate without rising when valve is operated from closed to open position.
6. Tight shutoff - butterfly valve designed for flow regulation, and manufactured to be tight in closed position.

2.02 GLOBE VALVES

A. Packing - select valves designed for repacking under pressure when fully opened, equipped with packing suitable for intended service. Select valves designed so back seating protects packing and stem threads from fluid when valve is fully opened, and equipped with gland follower.

B. Composition discs - where required, provide suitable material for intended service. For stem throttling service, fit composition disc valve with throttling nut. For metal seated globe valves, provide hardened stainless steel disc and seat ring.

C. Comply with the following standards:

1. Cast iron valves - MSS SP-85.
2. Bronze valves - MSS SP-80.
3. Steel valves - ANSI B16.34.

D. For HVAC hot and chilled water service:

1. Threaded ends 2" and smaller - Class 150, bronze body, union bonnet, rising stem, composition disc.
2. Soldered ends 2" and smaller - Class 125, bronze body, screwed bonnet, rising stem, composition disc.
3. Flanged ends 2 1/2" and larger - Class 125, iron body, bolted bonnet, rising stem, OS&Y, renewable seat and disc.

E. Manufacturer - subject to compliance with requirements, provide globe valves of one of the following:

1. Jenkins Bros, A Corp.
2. Kennedy Valve
3. Stockham Valves and Fittings, Inc.

2.03 DRAIN VALVES

A. For low pressure drainage service:

1. Threaded ends 2" and smaller - Class 125, bronze body, screwed bonnet, rising stem, composition disc, 3/4" hose outlet connection.
2. Soldered ends 2" and smaller - Class 125, bronze body, screwed bonnet, rising stem, composition disc, 3/4" hose outlet connection.

B. Manufacturer - subject to compliance with requirements, provide drain valves of one of the following:

1. NIBCO, Inc.
2. Watts

2.04 BALL VALVES

A. Comply with the following standards:

1. Cast iron valves - MSS SP-72.
2. Steel valves - ANSI B16.34.

B. For HVAC hot and chilled water service:

1. Threaded ends 2" and smaller - Class 125, bronze 2 piece body, full port, bronze ball, bronze stem.
2. Soldered ends 2" and smaller - Class 125, bronze 2 piece body, full port, bronze ball, bronze stem.

C. Manufacturer - subject to compliance with requirements, provide ball valves of one of the following:

1. Jenkins Bros.
2. Stockham Valves & Fittings
3. Watts

2.05 BUTTERFLY VALVES (only where specifically approved by the engineer)

A. General - comply with MSS SP-67. Valves to be tight shutoff.

Where butterfly valves are used as shutoffs for terminal or equipment removal or repair, select lug type valves. Select wafer type valves for other applications. Provide gear operators on butterfly valves 8" and larger.

B. For HVAC hot and chilled water service:

1. Lug type 3" and larger - Class 150, ductile iron body, lever operated, cadmium plated ductile iron disc, Type 316 stainless steel stem, EPT or EPDM seat.

C. Manufacturer - subject to compliance with requirements, provide butterfly valves of one of the following:

1. Demco Inc.
2. Jenkins Bros., A Corp.
3. Mark Controls Corp., MCC Centerline.
4. Stockham Valves and Fittings, Inc.
5. Crane Co., Valve Division

2.06 WAFER CHECK VALVES (only where specifically approved by the engineer)

A. General - provide wafer style, butterfly type, spring actuated check valves designed to be installed with gaskets between two standard Class 125 flanges. Construct iron body valves with pressure containing parts of materials conforming to ANSI/ASTM A-126, Grade B. Support hanger pins on both ends by removable side plugs.

B. For water service:

1. 2" and larger - Class 125, cast iron body, stainless steel trim, bronze disc, Buna-N seal.

C. Manufacturer - subject to compliance with requirements, provide wafer check valves of one of the following:

1. Bell & Gossett, ITT Fluid Handling Div.
2. Metraflex Co.
3. NIBCO, Inc.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General - except as otherwise indicated, comply with the following requirements:

1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward for horizontal plane unless unavoidable. Install valve drains with hose end adapter for each valve that must be installed with stem below horizontal plane.

B. Insulation - where insulation is indicated, install extended stem valves, arranged in proper manner to receive insulation.

C. Applications subject to shock - install valves with bodies of metal other than cast iron where thermal or mechanical shock is

indicated or can be expected to occur.

D. Applications subject to corrosion - do not install bronze valves and valve components in direct contact with steel, unless bronze and steel are separated by dielectric insulator. Install bronze valves in steam and condensate service and in other services where corrosion is indicated or can be expected to occur.

E. Mechanical actuators - install mechanical actuators with chain operators where indicated, and where valves 4" and larger are mounted more than 7'-0" above floor in mechanical rooms, boiler rooms, and where recommended by valve manufacturer because of valve size, pressure differential or other operating condition making manual operation difficult.

F. Selection of valve ends (pipe connections) - except as otherwise indicated, select and install valves with the following ends or types of pipe/tube connections.

1. Copper tube size 2" and smaller - soldered joint valves except ball valves used in plumbing systems.
2. Steel pipe, size 2" and smaller - threaded valves.
3. Pipe size 2 1/2" and larger - flanged valves.

G. Valve system - select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.

H. Non-metallic disc - limit selection and installation of valves with non-metallic discs to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.

I. Renewable seats - select and install valves with renewable seats, except where otherwise indicated.

J. Fluid control - except as otherwise indicated, install gate, ball, globe, and butterfly valves to comply with ANSI B31.1. Where throttling is indicated or recognized as principal reason for valve, install globe or butterfly valves.

K. Installation of Check valves: Wafer check valves – install between two flanges in horizontal or vertical position for proper direction of flow.

END OF SECTION

DIVISION 15 – MECHANICAL

SECTION 15135 - THERMOMETERS AND GAGES

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Thermometers and gages specified in this section include the following:

1. Thermometers and fittings:
2. Pressure gages and fittings:

PART 2 - PRODUCTS

2.01 THERMOMETERS

A. Thermometers:

1. General: Provide and install adjustable, variable angle type thermometers of materials, capacities and ranges indicated.
2. Case: Die cast aluminum finished in baked epoxy enamel, glass front, 9 inches long.
3. Adjustable joint: 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal plane, with locking device.
4. Tube and capillary: Blue liquid filled, magnifying lens, 1-percent scale range accuracy, shock mounted. (Mercury filled not acceptable).
5. Scale: Satin faced, non-reflective aluminum, permanently etched markings.
6. Stem: Copper plated steel, or brass, for separable socket.
7. Range: Conform to the following:

    a. Hot water: 30 to 240 degrees F with 2 degree F scale divisions.
    b. Chilled water: 30 to 180 degrees F with 2 degrees F scale divisions.

8. Manufacturer:

    a. Wika
    b. Trerice
    c. Weiss
    d. Or approved equal

B. Dial Thermommeters:

1. General – Provide dial bimetal type adjustable angle thermometers of materials, capacities and ranges indicated, designed and constructed for use in service indicted.
2. Case – Type 300 series stainless steel hermetically sealed.

3. Dial – White finished aluminum with black and blue marking.
4. Pointer – balanced aluminum with black finish.
5. Stem – type 300 series stainless steel 1/4"o.d.internal bimetal coil silicone dampened.
6. Range – conform to the following:

   a. Hot water 20° to 240° F. scale divisions.

7. Manufacturer – subject to compliance with requirements, provide glass thermometers of one of the following:

   a. Tel-Tru Mfg. Co.
   b. Trerice (H.O.) Co.
   c. Weiss Instrument Inc.

B. Thermometer wells:

1. General: Provide thermometer wells of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2 inch extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.
2. Manufacturer: Same as thermometers.

2.02 PRESSURE GAGES AND FITTINGS

A. Pressure gages:

1. General: Provide "AA" industrial rated liquid filled pressure gages of capacities and ranges indicated, designed and constructed for use in service indicated. All pressure gauges shall be liquid filled unless otherwise specified. Provide gauge cocks for all pressure gauges.
2. Type: General use, 1/2 percent accuracy, ANSI B 40.1 grade A, phosphor bronze bourdon type, bottom connection.
3. Case: Aluminum or brass, glass lens, 4 1/2 inch diameter.
4. Connector: Brass with 1/4 inch male NPT. Provide protective syphon when used for steam service.
5. Scale: White coated aluminum, with permanently etched markings.
6. Range: Conform to the following:

   a. Water - 0 - 100 psi.

7. Manufacturer - subject to compliance with requirements, provide pressure gages of one of the following:

   a. Ametek, U.S. Gage Div.
   b. Trerice
   c. Weiss

B. Pressure gage accessories:

1. Gage cocks: Brass cock with 1/4 inch female NPT on each end, and "T" handle brass plug.
2. Syphon: 1/4 inch straight coil constructed of brass tubing with 1/4 inch male NPT on each end.
3. Snubber: 1/4 inch brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.
4. Manufacturer: Same as gages.

PART 3 - EXECUTION

3.01 INSTALLATION OF THERMOMETERS

A. General: Install temperature gages in vertical upright position, and tilted so as to be easily read by observer standing on floor.

B. Locations: Install in the following locations and elsewhere as indicated:

1. At inlet and outlet of each hydronic zone 3-way valve.
2. At inlet and outlet of each hydronic boiler and chiller.
3. At inlet and outlet of each hydronic coil in air handling units, and built-up central systems.
4. At inlet and outlet of each hydronic heat exchanger.
5. At inlet and outlet of each hydronic heat recovery unit.
6. At inlet and outlet of each thermal storage tank.
7. At outlet of domestic hot water heater.
8. Common boiler supply and return header.

C. Thermometer wells: Install in piping tee where indicated, in vertical upright position. Fill well with Thermal grease.

3.2 INSTALLATION OF PRESSURE GAGES

A. General: Install pressure gages in piping tee with pressure gage cock, located on pipe at most readable position.

B. Locations: Install in the following locations, and elsewhere as indicated:

1. At suction and discharge of each hydronic pump.
2. At discharge of each pressure reducing valve.
3. At water service outlet.
4. At inlet and outlet of water side for condensers, chillers, and cooling towers.
5. System makeup water line.
6. Accessible hihg point of hydronic piping systems.

C. Pressure gage cocks: Install in piping tee with snubber or syphon if steam.

END OF SECTION

DIVISION 15 - MECHANICAL

SECTION 15215 - VIBRATION ISOLATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work specified in this section.

B. This section is a Division 15 Basic Materials and Methods section, and is a part of each Division 15 section making reference to vibration isolation products specified herein. Vibration isolation devices shall conform to the seismic requirements of section 1613 of the New York State Building Code. Isolators shall allow the amount of movement required by this code and shall be equipped with limit stops as required by this code.

1.02 DESCRIPTION OF WORK

A. Extent of vibration isolation work required by this section is indicated on drawings and schedules, and/or specified in other Division 15 sections.

B. Types of vibration isolation products specified in this section include the following:

1. Fiberglass Pad and Shapes
2. Neoprene Pads
3. Cork/Neoprene Pads
4. Equipment Rails
5. Fabricated Equipment Bases
6. Roof Curb Isolators
7. Isolation Hangers
8. Riser Isolators
9. Riser Support Isolators
10. Flexible Duct Connectors
11. Flexible Pipe Connectors

C. Vibration isolation products furnished as part of factory-fabricated equipment, are specified as part of the equipment assembly in other Division 15 sections.

D. Refer to other sections of these specifications for equipment foundations, hangers, sealants, gaskets and other work related to vibration isolation work.

1.03 QUALITY ASSURANCE

A. Product qualification - provide each type of vibration isolation unit produced by specialized manufacturer, with not less than 5 years successful experience in production of units similar to those required for project.

1. Except as otherwise indicated, obtain support isolation

1.04 SUBMITTALS

A. Product data - submit manufacturer's specifications, detailed drawings, performance characteristics data and installation instructions for each type of unit required.

1. Include data for each type and size of unit, showing isolation efficiency, stiffness, natural frequency and transmissibility at lowest operating speed of equipment.
2. Where required, include independent test agencies certified report of test results for each type of unit.
3. For spring units, show wire size, spring diameter, free height, solid-compression height, operating height, fatigue characteristics and ratio of horizontal to vertical stiffness.
4. For spring and pad type units, show basis of spring rate selection for range of loading weights.
5. Include performance certifications where required.

B. Shop drawings - submit shop drawings showing structural design and details of inertia bases, steel beam bases and other custom fabricated work not covered by manufacturer's submitted data.

1. Furnish templates to fabricators of equipment bases, foundations and other support systems, as needed for coordination of vibration isolation units with other work.

C. Submit shop drawings indicating scope of vibration isolation work and locations of units and flexible connections. Include support isolation points for piping and ductwork including risers, air housings and inertia bases.

1. Include schedule of units, showing size or manufacturer's part number, and weight supported and resulting deflection of each unit.

PART 2 - PRODUCTS

2.01 ISOLATION MATERIALS AND SUPPORT UNITS

A. Fiberglass pads and shapes - glass fiber of not more than 0.18 mil diameter, produced by multiple-flame attenuation process, molded with manufacturer's standard fillers and binders through 10 compression cycles at 3 times rated load bearing capacity, to achieve natural frequency of not more than 12 Hertz, in thicknesses and shapes required for use in vibration isolation units.

B. Neoprene pads - oil resistant neoprene sheets, of manufacturer's standard hardness and cross ribbed pattern, designed for neoprene in shear type vibration isolation, and in thicknesses required.

C. Cork/Neoprene pads - close grained composition cork sheet, laminated between 2 sheets of ribbed oil resistant neoprene, in thicknesses required.

D. Vibration isolation products furnished as part of factory-fabricated equipment, are specified as part of the equipment assembly in other Division 15 sections.

E. Refer to other sections of these specifications for equipment foundations, hangers, sealants, gaskets and other work related to vibration isolation work.

F. Equipment rails - where rails or beams are indicated for use with isolator units to support equipment, provide steel beams complying with ANSI/ASTM A36, with minimum depth of 6" or 0.08 x span of beam between isolators (whichever is greater). Provide welded bracket at each end of beams, and anchor each end to spring isolator unit. Provide bolt holes in beams matching anchor bolt holes in equipment. Provide beams of section modulus indicated or, if not indicated, selected for normal-weight equipment loading to limit static load stress to 16,000 psi.

1. Except as otherwise indicated, position equipment on equipment rails so that load will be equally supported by isolator units.

G. Fabricated equipment bases - where supplementary bases are indicated for use with isolator units to support equipment (base not integral with equipment), provide welded unit, fabricated of structural steel shapes, plates and bars complying with ANSI/ASTM A36, as shown. Provide welded support brackets at points indicated, and anchor base to spring isolator units.
Except as otherwise indicated, arrange brackets to result in the lowest possible mounting height for equipment. Provide bolt holes in base matching anchor bolt holes in equipment.

1. Where indicated, provide auxiliary steel base for support of motor, mounted on equipment base with slotted anchor bolt holes for adjustment of motor position.
2. Where sizes of base framing members are not indicated, fabricate base with depth of structure not less than 0.10 x longest span of base, rigidly braced to support equipment without deflections or distortions which would be detrimental to equipment or equipment performances.

G. Roof-curb isolators - fabricated frame units sized to match roof curbs as shown, formed with isolation springs between extruded aluminum upper and lower sections, which are shaped and positioned to prevent metal-to-metal contact. Provide continuous airtight and waterproof seal between upper and lower extrusions. Include provisions for anchorage of frame unit to roof curb, and for anchorage of equipment to unit.

H. Isolation hangers - hanger units formed with brackets and including manufacturer's standard compression isolators of type indicated. Design brackets for 5 times rated loading of units. Fabricate units to accept misalignment of suspension members, and for use with either rod or strap type members and including acoustical washers to prevent metal-to-metal contacts.

1. Provide vibration isolation spring with cap and pad type isolator, securely retained in unit.
2. Provide neoprene pad, securely retained in unit.
3. Provide fiberglass pad or shape, securely retained in unit, with threaded metal top plate.
4. Provide removable spacer in each unit, to limit deflection during installation to rated-load deflection.

I. Riser isolators - manufacturer's standard pad type isolator bonded to steel plate, formed for welding to pipe sleeve extension.

J. Riser support isolators - manufacturer's standard pad type isolator laminated between two formed steel plate members, one for welding to pipe sleeve extension and other for welding to pipe riser.

K. Flexible duct connectors - laminated flexible sheet of cotton duct and sheet elastomer (butyl, neoprene or vinyl), reinforced with steel wire mesh where required for strength to withstand duct pressure indicated. Form connectors with full faced flanges and accordian bellows to perform as flexible isolation unit, and of manufacturer's standard length for each size unless otherwise indicated. Equip each unit with galvanized steel retaining rings for airtight connection with ductwork.

L. Flexible pipe connectors:

1. For non-ferrous piping, provide bronze hose covered with bronze wire braid with copper tube ends or bronze flanged ends, brase-welded to hose.
2. For ferrous piping, provide stainless steel hose covered with stainless steel wire braid with NPT steel nipples or 150 psi ANSI flanges, welded to hose.
3. Rubber flexible pipe connectors - provide of rubber and butyl construction with integral full faced duck and butyl flanges, internally steel wire reinforced, and furnished complete with steel retaining rings. Select with temperature and pressure ratings to suit intended service.
4. Manufacturer - subject to compliance with requirements, provide vibration isolation products of one of the following:

    a. Korfund Dynamics Corp.
    b. Mason Industries, Inc.
    c. Vibration Eliminator Co., Inc.
    d. Vibration Mountings and Controls, Inc.

PART 3 - EXECUTION

3.01 PERFORMANCE OF ISOLATORS

A. General - comply with minimum static deflections recommended by the American Society of Heating, Refrigerating and Air Conditioning Engineers, including definitions of critical and noncritical locations, for selection and application of vibration isolation materials and units as indicated.

B. Manufacturer's recommendations - except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

3.02 APPLICATIONS

A. General - except as otherwise indicated, apply the following types of vibration isolators at indicated locations or for indicated items of equipment. Selection is Installer's option where more than one type is indicated.

B. Neoprene pad type isolators - install where the following equipment is indicated:

1. Floor mounted air handling units, in noncritical locations.

C. Equipment rails and spring isolators - install where the following floor mounted equipment is indicated:

1. Air handling units, 7 1/2 H.P. and larger.
2. Centrifugal fans, 7 1/2 H.P. and larger.

D. Fabricated equipment base and spring isolators - install where the following equipment is indicated:

1. Centrifugal fans.
2. Reciprocating refrigeration compressor, in noncritical locations.

E. Roof curb isolators - install where the following equipment is located on roof curbs over critical locations:

1. Air handling units.
2. Rooftop air conditioning units.
3. Fan or blower units, of more than 1.5 H.P.

F. Isolation hangers - install where the following suspended equipment is indicated:

1. Package air handling units.
2. Pipe over 1" pipe size, located in mechanical equipment rooms and each run connected to vibration isolation mounted equipment for a distance of 100 diameters but not less than 50' - 0".
3. Ductwork (except flexible ductwork), located in mechanical equipment rooms, and each run connected to vibration isolation mounted equipment for a distance of 50' - 0".
4. Sound traps in ductwork.
5. Ductwork, where air velocity is 3000 fpm or greater.

G. Riser isolators - install where the following risers pass through floors and roofs, provide support type where riser support is required:

1. Pipe risers.
2. Pipe risers, within 50' - 0" of connection with vibration isolation mounted equipment.
3. Pipe risers, in critical locations.
4. Pipe risers, 2" pipe size and larger, in critical locations.
5. Ductwork risers, in critical locations.
6. Ductwork risers, where air velocity is 3000 fpm or greater.
7. Ductwork risers, within 50' - 0" of connection with vibration isolation mounted equipment.

H. Flexible duct connectors - install at the following ductwork connections:

1. Connections with vibration isolation mounted air handling equipment.
2. Connections with fixed wall louvers for air intake and exhausts.
3. Where ductwork, 1.0 square foot and greater, changes directions in critical locations.

I. Flexible pipe connectors - install in piping systems at the following location:

1. Connections, 3/4" pipe size and larger, with vibration isolation mounted equipment.

3.03 INSTALLATION

A. General - except as otherwise indicated, comply with manufacturer's instructions for installation and load application to vibration isolation materials and units. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading, and are not short circuited by other contacts or bearing points. Remove space blocks and similar devices (if any) intended for temporary protection against overloading during installation.

B. Anchor and attach units to substrate and equipment as required for secure operation and to prevent displacement by normal forces, and as indicated.

C. Adjust leveling devices as required to distribute loading uniformly onto isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.

D. Locate isolation hangers as near overhead support structure as possible.

E. Weld riser isolator units in place as required to prevent displacement from loading and operations.

F. Bond flanges of flexible duct connectors to ducts and housings to provide airtight connections. Seal seams and penetrations to prevent air leakage.

G. Flexible pipe connectors - install on equipment side of shutoff valves, horizontally and parallel to equipment shafts wherever possible.

3.04 DEFLECTION MEASUREMENTS

A. Upon completion of vibration isolation work, prepare report showing measured equipment deflections for each major item of equipment as indicated.

END OF SECTION

DIVISION 15 - MECHANICAL

SECTION 15250 - MECHANICAL INSULATION

PART 1 - GENERAL

1.01 SUMMARY OF ITEMS INCLUDED

A. Extent of mechanical insulation work required by this section is indicated on Drawings and by requirements of this section.

B. Types of insulation and accessories specified in this section include the following:

1. Type P-1, Sectional molded glass fiber pipe insulation.
2. Type P-2, Sectional rigid foam glass pipe insulation.
3. Type P-3, Flexible elastomeric cellular pipe insulation.
3. Type P-5, Aluminum jacketing for piping
4. Type P-6, Hydrophobic 'pourable' underground pipe insulation
5. Type D-2, Flexible glass fiber blanket-aluminum foil facing.
6. Type D-4, Aluminum jacketing for ductwork.

1.02 QUALITY ASSURANCE

A. Fire Hazard Classification: In accordance with ASTM E-84.
B. NFPA 255 and UL 723, for insulation systems, including insulation, adhesives and coverings, not to exceed the following:

1. Flame spread 25.
2. Fuel contributed 50.
3. Smoke developed 50.

1.03 SUBMITTALS

A. Product Data: Submit manufacturers specification sheets, installation instructions, fire and smoke ratings. Submit schedule matching insulation type to mechanical systems and equipment.

PART 2 - PRODUCTS

2.01 INSULATION - TYPE P1

A. Sectional Molded Glass Fiber Pipe Insulation: Minimum density 4.5 pounds per cubic foot. Factory applied jacket consists of white, flame retardant jacket of .001 inch minimum aluminum foil, laminated to glass fiber reinforced kraft paper with a flame retardant snuffer type adhesive.
Jacket has minimum 1-1/2 inch longitudinal sealing lap. Minimum circumferential sealing strips, 3 inches wide.

B. Fittings Valves and Flanges: Molded, precut, or segmental insulation equal in thickness to adjoining pipe insulation. Alternate, hydraulic-setting insulating cement. Surface finish pre-molded PVC fitting cover system. Alternate: fitting mastic, fiberglass, reinforcing strips and top coat of fitting mastic.

C. Manufacturers:

1. Certain Teed
2. Knauf Fiberglass
3. Schuler
4. Owens-Corning
5. U.S.G.

2.02 INSULATION - TYPE P2

A. Sectional, Rigid, Foamed Glass Pipe Insulation: Minimum density 8.5 pounds per cubic foot.

B. Fittings, Valves, and Flanges: Molded or segmental foamed glass insulation equal in thickness to adjoining pipe insulation.

C. Exposed and Concealed Pipe: If exposed to weather, finish additionally with .016 inch embossed aluminum jacket, secured with 3/4 inch by .015 inch aluminum strappings and seals.

D. Fittings, Valves, and Flanges: Insulate with preformed or mitered segments of foamed glass, wired, or taped in place and finished with 2 coats of vinyl fitting mastic with glass fabric reinforcement between coats.

E. Manufacturer: Pittsburgh Corning Corp.

2.03 INSULATION TYPE P-3

A. Black flexible closed cell foamed elastomeric pipe insulation with inner and outer surface skin, extruded tubing. Water permeability .17 to .28 perm-inch; water absorption 3 to 10 percent.

B. Manufacturers:

1. Armstrong
2. Rubatex Corp.

2.04 ALUMINUM JACKETING FOR PIPING - TYPE P5

A. Jacketing: Aluminum roll, Type 3003, 0.016 inch thick, 36 inches wide with moisture barrier for cold applications, without moisture barrier for hot applications.

B. Fittings: Aluminum, preformed for tees, valves, 90 degree and 45 degree elbows: Childers ELL JAC or Premetco International.

2.05 HYDROPHOBIC 'POURABLE' FOR UNDERGROUND PIPING - TYPE P6

A. Pourable: 100% Calium Carbonate approximately 60-62 lbs/ sq ft bulk density with 4-6 mil thick polyethylene top vapor barrier.

B. Manufacturer:

1. Dritherm International, Inc.

2.06 INSULATION - TYPE D2

A. Flexible glass fiber duct blanket. Minimum density: 1 pound per cubic foot.

B. Facing: Aluminum foil, minimum .001 inches thick, reinforced with glass fiber yarn mesh and laminated to 40 pound permanently treated, fire-resistant kraft.

C. Manufacturers:

1. Certain Teed
2. Knauf Fiberglass
3. Schuller
4. Owens-Corning
5. U.S.G.

2.07 ALUMINUM JACKETING FOR DUCTWORK D-4

A. Jacketing: Aluminum preformed, Type 3003, 0.016 inch thick rolls with moisture barrier for cold applications, without moisture barrier for hot applications. [Childers] [Premetco International].

B. Stainless Steel Strip: AISI Type 301, 0.015 inches thick, 1/2 inch wide, No. 5 edge, annealed, embossed with "NON-ASBESTOS".

C. Strapping Seals: AISI Type 302, stainless steel, 1/2 inch wide. Interlaken 44.

D. Adhesive: Silicone rubber sealant. General Electric RTV. Dow Corning. Polymer One Sealant.

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL

A. Apply insulation in accordance with the Schedule of Insulation at the end of this Section.

B. Use only insulation and finish materials including adhesives, cements, and mastics which conform to the requirements of all local codes and ordinances.

C. Fire resistant adhesive is highly flammable in liquid form. Eliminate welding, smoking, or other sources of ignition during application.

D. Apply insulation after all piping pressure tests, as described in Piping Installation Procedure, have been completed.

E. Clean surfaces of loose scale, dirt, oil, and other foreign matter and dry prior to insulating.

F. Apply insulation to completely cover piping surface. Do not insulate over weld certification stamps.

G. "Exposed" as used in this section means exposed to view. "Concealed" means concealed to view such as in furred chases or

above suspended ceiling. Penthouse and equipment rooms are considered exposed locations.

H. Fill surface imperfections in the insulation such as chipped edges, small joints or cracks, and small voids or holes with appropriate insulation material and smooth with skim coat of hydraulic-setting insulating cement. Vapor barriers shall be continuous and unbroken at hanger installations.

I. Fit inside diameter of insulation sections or segments to outside curvature of pipe or previous insulation layer.

J. Where standard insulation shapes are not available, cut, score, or miter segments of appropriate block to fit contour of pipe. Stagger joints of adjoining segments. Fit insulation carefully and secure with No. 20 gage galvanized annealed steel wire. Finish with a smoothing coat of hydraulic-setting insulating cement.

K. Insulate valves, strainer, fittings, and flanges with identical material, density, thickness, and surface finish as the piping insulation. All edges shall be filled with filler and finished with a smoothing coat of hydraulic-setting insulating cement.

L. Insulate the entire surface of fittings and strainers. Insulate valves up to and including bonnets, unless authorized otherwise by Project Engineer. Do not cover removable valve bonnets.

M. Insulate strainers to permit removal of the basket without disturbing the insulation of the strainer body. Strainer covers shall be molded and taped to upper section of insulation.

N. Bevel the ends of pipe insulation adjacent to flanges to permit bolt removal. Provide a collar of sectional block insulation over the flanges and extend a minimum of 2 inches over the adjacent pipe insulation. Fasten with staples to permit easy removal. Prior to applying collar fill annular spaces with loose insulation.

O. Insulate all piping through sleeves.

P. Where pipelines pass through masonry walls or floors, completely fill the space between outside of pipe or insulation and the inside of the sleeve or framed opening with fibrous mineral wool or fiberglass pipe insulation.

Q. When it is unavoidable and hangers for cold lines must be installed directly on the pipe, insulate and finish the entire hanger and the rod for a length of not less than 12 inches above the pipe.

R. For hot lines supported on rollers, provide pipe covering protection saddles and fill the hollow interior of saddles with insulating cement or fibrous glass.

S. Insulate Dresser-type couplings and other gasketed joints in refrigerant systems in a manner to allow removal of insulation, without damage, for repair and leak-checking of couplings and gasketed joints.

T. Apply insulation to completely cover metal surfaces.

U. Cut, score, or miter insulation to fit shape and contour of ductwork and equipment. Where surfaces are flat, cylindrical, or regularly curved, use premolded blocks or segments.

V. Where required, provide permanently fastened angles or plates to support insulation.

W. Apply insulation on cover plates, heads and access openings as separate sections, with insulation cut back for access to boltheads and other fasteners.

X. Do not insulate over nameplates. Cut back insulation and line the insulation edges with 24 gage galvanized steel.

Y. Surface Finish.

1. Apply surface finish to present a tight, smooth appearance.
2. Do not apply sealant or cement until all previous applications of cement and adhesives have thoroughly dried.
3. Extend surface finish to protect all insulation surfaces. Prevent raw edges or ends of insulation from being exposed.

3.02 APPLICATION OF TYPE P1 INSULATION

A. Exposed and Concealed Pipe: Staple longitudinal lap unless factory pre-sealed laps are supplied or adhesive is used, with 9/16 inch coated staples, 2 inches on center, butt adjoining sections firmly together. Apply butt-joint strips, making sure coated or dull side is out. Center the strip for a snug fit and fasten with 2 staples, one each approximately 1/2 inch from each edge.

B. Exposed and Concealed Fittings, Valves, Flanges: Insulate with molded, pre-cut or segmental insulation equal in thickness to adjoining pipe insulation. Alternate: Hydraulic-setting insulating cement same thickness as adjoining insulation. Alternate: Pre-molded PVC fitting cover system.

C. Surface Finish (Indoor)

1. Exposed and Concealed Pipe: No additional finish required.

2. Exposed and Concealed Fittings, Valves, Flanges: Apply a skim coat of insulating cement to produce a smooth surface. After cement is dry, apply a light coat of fitting mastic. While mastic is still wet, wrap the fitting with fiberglass reinforcing cloth strips overlapping the preceding layer by 1 to 2 inches and adjoining pipe by 2 inches, and embedding the cloth into the mastic. When dry, apply a second coat of mastic over the entire fitting to a minimum wet thickness of 3/64 inch. Alternate: Apply one piece pre-molded PVC fitting covers with galvanized coated tack fasteners.

Tape circumferential joint between insulation and premolded fitting cover with 2 inch pressure sensitive polyvinyl tape. Note: Wipe all joints clean before applying tape. Alternate: Apply 8 ounce canvas between 2 coats of lagging cement.

3.03 APPLICATION OF TYPE P2 INSULATION

A. Exposed and Concealed Pipe: Seal lap of vapor barrier jacket with fire-resistant adhesive. Staple longitudinal lap with three 9/16 inch coated staples, applying lagging cement over staples. Adjoining sections of pipe insulation are to be butted tightly together and the vapor barrier continued by sealing the circumferential joint with butt joint strips adhered with fire-resistant adhesive.

B. Exposed and Concealed Fittings, Valves, Flanges: Insulate with molded or segmental foamed glass insulation equal in thickness to adjoining pipe insulation and secured with No. 20 gage galvanized annealed steel wire.

C. Surface Finish (Indoor)

1. Exposed and Concealed Pipe: No additional finish required.

3.04 APPLICATION OF TYPE P3 INSULATION

A. Slit insulation lengthwise. Coat longitudinal seams and joints with adhesive and install it on pipe. Miter insulation at elbows and glue.

B. Fully cover seams and butt joints with adhesive to assure a complete seal to maintain insulation efficiency and vapor barrier.

C. Do not stretch insulation to obtain longer lengths.

D. Unless otherwise specified, completely insulate common applications (such as hose stations, drinking fountains, etc.) for chilled and hot water.

E. On cold applications, insulate valves, unions, and pipe installed with direct contact clamp hangers, butt insulation to hanger both sides and install oversized materials over hanger. Lap 1 to 2 inches minimum onto the smaller sized material.

F. On cold applications wrap all gages, petcocks, etc. with Cork Insulation Tape.

3.05 APPLICATION OF TYPE P5 INSULATION

A. Provide a 1/2 inch to 3/4 inch safety edge on all exposed longitudinal seams (except corrugated aluminum jacketing).

B. Longitudinal lap to be a minimum of 2 inches, located on horizontal centerline. Overlap butt joints a minimum of 3 inches.

C. Install 1/2 inch wide stainless steel strips located on the edge of butt joint, and then on 12 inch centers thereafter. Use two strapping seals. The first to keep the strap tight and the second to cover and secure the cut end of the strap.

D. Use aluminum butt straps where jacket cannot be overlapped (gored fittings and flanges). Use 1/2 inch wide stainless steel strips to hold butt straps.

E. Seal seams, joints or openings in the jacket that cannot be sealed by overlapping the aluminum jacket or by butt straps with silicone rubber.

F. Jacket both 45 degree and 90 degree elbows through 10 inches with preformed aluminum jackets. For fittings 12 inches and larger, use mitred fittings.

G. Jacket other fittings or valves with sheet aluminum fabricated as necessary. Use aluminum jacketing only for end caps.

H. Install "S" clips on vertical piping to hold jacket in place.

I. Lap Directions, Horizontal Lines: Circumferential laps on exterior jacketing shall face east or south. Longitudinal laps shall face down (upper and lower) located on horizontal center line.

J. Lap Directions, Vertical Lines: Interior or exterior jackets shall be overlapped shingle style (upper over lower). Exterior longitudinal laps shall face east or south.

3.06 APPLICATION OF TYPE P6 INSULATION

A. GENERAL: Install hydrophobic pourable underground piping insulation in strict compliance with manufacturers installation guidelines and specifications. Provide and install all manufactures required forms, spacers, pipe supports, etc including polyfilm top vapor barrier and minimum 1’-6” backfill. (note: minimum depth of pipe to be 3’-0”)

3.07 APPLICATION OF TYPE D4 INSULATION

A. For round duct, fasten aluminum jacket in place with stainless steel strips. For rectangular duct, apply strips (corner beads) and sheet material secured with screws or pop rivets. Ducts greater than 24 inches shall have cross breaks.

B. Jacketing sequence shall be bottom, sides, then top.

C. Overlap seams a minimum of 2 inches.

D. After bands are secure, use stainless steel or aluminum screws or pop-rivets on seams where necessary.

E. Apply jacket shingle style on risers (upper jacket over lower) to provide drainage. Use stainless steel strip to secure jacketing.

F. Seal breaks and seams in aluminum jacket with silicone rubber sealant.

3.08 SCHEDULE OF PIPING INSULATION

Service	Size	Type	Thickness
Heating Hot Water	Thru 1-1/4"	P1	1-1/2"
Heating Hot Water	1-1/2" & over	P1	2"
Steam	Thru 3"	P1	2-1/2"
Steam	4" & over	P1	3"
Steam condensate	Thru 1-1/4"	P1	1-1/2"
Steam condensate	1-1/2" & over	P1	2"
Air Handling Unit Drain Line (Condensate)	All	P1	1/2" (a)
Refrigerant (piping)	Thru 2"	P2	1"
Refrigerant (piping)	Over 2"	P2	2"
Pipe Supports (b)	All	P3	Varies (b)
Chilled Water	Thru 6"	P1	2" *

(*underground piping 'pourable' insulation minimum thickness=6"all around top/bottom/sides of pipe)

a. All insulation thickness services shall be 1 inch thickness when applied outdoors-above ground. (Consider heating cables).
b. Refer to D1.2.0, Insulation Protection at Pipe Support.

3.09 SCHEDULES OF DUCT INSULATION

Insulation Service	Type	Thickness
Concealed/Exposed Supply Ducts,etc (Refer to section 15290)	D2	2"

END OF SECTION

DIVISION 15 – MECHANICAL

SECTION 15290 – DUCT INSULATION - INTERIOR

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and provisions of contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.02 SUMMARY

A. This section includes duct and plenum insulation.

B. Related Sections: The following sections contain requirements that relate to this section:

1. Division 15 Section "Ductwork" for duct lining.

1.03 DEFINITIONS

A. Hot Surfaces: Normal operating temperatures of 100 deg F or higher.

B. Dual-Temperature Surfaces: Normal Operating temperatures that vary from hot to cold.

C. Cold Surfaces: Normal operating temperatures less than 75 deg F.

D. Thermal Conductivity (k-value): Measure of heat flow through a material at a given temperature difference; conductivity is expressed in units of Btu x inch/h x sq. ft. x deg F.

E. Density: Is expressed in lb/cu. ft.

1.04 SUBMITTALS

A. General: Submit the following in accordance with General Conditions of the Contract and Division 1 specification sections.

B. Product and data for each type of duct insulation identifying k-value, thickness, and accessories.

C. Material certificates, signed by the manufacturer, certifying that materials comply with specified requirements where laboratory test reports cannot be obtained.

D. Material test reports prepared by a qualified independent testing laboratory. Certify insulation meets specified requirements.

1.05 QUALITY ASSURANCE

A. Fire Performance Characteristics: Conform to the following characteristics for insulation including facings, cements, and adhesives, when tested according to ASTM E 84, by UL or other testing or inspecting organization acceptable to the authority having jurisdiction. Label insulation with appropriate markings of testing laboratory.

1. Interior Insulation: Flame spread rating of 25 or less and a smoke developed rating of 50 or less.

1.06 SEQUENCING AND SCHEDULING

A. Schedule insulation application after testing of duct systems.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering 'GREENGUARD' certified products that may be incorporated in the Work include, but are not limited to the following:

1. Glass Fiber:

a. CertainTeed Corporation.
b. Knauf Fiberglass GmbH.
c. Manville.

2.02 GLASS FIBER

A. Material: Inorganic glass fibers, bonded with a thermosetting resin.

B. Jacket: All-purpose, factory-applied, laminated glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil having self-sealing lap.

C. Board: ASTM C 612, Class 2, semi-rigid jacketed board.

1. Thermal Conductivity: 0.23 Btu x inch/h x sq. ft. x deg F average maximum at 75 deg F mean temperature.

2. Density: 3 pcf average maximum.

D. Blanket: ASTM C 553, Type II, Class F-1, jacketed flexible blankets. (maximum 25% compression installed)

1. Thermal Conductivity: 0.23 Btu x inch/h x sq. ft. x deg F average maximum at 75 deg F mean temperature.

E. Adhesive: Produced under the UL Classification and follow-up service.

1. Type: Non-flammable, water-based.
2. Service Temperature Range: Minus 20 to 180 deg F (Minus 29 to 82 deg C).

F. Vapor Barrier Coating: Waterproof coating recommended by insulation manufacturer for outside service.

2.03 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Woven glass fiber fabrics, plain weave, pre-sized a minimum of 8 ounces per sq. yd.

1. Tape Width: 4 inches
2. Cloth Standard: MIL-C-20079H, Type I.
3. Tape Standard: MIL-C-20079H, Type II.

B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:

1. Stainless Steel: Type 304, 0.020 inch thick.
2. Aluminum: 0.0070 inch thick.

C. Wire: 14-gauge nickel copper alloy, 16-gauge, soft-annealed stainless steel, or 16-gauge, soft annealed galvanized steel.

D. Corner Angles: 28-gauge (0.3 mm), 1 inch by 1 inch (25 mm by 25 mm) aluminum, adhered to 2 inches by 2 inches (51 mm by 51 mm) kraft paper.

E. Anchor Pins: Capable of supporting 20 pounds each. Provide anchor pins and speed washers of sizes and diameters as recommended by the manufacturer for insulation type and thickness.

2.04 SEALING COMPOUNDS

A. Vapor Barrier Compound: Water-based, fire-resistive composition.

1. Water Vapor Permeance: 0.08 perm maximum.
2. Temperature Range: Minus 20 to 180 deg F.

B. Weatherproof Sealant: Flexible-elastomer-based, vapor-barrier sealant designed to seal metal joints.

1. Water Vapor Permeance: 0.02 perm maximum.
2. Temperature Range: Minus 50 to 250 deg F.
3. Cooler: Aluminum.

PART 3 - EXECUTION

3.01 PREPARATION

A. Surface Preparation: Clean, dry and remove foreign materials such as rust, scale, and dirt.

3.02 INSTALLATION

A. Refer to schedules at the end of this section for materials, forms, jackets, and thicknesses required for each duct system.

B. Select accessories compatible with materials suitable for the service. Select accessories that do not corrode, soften, or otherwise attack the insulation or jacket in either the wet or dry state.

C. Install vapor barriers on insulated ducts and plenums having surface operating temperatures below 60 deg.

D. Apply insulation material, accessories, and finishes according to the manufacturer's printed instructions.

E. Install insulation with smooth, straight, and even surfaces.

F. Seal joints and seams to maintain vapor barrier on insulation requiring a vapor barrier.

G. Seal penetrations for hangers, supports, anchors, and other projections in insulation requiring a vapor barrier.

H. Seal Ends: Except for flexible elastomeric insulation, taper ends at 45 degree angle and seal with lagging adhesive. Cut ends of flexible elastomeric cellular insulation square and seal with adhesive.

I. Apply water based adhesives and coatings at the manufacturer's recommended coverage-per-gallon rate.

J. Keep insulation materials dry during application and finishing.

K. Install board insulation as follows:

1. Adhesive and Band Attachment: Secure board insulation tight and smooth with at least 50 percent coverage of water based adhesive. Install bands spaced 12 inches apart. Protect insulation under bands and at exterior corners with metal corner angles. Fill joints, seams, and chipped edges with vapor barrier compound.

2. Speed Washers Attachment: Secure insulation tight and smooth with speed washers and welded pins. Space anchor pins 18 inches apart each way and 3 inches from insulation joints. Apply vapor barrier coating compound to insulation in contact, open joints, breaks, punctures, and voids in insulation.

L. Blanket Insulation: Install tight and smooth. Secure to ducts having long sides or diameters as follows:

1. Smaller Than 24 Inches: Bonding water based adhesive applied in 6-inch (150-mm) wide transverse strips on 12-inch centers.

2. 24 inches and Larger: Anchor pins spaced 12 inches (300 mm) apart each way. Apply bonding adhesive to prevent sagging of the insulation.
3. Overlap joints 3 inches.

4. Seal joints, breaks, and punctures with vapor barrier compound.

3.03 JACKETS

A. Foil and Paper Jackets (FP): Install jackets drawn tight. Install lap or butt strips at joints with material same as jacket. Secure with adhesive. Install jackets with 1-1/2 inches (40 mm) laps at longitudinal joints and 3 inches (75 mm) wide butt strips at end joints.

1. Seal openings, punctures, and breaks in vapor barrier jackets, and exposed insulation with vapor barrier compound.

3.04 APPLICATIONS

A. General: Materials and thicknesses are specified in schedules at the end of this Section.

B. Duct Systems: Insulate all new interior ductwork.

3.05 DUCT SYSTEMS INSULATION SCHEDULE

A. All interior supply and return ducts:

Material	Type	Installed R-value	Vapor Barrier Req'd	Field-Applied Jacket
Glass Fiber	Blanket	6.0	Yes	None

B. All outdoor air intake ducts and outdoor air plenums:

Material	Type	Installed R-value	Vapor Barrier Req'd	Field-Applied Jacket
Glass Fiber	Blanket	8.0	Yes	None

END OF SECTION

DIVISION 15 - MECHANICAL

SECTION 15511 – FIRE STOPPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 DEFINITIONS

A. Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in/ joints between fire rated wall and floor assemblies.

1.03 GENERAL DESCRIPTION OF THE WORK OF THIS SECTION

A. Only tested fire stop systems shall be used in specific locations as follows:

1. Penetrations for the passage of ductwork, cable, cable tray, conduit, piping, electrical bus ways and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.

B. Safing slot gaps between edge of floor slabs and curtain walls.

C. Openings between structurally separate sections of wall or floors.

D. Gaps between the top of walls and ceilings or roof assemblies.

E. Expansion joints in walls and floors.

F. Openings and penetrations in fire-rated partitions or walls containing fire doors.

G. Openings around structural members which penetrate floors or walls.

1.04 RELATED WORK OF OTHER SECTIONS

A. Coordinate work of this section with work of other sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other sections, including:

1. Section 03300 - Cast-In-Place Concrete Work
2. Section 07900 - Caulking
3. Section 04200 – Unit Masonry
4. Section 09200 - Lath and Plaster
5. Section 09250 - Gypsum Wall Board
6. Section 15050 - Basic Materials and Methods
7. Section 15250 - Mechanical Insulation

1.05 REFERENCES

A. Test Requirements: ASTM E-814-02, "Standard Method of Fire Tests of Through Penetration Fire Stops"

B. Underwriters Laboratories (UL) of Northbrook, IL runs ASTM E-814 under their designation of UL 1479 and publishes the results in their "FIRE RESISTANCE DIRECTORY" that is updated annually.

1. UL Fire Resistance Directory:

a. Fire stop Devices (XHJI)
b. Fire Resistance Ratings (BXUV)
c. Through-Penetration Fire stop Systems (XHEZ)
d. Fill, Voids, or Cavity Material (XHHW)
e. Forming Materials (XHKU)

2. Alternate “Omega Point Laboratories Directory” (updated annually)

C. Test Requirements: UL 2079, “Tests for Fire Resistance of Building Joint Systems” (July 1998.)

D. Test Requirements: ASTM E 1966-01, “Standard test method for Fire Resistive Joint Systems”

E. Inspection Requirements: ASTM E 2174 – 01, “Standard Practice for On-site Inspection of Installed Fire Stops.”

F. International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments

G. ASTM E-84-01, Standard Test Method for Surface Burning Characteristics of Building Materials.

H. All major building codes: ICBO, SBCCI, BOCA, and IBC.

I. NFPA 101 - Life Safety Code

J. NFPA 70 - National Electric Code

1.06 QUALITY ASSURANCE

A. A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.

B. Firestop System installation must meet requirements of ASTM E-814, UL 1479 or UL 2079 tested assemblies that provide a fire rating equal to that of construction being penetrated.

C. Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.

D. Firestop Systems do not reestablish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.

E. For those firestop applications that exist for which no UL tested system is available through a manufacturer, an engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council (September 7, 1994, as may be amended from time to time).

1.07 SUBMITTALS

A. Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of UL firestop systems to be used and manufacturer's installation instructions to comply with Section 1300.

B. Manufacturer's engineering judgment identification number and drawing details when no UL system is available for an application. Engineer judgment must include both project name and contractor’s name who will install firestop system as described in drawing.

C. Submit material safety data sheets provided with product delivered to job-site.

1.08 INSTALLER QUALIFICATIONS

A. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer’s products per specified requirements. A supplier’s willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.
B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.
C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements, including temperature restrictions.
D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.
E. Do not use damaged or expired materials.

1.10 PROJECT CONDITIONS

A. Do not use materials that contain flammable solvents.

B. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

C. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

D. Weather conditions: Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.

E. During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

PART 2 - PRODUCTS

2.01 FIRESTOPPING GENERAL

A. Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

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

C. Firestopping Materials are either “cast-in-place” (integral with concrete placement) or “post installed.” Provide cast-in-place firestop devices prior to concrete placement.

2.02 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with through penetration firestop systems (XHEZ) and joint systems (XHBN) listed in Volume 2 of the UL Fire Resistance Directory, provide products of the following manufacturers as identified below:

1. Hilti, Inc., Tulsa, Oklahoma (or equal)
   800-879-8000

2.03 MATERIALS

A. Use only firestop products that have been UL 1479, ASTM E-814, or UL 2079 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

B. Cast-in place firestop devices for use with non-combustible and combustible plastic pipe (closed and open piping systems) penetrating concrete floors, the following products are

acceptable:

1. Hilti CP 680 Cast-In Place Firestop Device
   a. Add Aerator adaptor when used in conjunction with aerator (“sovent”) system.

2. Hilti CP 681 Tub Box Kit for use with tub installations.

C. Sealants, caulking materials, or foams for use with non-combustible items including steel pipe, copper pipe, rigid steel conduit and electrical metallic tubing (EMT), the following products are acceptable:

1. Hilti FS-ONE Intumescent Firestop Sealant
2. Hilti CP 604 Self-leveling Firestop Sealant
3. Hilti CP 620 Fire Foam
4. Hilti CP 606 Flexible Firestop Sealant
5. Hilti CP 601s Elastomeric Firestop Sealant

D. Sealants or caulking materials for use with sheet metal ducts, the following products are acceptable:

1. Hilti CP 601s Elastomeric Firestop Sealant
2. Hilti CP 606 Flexible Firestop Sealant
3. Hilti FS-ONE Intumescent Firestop Sealant

E. Sealants, caulking or spray materials for use with fire-rated construction joints and other gaps, the following products are acceptable:

1. Hilti CP 672 Speed Spray
2. Hilti CP 601s Elastomeric Firestop Sealant
3. Hilti CP 606 Flexible Firestop Sealant
4. Hilti CP 604 Self-leveling Firestop Sealant

F. Pre-formed mineral wool designed to fit flutes of metal profile deck and gap between top of wall and metal profile deck; as a backer for spray material.

1. Hilti CP 677 Speed Plugs
2. Hilti CP 767 Speed Strips

G. Intumescent sealants, caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed, flexible cable or cable bundles and plastic pipe, the following products are acceptable:

1. Hilti FS-ONE Intumescent Firestop Sealant

H. Foams, intumescent sealants, caulking or putty materials for use with flexible cable or cable bundles, the following products are acceptable:

1. Hilti FS-ONE Intumescent Fire stop Sealant
2. Hilti CP 618 Fire stop Putty Stick
3. Hilti CP 620 Fire Foam
4. Hilti CP 601s Elastomeric Fire stop Sealant

5. Hilti CP 606 Flexible Fire stop Sealant

I. Non curing, re-penetrable intumescent sealants, caulking or putty materials for use with flexible cable or cable bundles, the following products are acceptable:

1. Hilti CP 618 Fire stop Putty Stick

J. Wall opening protective materials for use with U.L. listed metallic and specified nonmetallic outlet boxes, the following products are acceptable:

1. Hilti CP 617 Fire stop Putty Pad

K. Fire stop collar or wrap devices attached to assembly around combustible plastic pipe (closed and open piping systems), the following products are acceptable:

1. Hilti CP 642 Fire stop Collar
2. Hilti CP 643 Fire stop Collar
3. Hilti CP 645 Wrap Strips

L. Materials used for complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical bus ways in raceways, the following products are acceptable:

1. Hilti CP 637 Trowelable Fire stop Compound
2. Hilti FS 657 FIRE BLOCK
3. Hilti CP 620 Fire Foam

M. Non curing, re-penetrable materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical bus ways in raceways, the following products are acceptable:

1. Hilti FS 657 FIRE BLOCK

N. Sealants or caulking materials used for openings between structurally separate sections of wall and floors, the following products are acceptable:

1. Hilti CP 672 Speed Spray
2. Hilti CP 601s Elastomeric Fire stop Sealant
3. Hilti CP 606 Flexible Fire stop Sealant
4. Hilti CP 604 Self-Leveling Fire stop Sealant

O. Provide a fire stop system with a "F" Rating as determined by UL 1479 or ASTM E814 which is equal to the time rating of construction being penetrated.

P. Provide a fire stop system with an Assembly Rating as determined by UL 2079 which is equal to the time rating of construction being penetrated.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

1. Verify penetrations are properly sized and in suitable condition for application of materials.

2. Surfaces to which fire stop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.

3. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

4. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.

5. Do not proceed until unsatisfactory conditions have been corrected.

3.02 COORDINATION

A. Coordinate location and proper selection of cast-in-place Fire stop Devices with trade responsible for the work. Ensure device is installed before placement of concrete.

B. Responsible trade to provide adequate spacing of field run pipes to allow for installation of cast-in-place fire stop devices without interferences.

3.03 INSTALLATION

A. Regulatory Requirements: Install fire stop materials in accordance with UL Fire Resistance Directory or Omega Point Laboratories Directory.

B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration and construction joint materials.

1. Seal all holes or voids made by penetrations to ensure an air and water resistant seal.
2. Consult with mechanical engineer, project manager, and damper manufacturer prior to installation of UL fire stop systems that might hamper the performance of fire dampers as it pertains to duct work.

3. Protect materials from damage on surfaces subjected to traffic.

3.04 FIELD QUALITY CONTROL

A. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by applicable code authorities.

C. Inspection of through-penetration firestopping shall be performed in accordance with ASTM E 2174, "Standard Practice for On-Site Inspection of Installed Fire Stops" or other recognized standard.

D. Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing fire stop systems already installed by other trades.

3.05 ADJUSTING AND CLEANING

A. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

B. Clean all surfaces adjacent to sealed holes and joints to be free of excess fire stop materials and soiling as work progresses.

END OF SECTION

DIVISION 15 – MECHANICAL

SECTION 15515 - HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

A. Extent of hydronic specialties required by this section is indicated on drawings, and/or specified in other Division 15 hydronic piping system sections.

B. Types of hydronic specialties specified in this section include the following:

1. Balance valves.
2. Vent valves.
3. Flow control valves.
4. Diverting fittings.
5. Air separators.
6. Compression tanks.
7. Pump discharge valves.
8. Shot feeders.
9. Water relief valves.
10. Pressure reducing valves.
11. RPZ – Backflow Preventer

1.03 QUALITY ASSURANCE

A. Materials and equipment shall be provided by one of the manufactuers listed in Part 2 - Products. Materials and equipment from other manufacturers may be accepted if proven equal to those specified. This contractor is liable for and shall pay for all architectural and engineering review and redesign costs for substitute materials and equipment. This contractor also is liable for all costs of changes in the work required by substitute equipment.

B. The length of time the manufacturer has been in business, the location and capability of complete repair facilities, availability of repair parts and annual maintenance contracts all will be considered in determining equality. Refer to requirements pertaining to substitute materials and equipment.

1.04 SUBMITTALS

A. Product data - submit catalog cuts, specifications, installation instructions and dimensioned drawings for each type of manufactured hydronic specialty. Include pressure drop curve or chart for each type and size of hydronic specialty.

B. Shop drawings - submit for fabricated specialties, indicating details of fabrication, materials and method of support.

C. Maintenance data - submit maintenance data and spare parts lists for each type of manufactured hydronic specialty. Include this data in maintenance manual.

D. Hydronic specialty types - provide hydronic specialties of same type by same manufacturer.

PART 2 - PRODUCTS

2.01 MANUFACTURED HYDRONIC SPECIALTIES

A. General - provide factory fabricated hydronic specialties recommended by manufacturer for use in service indicated. Provide hydronic specialties of types and pressure ratings indicated for each service, or if not indicated, provide proper selection as determined by the engineer to comply with installation requirements. Provide sizes as indicated and connections which properly mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is the engineers' option, but more than one type cannot be used on project.

B. Balance valves:

1. General - provide balance valves as indicated, of one of the following types:

   a. Threaded ends 2" and smaller - Class 125, bronze body, ball valve with memory stop.
   b. Soldered ends 2" and smaller - Class 125, bronze body, ball valve with memory stop.
   c. Threaded, soldered, of flanged end globe style providing three (3) functions:

      1) Precise flow measurement
      2) Precision flow balancing
      3) Positive shut-off, no drip seat, teflon disk, 1-1/2" to 2" size - drain connection with protective cap.
         Vernier-type setting with "hidden memory" feature to program valve for tamper-proof setting. Balance meter, valved connections. Manufacturer: Armstrong Pumps, Type CBV.

C. Vent valves:

1. Manual vent valves - provide manual vent valves designed to be operated manually with screwdriver or thumbscrew, 1/8" N.P.T. connection.
2. Automatic vent valves - provide automatic vent valves designed to vent automatically with float principle, stainless steel float and mechanisms, cast iron body,

pressure rated for 125 psi, 1/2" N.P.T. inlet and outlet connections.

3. Manufacturer - subject to compliance with requirements, provide vent valves of one of the following:

   a. Bell & Gossett, ITT Fluid Handling Div.
   b. Taco, Inc.
   c. Armstrong Co.

D. Flow control valves:

1. General - provide flow control valves pressure rated for 125 psi, containing lift check assembly which will automatically open by means of pump flow pressure, and automatically close when pump is not operating. Provide with means to manually open in case of pump failure.

   a. Threaded ends 2" and smaller - cast iron body, bronze check mechanism, screw-in bonnet, straight or angle pattern.
   b. Soldered ends 1 1/4" and smaller - cast bronze body, bronze check mechanism, screw in bonnet, straight or angle pattern.
   c. Threaded ends 2 1/2" through 4" - cast iron body, bronze check mechanism, screw in bonnet, straight or angle pattern.

2. Manufacturer - subject to compliance with requirements, provide flow control valves of one of the following:

   a. Bell & Gossett, ITT Fluid Handling Div.
   b. Taco, Inc.
   c. Armstrong Pump Co.

E. Diverting fittings:

1. General - provide diverting fittings as indicated for one pipe hydronic piping systems. Construct fittings of cast iron with threaded ends or wrought copper with solder ends, pressure rated for 125 psi. Provide indication on fitting of direction of flow for supply or return applications. Furnish flow and pressure drop curves based on manufacturer's testing with submittal.
2. Manufacturer - subject to compliance with requirements, provide diverting fittings of one of the following:

   a. Armstrong Pumps, Inc.
   b. Bell & Gossett, ITT Fluid Handling Div.

F. Air Separators:

1. General – provide air separators pressure rated for 125 psi. Select capacity based on total system gpm.

2. Dip tube fittings – provide dip tube fittings in boilers as

indicated to prevent free air collected in boiler from rising into system.

3. In-Line air separators – provide in-line air separators as indicated. Construct sizes 1 1/2” and smaller of cast iron, and sizes 2” and larger of steel complying with ASME Boiler and Pressure Vessel Code and stamped with”U” symbol. Furnish National board Form U-1 denoting compliance.

4. Combination separator/strainer – provide external combination air separators/strainers as incicated. Construct of steel complying with ASME Boiler and Pressure Vessel Code and stamped with “U” symbol. Furnish National Board Form U-1 denoting compliance. Provide galvanized steel integral strainer with 3/16” preforations and free area of not less than 5 times cross sectional area of connecting lines. Provide tangential inlet and outlet connections and internal stainless steel air collector tube designed to direct released air into compression tank. Provide blowdown connections.

5. Manufacturer – subject to compliance with requirements, provide air separators of one of the following:

   a. Armstrong Pumps, Inc.
   b. Bell & Gosett, ITT Fluid Handling Div.
   c. Taco, Inc.

G. Compression tank:

1. General – provide compression tanks of size and number as indicated. Construct of steel for 125 psi pressure rating complying with ASME Boiler and pressure Vessel Code and stamped with ”U” symbol. Furnish National Board Form U-1 denoting compliance. Provide tappings in bottom of tank for tank fitting.

   a. Tank fittings – provide tank fittings for compression tanks as incidcated, sized for compression tank diameter. Design tank fittings for 125 psi pressure rating and include manual vent to establish proper air volume in tank on initial fill.

2. Manufacturer – subject to compliance with requirements, provide compression tanks and tank fittings of one of the following:

   a. Armstrong Pumps, Inc.
   b. Bell & Gossett, ITT Fluid Handling Div.
   c. Taco, Inc.

H. Diaphragm type compression tanks:

1. General – provide diaphragm compression tanks of size and number as indicated. Construct tank of welded steel, constructed, tested and stamped in accordance with Section VII of the ASME Boiler and Pressure Vessel Code for a working pressure of 125 psi. Furnish National Board Form U-1 denoting compliance. Support vertical tanks with steel legs or base, support horizontal tanks with steel saddles. Provide specially compounded flexible diaphragm securely sealed into tank to permanently separate air charge from system water, to maintain design expansion capacity. Provide pressure gauge and air charging fitting.

2. Manufacturer – subject to compliance with requirements, provide diaphragm type compression tanks of the following:

   a. Bell & Gossett, ITT Fluid Handling Div.
   b. Armstrong Pumps, Inc.

I. Pump discharge valves:

1. General – provide pump discharge valves as indicated. Provide Non-slam check valve with spring loaded disc and calibrated adjustment feature permitting regulation of pump discharge flow and shutoff. Provide flanged cast iron valve body, pressure rated for 175 psi, maximum operationg temperature of 300 degrees F. Provide straight or angle pattern as required.

2. Manufacturer – subject to compliance with requirements, provide Pump discharge valves of one of the following:

   a. Armstrong Pumps, Inc.
   b. Bell & Gossett, ITT Fluid Handling Div.

J. Shot feeders:

1. General – provide shot feeders of 5 gallon capacity or otherwise as indicated, constructed of cast iron or steel, for introducing chemicals in hydronic system. Provide funnel and valve on top for loading drain valve in bottom, and recirculating valves on side. Construct for presssure rating of 125 psi.

2. Manufacturer – subject to compliance with requirements, provide shot feeders of one of the following:

   a. Culligan USA
   b. Laboratories, Subsidary of Clow Corp.
   c. Mougul Div., The Dexter Corp.

K. Water relief valves:

1. General – provide water relief valves as indicated, of size and capacity as selected by Installer for proper relieving capacity, in accordance with ASME Boiler and Pressure Vessel Code.

a. Combined pressure temperature relief valves – bronze body, test lever, thermostat, complying with ANSI Z21.22 listing requirements for temperature discharge capacity. Provide temperature relief at 210 degrees F (99 C) and pressure relief as indicated on drawing.
b. Pressure relief valves – bronze body, test lever, ASME rated. Provide pressure relief at as indicated on drawing.

2. Manufacturer – subject to compliance with requirements, provide water relief valves of one of the following:

L. Pressure Reducing Valves:

1. General – provide pressure reducing valves as indicated, of size and capacity as selected by Installer to maintain operating pressure on boiler system.

2. Construction – brass body, low inlet pressure check valve, inlet strainer removable without system shutdown, non-corrosive valve seat and stem, factory set at operating pressure.

3. Manufacturer – subject to compliance with requirements, provide pressure reducing valves of one of the following:

a. Bell & Gossett, ITT Fluid Handling Div.
b. Taco, Inc.
c. Armstrong Pumps, Inc.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Balance valves:

1. General - Install on each hydronic terminal and elsewhere as indicated.

B. Vent valves:

1. Manual vent valves - install manual vent valves on each hydronic terminal at highest point, and on each hydronic piping drop in direction of low for mains, branches and runouts and elsewhere as indicated.

2. Automatic vent valves - install automatic vent valves at top of each hydronic riser and elsewhere as indicated. Install shutoff valve between riser and vent valve, pipe outlet to suitable plumbing drain, or as indicated.

C. Flow control valves:

1. General - install flow control valves on discharge of each pump serving a hot water heating system or zone and elsewhere as indicated. Install in upright position in a horizontal line with adequate clearance for service and replacement. Adjust flow sensitivity for automatic operation.

D. Diverting fittings:

1. General - install diverting fittings as indicated and in accordance with manufacturer's instructions. Position fittings on supply and return mains with proper orientation for flow.

E. Air separators:

1. Dip tube fittings – install dip tube fittings in boiler outlet in accordance with manufacturer’s instructions. Run piping to compression tank pitched towards tank at 1” rise in 5’ runs (1.7%).

2. In-Line air separators – install in-line air separators in pump suction lines. Connect inlet and outlet piping. Run piping to compression tank pitched towards tank at 1” rise in 5’ run (1.7%). Install drain valve on units 2” and over.

3. Combination separator/strainer – install external combination separators/strainers in pump suction lines. Connect inlet and outlet piping. Run piping to compression tank pitched towards tank at 1” rise in 5’ run (1.7%). Install blowdown valve and piping. Remove and clean strainer after 24 hours and again after 30 days of system operation.

F. Compression tanks:

1. General – install compression tanks on trapeze hangers sized for tank fully loaded, or otherwise as indicated. Install tank fitting and drain valve in tank bottom and charge tank in accordance with manufacturer’s instructions.

G. Diaphragm type compression tanks:

1. General – install diaphragm type compression tanks on floor as indicated, in accordance with manufactureer’s instructions. Vent and purge air from hydronic system, charge tank with proper air charge as recommended by manufacturer.

H. Pump discharge valves:

1. General – at engineers option, install pump discharge valves on each pump discharge line in lieu of separate shutoff valve, check valve, and balance cock. Install in horizontal or vertical position with stem in upward position, allow clearance above stem for check mechanism removal. After hydronic system has been completed, mark calibrated name plate with stripe of yellow lacquer to permanently mark final balanced position.

I. Shot feeders:

1. General – install shot feeders on each hydronic system at pump discharge and elsewhere as indicated. Install in upright positiion with top of funnel not more than 48" above floor. Install in pump discharge line as indicated.

J. Water relief valves:

1. General – Install on hot water generators and elsewhere as indicated. Pipe discharge to floor. Comply with ASME Boiler and Pressure Vessel Code. Cut discharge pipe at 45° angle.

K. Pressure reducing valves:

1. Install for each hot water boiler or heat exchanger as indicated, and in accordance with manufacturer's installation instructions.

END OF SECTION

DIVISION 15 - MECHANICAL

SECTION 15650 - HEATING, VENTILATING, AND AIR CONDITIONING

1.01 GENERAL

A. The following specifications are intended to supplement the applicable drawings. The drawings and specifications provide for a complete detailed installation. The Contractor shall also prepare final drawings for duct work, piping, controls, etc. These drawings must be submitted for approval and then be included as a supplement to the Instruction Manuals. The work, as defined, is generally in compliance with all code requirements. The Contractor shall be required to coordinate the final installation with the local codes governing the installation and other trades under this contract.

END OF SECTION

DIVISION 15 - MECHANICAL

SECTION 15657 - ELECTRICAL WORK

1.01 GENERAL

A. The Contractor shall furnish all labor and material required for the installation of the systems. A brief description of the work is as follows.

a. Furnish all electrical feeders, circuit, and control wiring for the new burner and boiler controls utilizing existing boiler/burner feeds where possible.

b. Furnish all electrical connections for new oil fired separate domestic water heater inclusive of aquastats and circulator operation for recirculation lines.

c. All cutting, patching, and painting as required.

d. All controls for burners as specified inclusive of disconnect switches.

e. Testing of all wiring as directed.

B. Drawings:

1. The Contractor shall submit six (6) copies of each new item, bill of material, drawings, and wiring diagrams for approval prior to the installation of the equipment. These shall be certified factory drawings prepared by the manufacturer specifically for this project. Stock drawings or field drawings pertinent to other projects will not be acceptable.

ALL ELECTRICAL WORK SHALL MEET THE REQUIREMENTS OF THE NATIONAL ELECTRIC CODE.

END OF SECTION

DIVISION 15 – MECHANICAL
15755 – EXHAUST FANS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: HVAC Power Ventilators

B. Related Sections:

1. Division 1 Through Division 14 – General Requirements
2. Division 1 Through Division 14 – Thermal and Moisture Protection
3. Division 1 Through Division 14 – Finishes
4. Division 15 – Heating, Ventilating, and Air-Conditioning (HVAC)
5. Division 16 – Electrical

1.02 REFERENCES

A. Air Movement and Control Association Inc. (AMCA):

1. 99 – Standards Handbook
2. 200 – Publication, Air Systems
3. 201-90 – Publication, Fans and Systems
4. 202-88 – Publication, Troubleshooting
5. 203-90 – Publication, Field Performance Measurement of Fan Systems
6. 211-05 – Publication, Certified Ratings Program – Product Rating Manual for Fan Air Performance
7. 300-96 – Standard Reverberant Room Method for Sound Testing of Fans
8. 311-05 – Publication Certified Ratings Program – Product Rating Manual for Fan Sound Performance
9. 99-0401-86 – Classification for Spark Resistant Construction
10. 99-2408-69 – Operating Limits for Centrifugal Fans

B. Air Movement and Control Association Inc. (AMCA), American National Standards Institute (ANSI):

1. 204-05 – Standard Balance Quality and Vibration Levels for Fans
2. 210-99 – Standard Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

C. American National Standards Institute (ANSI):

1. 11-r1999 – Method of Evaluating Load Ratings of Bearings

D. American Society of Civil Engineers (ASCE):

A. 7-02 – Minimum Design Loads for Building and Other Structures

E. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc (ASHRAE):

1. Chapter 45 – 2003 handbook, HVAC Applications
2. Chapter 7 – 2001 Fundamentals handbook, Sound-Vibration

3. Chapter 32 – 2001 Fundamentals handbook, Duct Design
4. Chapter 18 – 1992 HVAC System and Equipment handbook, Fans

F. American Society for Testing and Materials (ASTM):
1. E330-02 – Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylight and Curtain Walls by Uniform Static Air Pressure Difference

G. National Fire Protection Association (NFPA):
1. 70 – National Electrical Code
2. 90A-02 – Standard for the Installation of Air-Conditioning and Ventilating Systems
3. 92A-06 – Recommend Practice for Smoke-Control System
4. 92B-05 – Standard for Smoke Management System in Malls, Atria, and Large Areas
5. 96-04 – Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

H. Occupational Safety and Health Administration (OSHA):
1. 1910.212 – General requirements for Machine Guarding
2. 1910.219 – General requirements for guarding safe use of mechanical power transmission apparatus
3. 1926.300 – General requirements for safe operation and maintenance of hand and power tools

I. Occupational Safety and Health Administration (OSHA):
1. 507 – Electric Fans
2. 555 – Fire Dampers
3. 555S – Smoke Dampers
4. 705 – Standard Power Ventilators
5. 762 – Standard Power Roof Ventilators for Restaurant Exhaust Appliances
6. 793 – Snow Load

1.03 SUBMITTALS

A. General: Submit in accordance with Section 01 33 00 Submittal Procedures
1. Provide dimensional drawings and product data on each fan.
2. Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted.
3. Provide outlet velocity and fan's inlet sound power readings for the eight octave bands, decibels, and sones.
4. Strictly adhere to QUALITY ASSURANCE requirements as stated in section 1.04 of this specification.
5. Provide manufacturer's certification that exhaust fans are licensed to bear Air Movement and Control Association (AMCA), Certified Rating Seal for sound and air performance.
6. Installation, Operation, and Maintenance Manual (IOM): Provide manufacturer's installation, operations, and maintenance manual, including instructions on installation, operations, maintenance, pulley adjustment, receiving,

handling, storage, safety information and cleaning. A troubleshooting guide, parts list, warranty and electrical wiring diagrams.

1.04 QUALITY ASSURANCE

A. Performance ratings: Conform to AMCA standard 211 and 311. Fans must be tested in accordance with ANSI/AMCA Standard 210-99 and AMCA Standard 300-96 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA label for sound and air performance seal.

B. Classification for Spark Resistant Construction, levels A, B, and C conform to AMCA 99

C. Each fan shall be given a balancing analysis which is applied to wheels at the outside radius. The maximum allowable static and dynamic imbalance is 0.05 ounces (Balance grade of G6.3).

D. Comply with the National Electrical Manufacturers Association (NEMA), standards for motors and electrical accessories.

E. The High Wind models have been analyzed and stamped by a state license P.E. to the ASCE 7-02 Standard which meets the IBC, Florida and Miami-Dade codes.

F. Each High Wind model is subject to be certified by a third party to the ASTM E330 Static Pressure Difference Standard.

G. All High Wind models have been analyzed using Computational Fluid Dynamics (CFD). The CFD simulates the flow of high speed (150 MPH) winds over the surface of objects.

H. The Finite Element Analysis (FEA) is the results from the CFD and it can accurately predict the stress, strain, and deflection resulting from high wind loads.

1.05 DELIVERY, STORAGE, and HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.

B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer’s instructions. For long term storage follow manufacturer's Installation, Operations, and Maintenance Manual

C. Handling: Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

1.06 WARRANTY

A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and is not a limitation of, other rights Owner may have under Contract Documents.

1. The warranty of this equipment is to be free from defects in material and workmanship for a period of 1 Yr (Standard) from the purchase date. Any units or parts which prove defective during the warranty period will be replaced at the Manufacturers option when returned to Manufacturer, transportation prepaid.

2. Motor Warranty is warranted by the motor manufacturer for a period of one year. Should motors furnished by us prove

defective during the period, they should be returned to the nearest authorized motor service station.

1.07 MAINTENANCE

A. Refer to Manufacturer's Installation, Operation and Maintenance Manual (IOM), to find maintenance procedures.

PART 2 – PRODUCTS

2.01 MANUFACTURER

A. Greenheck, PO Box 410, Schofield, Wisconsin 54476. Phone (715) 359-6171 Fax (715) 355-2399. Website: www.greenheck.com

B. Approved equivalent

2.02 DIRECT DRIVE ROOF DOWNBLAST CENTRIFUGAL EXHAUST FANS- GREENHECK MODEL G

A. General Description:

1. Refer to plans for equipment schedule(s).
2. Downblast fan shall be for roof mounted applications
3. Performance capabilities up to 14,500 cubic feet per minute (cfm) and static pressure to 2.75 inches of water gauge
4. Fans are available in twenty sizes with nominal wheel diameters ranging from 8 inches through 30 inches (071 – 300 unit sizes)
5. Maximum continuous operating temperature is 180 Fahrenheit (82.2 Celsius)
6. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number.

B. Wheel:

1. Constructed of Composite
2. Non-overloading, backward inclined centrifugal
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency

C. Motors:

a) Electronically Commutated Motor

a) Motor enclosure: ODP

b) Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors

c) Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase

d) Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor

e) Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by

either a potentiometer dial mounted at the motor or by a 0-10 VDC signal

f) Motor shall be a minimum of 85% efficient at all speeds

D. Housing:

1. Motor cover, shroud, curb cap, and lower windband shall be constructed of heavy gauge aluminum
2. Shroud shall have an integral rolled bead for extra strength
3. Shroud shall be drawn from a disc and direct air downward
4. Lower windband shall have a formed edge for added strength
5. Motor cover shall be drawn from a disc
6. All housing components shall have final thicknesses equal to or greater then preformed thickness
7. Curb cap shall have pre-punched mounting holes to ensure correct attachment
8. Rigid internal support structure
9. Leak proof

E. Housing Supports and Drive Frame:

1. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators

F. Vibration Isolation:

1. Rubber isolators
2. Sized to match the weight of each fan

G. Disconnect Switches:

1. NEMA rated: NEMA 1: indoor application no water. Factory standard.
2. Positive electrical shut-off
3. Wired from fan motor to junction box installed within motor compartment

H. Options/Accessories:

1. Birdscreen:
   a) Material Type: Galvanized
   b) Protects fan discharge
2. Roof Curbs (Where shown on schedule)
   a) Type: GPI - Welded, straight sided curb with 2 inches of flashing flange and wood nailer
   b) Mounted onto roof with fan
   c) Material: Galvanized
   d) Insulation thickness: 1 inch
3. Curb Extension:
   a) Type: GPE - Bolted access door and damper holding tray
   b) Material Type: Aluminum
   c) Coating Type: N/A

4. Dampers:
    a) Type: VCD-43, 115 VAC
    b) Prevents outside air from entering back into the building when fan is off
    c) Balanced for minimal resistance to flow
    d) Galvanized frames with prepunched mounting holes

2.03 BELT DRIVE ROOF DOWNBLAST CENTRIFUGAL EXHAUST FANS - GREENHECK MODEL GB

A. General Description:
1. Refer to plans for equipment schedule(s).
2. Downblast fan shall be for roof mounted applications
3. Performance capabilities up to 44,700 cubic feet per minute (cfm) and static pressure to 2.5 inches of water gauge
4. Fans are available in twenty sizes with nominal wheel diameters ranging from 11 inches through 54 inches (071 - 540 unit sizes)
5. Maximum continuous operating temperature is 180 Fahrenheit (82.2 Celsius)
6. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number.

B. Wheel:
1. Constructed of Aluminum
2. Non-overloading, backward inclined centrifugal
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency

C. Motors:
1. AC Induction Motor
    a) Motor Enclosure: Open drip proof (ODP) - opening in the frame body and or end brackets
    b) Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase
    c) Accessible for maintenance

D. Shaft and Bearings:
1. Fan Shaft shall be ground and polished solid steel with an anti-corrosive coating
2. Permanently sealed bearings or pillow block ball bearings
3. Bearing shall be selected for a minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed
4. Bearings are 100 percent factory tested
5. Fan Shaft first critical speed is at least 25 percent over maximum operating speed

E. Housing:
1. Motor cover, shroud, curb cap, and lower windband shall be constructed of heavy gauge aluminum

2. Shroud shall have an integral rolled bead for extra strength
3. Shroud shall be drawn from a disc and direct air downward
4. Lower windband shall have a formed edge for added strength
5. Motor cover shall be drawn from a disc
6. All housing components shall have final thicknesses equal to or greater then preformed thickness
7. Curb cap shall have pre-punched mounting holes to ensure correct attachment
8. Rigid internal support structure
9. Leak proof

F. Housing Supports and Drive Frame:
1. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators

G. Vibration Isolation:
1. Double studded true isolators
2. No metal to metal contact
3. Sized to match the weight of each fan

H. Disconnect Switches:
1. NEMA rated: NEMA 1: indoor application no water. Factory standard.
2. Positive electrical shut-off
3. Wired from fan motor to junction box installed within motor compartment

I. Drive Assembly:
1. Belts, Pulleys, and keys oversized for a minimum of 150 percent of driven horsepower
2. Belts: Static free and oil resistant
3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts
4. The motor pulley shall be adjustable for final system balancing
5. Readily accessible for maintenance

J. Options/Accessories:
1. Birdscreen:
a) Material Type: Galvanized
b) Protects fan discharge
2. Curb Extension:
a) Type: GPE - Bolted access door and damper holding tray
b) Material Type: Aluminum
c) Coating Type: N/A
3. Dampers:
A. Type: VCD-43, 24 VDC
B. Prevents outside air from entering back into the building when fan is off
C. Balanced for minimal resistance to flow
D. Galvanized frames with prepunched mounting holes

2.04 DIRECT DRIVE ROOF OR SIDEWALL UPBLAST CENTRIFUGAL EXHAUST FANS - GREENHECK MODEL CUE

A. General Description:

1. Refer to plans for equipment schedule(s).

2. Discharge air directly away from the mounting surface.

3. Upblast fan shall be for roof mounted applications for fan sizes 060-300 or wall mounted applications for fan sizes 060-200.

4. Performance capabilities up to 14,700 cubic feet per minute (cfm) and static pressure to 3 inches of water gauge.

5. Fans are available in twenty-two sizes with nominal wheel diameters ranging from 9 inches through 30 inches (060 - 300 unit sizes).

6. Maximum continuous operating temperature for fan sizes 098-300 is 400 Fahrenheit (204.4 Celsius) and for fan sizes 060-095 is 160 Fahrenheit (71.1 Celsius)

7. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number

B. Wheel:

1. Material Type: Aluminum

2. Non-overloading, backward inclined centrifugal wheel

3. Statically and dynamically balanced in accordance to AMCA Standard 204-05

4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency

C. Motors:

1. Electronically Commutated Motor

a) Motor enclosure: Open drip proof

b) Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors

c) Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase

d) Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor

e) Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal

f) Motor shall be a minimum of 85% efficient at all speeds

D. Housing:

1. Constructed of heavy gauge aluminum includes exterior housing, curb cap, windband, and motor compartment housing. Galvanized material is not acceptable

2. Housing shall have a rigid internal support structure

3. Windband to be one piece uniquely spun aluminum construction and maintain original material thickness throughout the housing

4. Windband to include an integral rolled bead for strength

5. Curb cap base to be fully welded to windband to ensure a leak proof construction. Tack welding, bolting, and caulking are not acceptable

6. Curb cap to have integral deep spun inlet venturi and pre-punched mounting holes to ensure correct attachment to curb

7. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators

8. Breather tube shall be 10 square inches in size for fresh air motor cooling, and designed to allow wiring to be run through it

E. Motor Cover:

1. Constructed of aluminum

F. Vibration Isolation:

1. Double studded or pedestal style true isolators

2. No metal to metal contact

3. Sized to match the weight of each fan

G. Disconnect Switches:

1. NEMA rated: NEMA 1: indoor application no water. Factory standard.

2. Positive electrical shut-off

3. Wired from fan motor to junction box installed within motor compartment

H. Drain Trough:

1. Allows for one-point drainage of water, grease, and other residues

I. Options/Accessories:

1. Curb Extension:

a) Type: GPE - Bolted access door and damper holding tray

b) Material Type: Aluminum

2. Dampers:

a) Type: VCD-43, 115 VAC

b) Prevents outside air from entering back into the building when fan is off

c) Balanced for minimal resistance to flow

d) Galvanized frames with prepunched mounting holes

PART 3 - EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with manufacturer's product data, including technical bulletins, product catalog installation instructions

3.02 EXAMINATION

A. Examine areas to receive fans. Notify the Engineer of conditions that would adversely affect installation or subsequent

utilization and maintenance of fans. Do not proceed with installation until unsatisfactory conditions are corrected

3.03 PREPARATION

A. Ensure roof openings are square, accurately aligned, correctly located, and in tolerance

B. Ensure duct is plumb, sized correctly, and to proper elevation above roof deck. Install duct as specified in Air Distribution (Division 23)

3.04 INSTALLATION

A. Install fans system as indicated on the Installation, Operation and Maintenance Manual (IOM) and contract drawings

B. Install fans in accordance with manufacturer's instructions

3.05 SYSTEM STARTUP

A. Refer to Installation, Operation, and Maintenance Manual (IOM)

3.06 CLEANING

A. Clean as recommended by manufacturer. Do not use material or methods which may damage finish surface or surrounding construction

3.07 PROTECTION

A. Protect installed product and finished surfaces from damage during construction

B. Protect installed exhaust fans to ensure that, except for normal weathering, fans will be without damage or deterioration at time of substantial completion

END OF SECTION

DIVISION 15 - MECHANICAL

SECTION 15800 - AIR DISTRIBUTION

1.01 GENERAL

A. Construct all apparatus of materials suitable for the conditions encountered during operation.

B. Where corrosion can occur, appropriate corrosion-resistant materials and assembly methods must be used including isolation of dissimilar metals against galvanic interaction.

C. All factory applied acoustical and thermal insulation, including facing and adhesives, it to be fire-resistant and to conform to requirements of NBFU and State Codes.

D. Where in contact with the air stream, protect insulation against erosion or flaking by a factory applied plastic or mat facing.

E. Locate and arrange motors, eliminators, filters, cooling and heating coils, and other components and accessories so that they are accessible for repair, maintenance, and replacement.

F. Mount grease fitting directly on bearings unless the latter are not readily accessible. Where equipment bearings are not visible or are inaccessible, provide easily accessible extensions to bearing lubrication fittings.

G. Thoroughly clean the entire system before installing filters or operating the fans.

H. On systems containing filters, install filters and permanently seal the filter frames airtight before operating the fans. The Contractor, at his own expense, shall replace all dirty filters before turning over the system to the Owner, and furnish the Owner with one complete set of replacement filters for all banks. Seal all outlets around the edges to prevent air leakage.

I. Bracing and supports indicated are the minimum acceptable. Install additional bracing or supports to eliminate any distortion or vibration when the systems are operating or under tests.

J. Install ducts, castings, and hangers plumb and level, with joints square and devoid of sharp edges.

K. Unless otherwise specified, construct all duct work, including angles, bars, and other bracings, hangers, supports, and accessories of galvanized steel, all in accordance with schedules in the latest ASHRAE Guide.

L. Diffusers, grilles, registers, and transfers shall be sized and located as shown on the drawings.

END OF SECTION

DIVISION 15 - MECHANICAL

SECTION 15802 - INSPECTION TESTING, AND BALANCING

1.01 GENERAL

A. All tests shall be conducted in the presence of a representative of the Owner and/or the Architect, by a qualified vendor specializing in balancing of air systems.

B. The H.V.A.C. systems shall be adjusted, balanced, and set so as to provide the temperature and air volumes required and as shown on the drawings.

C. The Contractor shall demonstrate that all air distribution systems and apparatus fulfill the requirements of the specifications and shall operate the equipment for a sufficient time to properly adjust the controls and conscientiously instruct the Owner's representatives in the care and operation of the systems.

D. The Contractor shall obtain and pay for all required inspections and permits required by State Ordinances and by the NBFU and provide all required testing equipment. All equipment shall be properly calibrated.

E. The Contractor shall refer to ASHRAE handbook, "Testing, Adjusting, and Balancing" A.A.B.C. and N.E.B.B. required testing procedures.

F. Balance all systems to design ratings, record pressure drop readings across all major systems, and make flow and pressure measurements.

G. Record all measurements, complete all flow diagrams, and submit complete to the Architect.

1.02 SCOPE

A. This section outlines the recommended test and inspection procedures to be followed in the inspection of any H.V.A.C. plant prior to acceptance and subsequent operation. In addition, the areas of responsibility are defined such that all tests and inspections are conducted in a manner to assure that the system meets the requirements of all applicable codes.

1.03 PRELIMINARY PROCEDURES

A. It shall be the responsibility of the Contractor to complete the following work prior to conducting and tests:

1. Installation of the system(s) and all applicable controls and accessories as outlined in the specifications and/or drawings.

2. Ensure all wiring is permanently affixed. Temporary wiring and/or connections will not be permitted during testing.

B. It shall be the responsibility of the Contractor, under the direction of the Architect, to perform electrical continuity tests only to ascertain that the field wiring is correct from the H.V.A.C. equipment control panel terminal strip to the H.V.A.C. equipment controls.

1.04 TESTS

A. Test all electrical components, including starters and heaters, overload equipment, scanner system, all controls, valves, and safety equipment.

B. Test all circulation air portions of the air distribution system(s).

C. Provide a list of all components that have been satisfactorily tested. Notify the Architect, in writing, a week in advance of this test so as to permit his attendance.

END OF SECTION

DIVISION 15 - MECHANICAL

SECTION 15806 - FIRE DAMPERS

1.01 GENERAL

A. Fire dampers shall be furnished and installed where shown on the drawings. Each fire damper shall be provided with access doors.

B. Fire dampers shall be fabricated in compliance with NFPA and shall be U.L. labeled. Approved fire dampers shall be made by Air Balanced, Inc., Model 119, Type B of 319-P, or equal.

END OF SECTION

DIVISION 15 - MECHANICAL

SECTION 15891 - DUCTWORK

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Extent of ductwork is indicated on drawings and by requirements of this section.

B. Types of ductwork required for project include the following:

1. Heating supply and return air systems.
2. Air conditioning supply and return air systems.
3. Fresh air supply systems.
4. Mechanical exhaust systems.
5. Air relief systems.
6 Fume hood exhaust systems.
7. Wood shop exhaust system.

C. Specific Duct System Classifications:

Service	Material	Pressure Class	Velocity
HVAC Supply	Galvanized Steel	2" WG	2500 FPM
Return Relief Exhaust	Galvanized Steel	1" WG Negative	1500 FPM
Air Plenums	Galvanized Steel	2" WG	2500 FPM
Fume hood	Stainless Steel	4" WG Negative	4000 FPM
Woodshop	Galvanized Steel	5" WG Negative	3000 FPM

D. External insulation for ductwork is specified in Division 15 insulation sections, and is not included as work of this section.

E. Duct accessories are specified in Division 15 Section and are included as work of this section.

F. Inlets and outlets are specified in Division 15 section and are included as work of this section.

G. Duct lining, as specified herein and indicated on drawings, is included as work of this section.

1.02 SUBMITTALS

A. Product data: Submit manufacturer's specifications on manufactured products and factory fabricated ductwork, used for work of this section.

B. Shop drawings: Submit dimensioned layouts of ductwork showing both the accurately scaled ductwork and its relation to space enclosure. Duct dimensions shall be external and provide adequate space to include lining and maintain internal dimensions

indicated on contract drawings. When appropriate, show modifications of indicated requirements made to conform to local shop practice, and how those modifications ensure that free area, materials, and rigidity are not reduced.

C. As-Built drawings: At project closeout, submit as-built drawings of installed ductwork, duct accessories, and outlets and inlets, in accordance with requirements of Division 1.

1.03 QUALITY ASSURANCE AND REQUIRED CODES AND STANDARDS

A. SMACNA standards (metal and flexible ductwork) - comply with SMACNA "HVAC Duct Construction Standards" latest edition for fabrication and installation of metal and flexible ductwork.

B. SMACNA standards (thermoplastic duct) - comply with SMACNA "Thermoplastic Duct (PVC) Construction Manual" latest edition for fabrication and installation of thermoplastic (PVC) ductwork.

C. SMACNA standards (fibrous glass ductwork) - comply with SMACNA "Fibrous Glass Duct Construction Standards" latest edition for fabrication and installation of fibrous glass ductwork.

D. SMACNA standards (industrial duct) - comply with SMACNA "Accepted Industry Practice for Industrial Duct Construction"; "Accepted Industry Practice for Round Industrial Duct Construction"; and "Accepted Industry Practice for Square Industrial Duct Construction", latest editions, for fabrication and installation of industrial ductwork.

E. SMACNA standards: Comply with SMACNA "Duct Liner Standards" for installations of duct liner in sheet metal ductwork.

F. NYS compliance: Comply with NFPA 90 A "Standard for the Installation of Air Conditioning and Ventilating Systems."

G. Mechanical Code of New York State

1.04 DELIVERY, STORAGE AND HANDLING

A. Protect shop fabricated and factory fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

B. Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.01 DUCTWORK MATERIALS

A. Exposed ductwork materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks,

roller marks, oil canning, stains and discolorations, and other imperfections, including those which would impair painting.

B. Sheet metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ANSI/ASTM A 527, lockforming quality, with ANSI/ASTM A 525, G90 zinc coating, mill phosphatized for exposed locations.

C. Flexible Duct - Polyethylene Vapor Barrier Type. Where indicated, provide insulated flexible duct as follows:

1. Galvanized steel helix, formed and mechanically locked to fabric.
2. Aluminum foil trilaminate, fiberglass and aluminized polyester, mechanically locked (no adhesive).
3. Exterior fiberglass insulation blanket factory wrapped. Thermal conductance, C factor, not more than 0.23.
4. Outer jacket of gray fire retardant polyethylene material.
5. UL listed per UL 181, Class 1 Air Duct.
6. Operating temperature range -20 degrees to 250 degrees F.
7. Flame spread less than 25, smoke developed less than 50.
8. Working pressures:

    a. 6 inch w.g. positive (all diameters).
    b. 4 inch w.g. negative, through 16 inch diameters.
    c. 1 inch w.g. negative, 18 to 20 inch diameters.

9. Rated velocity: 4,000 FPM.
10. Manufacturer:

    a. Flexmaster, Type 3.
    b. Clevaflex USA, Inc.
    c. Thermaflex.

D. Flexible Duct Fittings: Provide factory manufactured galvanized steel fittings. Use 45 degree laterals, ball mouth tees, spin collars, or conical tees for duct taps. 90 degree tees shall not be allowed.

2.02 DUCT LINER

A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.

1. Manufacturers:

    a. CertainTeed Corp.; Insulation Group.
    b. Johns Manville International, Inc.
    c. Knauf Fiber Glass GmbH.
    d. Owens Corning.

2. Materials: ASTM C 1071; surfaces exposed to air stream shall be coated to prevent erosion of glass fibers.

    a. Thickness: 2 inches.

b. Thermal Conductivity (k-Value): 0.26 at 75°F (0.037 at 24°C) mean temperature.
c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
d. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
e. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.

1) Tensile Strength: Indefinitely sustain a 50-lb- (23-kg) tensile, dead-load test perpendicular to duct wall.
2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch (3 mm) into air stream.
3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

2.03 MISCELLANEOUS DUCTWORK MATERIALS

A. General: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.

B. Duct sealant: Non-hardening, non-migrating mastic elastic sealant (type applicable for fabrication/installation detail) as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork. Liquid allowed for slip joints only. Silicone base duct sealer shall be used on duct joints exposed to weather.

C. Ductwork support materials.

1. For galvanized steel ductwork, provide hot dipped galvanized steel fasteners, anchors, rods, straps, trim and angles.
2. For stainless steel ductwork, provide matching stainless steel support materials.
3. For flexible ductwork, provide hot dipped galvanized steel support material.

D. Duct Connector: Where duct system meets or exceeds pressure class of 2" w.g., positive or negative, incorporate the use of rolled, formed, machine manufactured duct connector.

1. Manufacturer: Subject to compliance with requirements, provide duct connector of one of the following:

a. Ward.
b. Ductmate.
c. United McGill.
d. Flexmaster.

2.04 SHOP FABRICATION

A. Shop fabricate ductwork in 4, 8, 10 or 12 foot lengths, unless otherwise indicated or required to complete runs. Pre-assemble work in shop to greatest extent possible, so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match-mark sections for re-assembly and coordinated installation.

B. Shop fabricate ductwork of gages and reinforcement complying with applicable SMACNA standard.

C. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with inside radius equal to associated duct width. Limit angular tapers to 30 degrees for contracting tapers and 20 degrees for expanding tapers.

D. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to Division 15 section "Duct Accessories" for accessory requirements.

E. Fabricate ductwork with duct liner in each section of duct where indicated. Fabricate ductwork large enough to accept liner of thickness indicated and to maintain inside dimensions shown on contract drawings. Laminate liner to internal surfaces of duct in accordance with instructions by manufacturers of lining and adhesive, and fasten with mechanical fasteners.

F. Provide lining in all ductwork that is conveying below ambient temperature air and is not insulated. Provide lining in supply air and return air ductwork from air handling unit to 20 feet away from the unit. Provide lining in ductwork as indicated on drawings.

2.05 FACTORY FABRICATED DUCTWORK

A. General: At Installer's option, provide factory fabricated spiral, round or oval duct and fittings, in lieu of shop fabricated duct and fittings.

B. Gauge: Tables 3-2 and 3-3 SMACNA "HVAC Duct Construction Standards." No standing rib shall be allowed.

C. Oval Elbows: 3 gore 90 degree and 2 gore 45 degree with machine formed seam.

D. Round Elbows: one piece construction for 90 degree and 45 degree elbows 14" and smaller. Provide 5 gore 90 degree and 3 gore 45 degree construction for larger diameter with machine formed seam joint.

E. Divided flow fittings: 90 degree tees, constructed with saddle tap spot welded and bonded to duct fitting body.

F. Manufacturer: subject to compliance with requirement, provide factory fabricated ductwork of one of the following:

1. United Sheet Metal Div., United McGill Corp.
2. Semco

PART 3 - EXECUTION

3.01 INSTALLATION OF DUCTWORK

A. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve air tight (5% leakage) and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum of joints. Align ductwork accurately at connections, within 1/8" misalignment tolerance and with internal surfaces smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling.

B. Duct Sizing: Duct sizes indicated on drawings are inside dimensions.

C. Flexible Duct: Flexible duct may be used for connecting room diffuser to sheet metal duct and/or ceiling terminal box only. Extend flexible duct completely and limit lengths to five feet (5'), or as indicated on Drawings. Support according to SMACNA.

D. Seal ductwork to seal class as prescribed in SMACNA "HVAC Duct Construction Standards" for the static pressure classes indicated, unless otherwise recommended.

E. Complete fabrication of work at project as necessary to match shop fabricated work and accommodate installation requirements.

F. Locate ductwork runs, except as otherwise indicated, vertically and horizontally and avoid diagonal runs wherever possible. Locate runs as indicated by diagrams, details and notations or, if not otherwise indicated, run ductwork in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building. Limit clearance to 1/2" where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any. Where possible, locate insulated ductwork for 1" clearance outside of insulation. Wherever possible in finished and occupied spaces, conceal ductwork from view, by locating in mechanical shafts, hollow wall construction or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

G. Electrical equipment spaces: Do not run ductwork through transformer vaults and their electrical equipment spaces and enclosures.

H. Boiler Rooms: Do not run ductwork through boiler rooms unless protected per NFPA requirements.

I. Where ducts pass through interior partitions and exterior walls, conceal space between construction opening and duct or duct-plus insulation with sheet metal flanges of same gage as duct. Overlap opening on four sides by at least 1-1/2".

J. Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.

K. Support ductwork in manner complying with appropriate SMACNA standard.

3.02 INSTALLATION OF WOODSHOP EXHAUST (N/A)

3.03 APPLICATION OF LINER IN RECTANGULAR DUCTSS

A. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.

B. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.

C. Butt transverse joints without gaps and coat joint with adhesive.

D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

E. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.

F. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm (12.7 m/s).

G. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.

H. Secure transversely oriented liner edges facing the airstream with metal nosing's that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

1. Fan discharges.
2. Intervals of lined duct preceding unlined duct.

3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm (12.7 m/s) or where indicated.

I. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used; secure buildouts to duct walls with bolts, screws, rivets, or welds.

3.04 CLEANING AND PROTECTION

A. Clean ductwork internally, unit-by-unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.

B. Strip protective paper from stainless ductwork surfaces, and repair finish wherever it has been damaged.

C. Temporary closure - at ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.

3.04 BALANCING

A. Refer to Division 15 Section 15990 "Testing, Adjusting and Balancing" for air distribution balancing of ductwork. Seal any leaks in ductwork that become apparent in balancing process.

END OF SECTION

DIVISION 15 - MECHANICAL

SECTION 15893 - DUCT ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY OF ITEMS INCLUDED

A. Extent of duct accessories work is indicated on drawings and in schedules, and by requirements of this section.

B. Types of duct accessories required for project include the following:

1. Fire and smoke dampers(in compliance with NFPA80-STD for opening protectives)
2. Access doors
3. Turning vanes
4. Manual Dampers
    a. Butterfly manual dampers
    b. Opposed-blade manual dampers
5. Intake/Exhaust dampers
6. Flexible connections

1.02 SUBMITTALS

A. Product data - submit manufacturer's specifications for each type of duct accessory, including dimensions, capacities, and materials of construction, and installation instructions.

B. Shop drawings - submit assembly type shop drawings for each type of duct accessory showing interfacing requirements with ductwork, and method of fastening or support.

C. Maintenance data - submit manufacturer's maintenance data including parts lists for each type of duct accessory, include this data in Maintenance Manual.

1.03 QUALITY ASSURANCE

A. SMACNA compliance - comply with applicable portions of Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) high pressure and low pressure duct construction standards.

B. Industry standards - comply with American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE) recommendations pertaining to construction of duct accessories, except as otherwise indicated.

C. UL compliance - construct, test and label fire dampers in accordance with Underwriters Laboratories (UL) Standard 555 "Fire Dampers and Ceiling Dampers".

D. NFPA compliance - comply with applicable provisions of ANSI/NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of duct accessories.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver components with factory installed packing and protective containers.

B. Handle components carefully to prevent damage to components and finish. Do not install damaged components; replace with new.

C. Protect components from weather, dirt, construction traffic and debris, etc.

PART 2 - PRODUCTS

2.01 FIRE AND SMOKE DAMPERS

A. Standards, Fire and Smoke Dampers: Conform to the requirements of NFPA 90A and UL listed, labeled and rated 1-1/2 hours, and in compliance with NFPA80-STD for opening protectives.
Provide fusible links 165 degrees F., vibration proof and secured with clinched "S" hooks or stainless steel bolts and lock nuts.

B. Smoke Dampers: Conform to UL, fit with control shafts for operation by electric or pneumatic motors. Provide a 165 degrees F thermal link.

C. Access Doors: Provide adjacent to all fire and smoke dampers.

D. Manufacturer: Subject to compliance with requirements, provide products by one of the following.

1. Ruskin Mfg. Co.
2. Controlled Air, Inc.

2.02 ACCESS DOORS

A. Standard: Conform to SMACNA.

B. Location: Provide access doors in casings, plenums and ducts where shown on Drawings and where specified for ready access to operating parts including fire dampers, smoke dampers, valves, and concealed coils.

C. Pressure Classification: Construct and install access doors in accordance with SMACNA Standards to suit the static pressure classifications and the locations where installed.

D. Access Doors in Ducts: Provide and size doors as follows.

1. Minimum 24-inch by 24-inch clear opening.
2. When field conditions require an access opening smaller than 16-inch by 12-inch, provide a 24-inch long removable

section of casing or duct, secured with quick acting locking devices, 6 inches on centers, to permit ready access without dismantling other equipment.

E. Door Requirements: Provide doors in casings and duct as follows.

1. Arrange doors so that system air pressure will assist closure and prevent opening when the system is in operation.
2. Coordinate doors and equipment to provide unrestricted passage through clear door opening, without removal of any equipment.
3. Where pressure regulating dampers are installed in ducts or plenums, provide access doors with a clear wire glass observation port, 6-inch by 6-inch minimum size. Anchor port with structural metal frame, resilient gaskets and stainless steel bolts.

F. Manufacturer: Subject to compliance with requirements, provide products by one of the following manufacturers.

1. Ruskin Mfg. Co.
2. Flexmaster USA, Inc.
3. Ductmate Ind., Inc.
4. United McGill Corp.

2.03 TURNING VANES

A. Acoustic Turning Vanes: Construct of airfoil shaped aluminum extrusions with perforated faces and fiberglass fill.

B. Manufacturer: Subject to compliance with requirements, provide products by one of the following manufacturers.

1. Air Filter Corp.
2. Anemostat Products Div., Dynamics Corp. of America.
3. Duro-Dyne Corp.
4. United McGill Corp.

2.04 MANUAL DAMPERS

A. Provide dampers of single blade (butterfly) type, constructed in accordance with SMACNA Duct Standards.

B. Provide dampers of multiple, opposed-blade type, constructed in accordance with SMACNA Duct Standards.

C. Bearings: Two piece molded synthetic.

D. Axles: 1/2" plated steel hew.

E. Control Shaft: 1/2" diameter.

F. Finish: Mill.

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

1. Ruskin Mfg. Co.
2. Controlled Air, Inc.
3. United McGill Corp.

2.05 INTAKE OR EXHAUST DAMPERS

A. General: Provide low leakage, airfoil dampers; opposed blade arrangement; AMCA rated 6 CFM/sq. ft. at 4" w.g.

B. Construction

1. Frame: 6063T5 extruded aluminum hat channel 0.125 wall thickness 5" x 1" (5" x 1/2" top and bottom 12" high or less).
2. Blades: 6" wide 6063T5 heavy gage extruded aluminum airfoil shape with extruded metal (aluminum) jam seals.
3. Linkage: Concealed.
4. Operators: Control operators specified under "Controls" Section, and is work of Division 15.

C. Manufacturer: Subject to compliance with requirements, provide products by one of the following manufacturers.

1. Construction Specialties, Inc.
2. Ruskin Mfg. Co.
3. Arrow United Industries, Inc.

2.06 FLEXIBLE CONNECTIONS

A. Fans: Provide flexible connections between fans and ducts or casings where indicated on the Drawings or required to accommodate expansion and vibration.

B. Material: Construct connections of cotton duck, minimum 20 ounces per square yard.

C. Elevated Temperature: For temperatures in excess of 100 degrees F., and corrosive, acid alkali or garage exhausts use close woven glass cloth, double neoprene coated, minimum 28 ounces per square yard.

D. Length: Limit flexible connections to 4-inch active length in the direction of airflow.

E. Standard: Construct in accordance with SMACNA Standards.

F. Attachment: Attach to fans, casings and ductwork as specified by manufacturer.

G. Manufacturer: Subject to compliance with requirements, provide products by one of the following manufacturers.
1. Vent Fabrics, Inc. or equal.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which duct accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install duct accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

B. Install turning vanes in square or rectangular 90 degree elbows in supply and exhaust air systems, and elsewhere as indicated.

C. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.

D. Coordinate with other work, including ductwork, as necessary to interface installation of duct accessories properly with other work.

E. Field quality control - operate installed duct accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

END OF SECTION

DIVISION 15 - MECHANICAL

SECTION 15895 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.01 SUMMARY OF ITEMS INCLUDED

A. Scope: Extent of air diffuser and register work required in this Section is indicated on the Drawings and schedules and by the requirements of this Section.

B. Types required for project include the following:

1. Ceiling air diffusers.
2. Wall and duct registers and grilles.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's standard technical product data including capacity ratings, throw, drop, diffusion, terminal velocities, noise levels, adjustability, construction details, finish and mounting details.

B. Shop Drawings.

1. Provide dimensioned shop drawings of linear diffuser mounting, plenum dimensions, plenum connections, damper connections and branch ductwork connections.

a. Draw shop drawings showing plans, sections, mounting details and finishes.
b. Furnish certified test data, including acoustical performance of the air troffer/boot combination with maximum air quantities indicated on the drawings.

C. Schedule: Submit a schedule of proposed air diffusers, registers and grilles, keyed to the Contract Drawings and indicating the proposed type, size, air quantity, pressure drop and location of each device proposed under this Contract.

1. Manufacturer: Same for all diffusers and registers on project.

1.03 QUALITY ASSURANCE

A. ASHRAE: Test and rate air outlets and inlets in certified laboratories under the requirements of ASHRAE Standard 70.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Original Containers: Deliver air diffusers and registers to the site in manufacturer's original containers. Identify on outside of container type and location to be installed.

B. Protect From Damage: Do not install bent, marred or damaged devices. Replace with new. Store indoors, where possible, or outdoors in weatherproof enclosures above grade.

PART 2 - PRODUCTS

2.01 AIR DIFFUSERS AND REGISTERS: GENERAL

A. Construction: Provide devices as specified on drawinngs.

1. Treat steel with zinc phosphate or zinc chromate after fabrication.
2. Grind, polish and factory prime.
3. Factory finish with white baked enamel finish, unless otherwise indicated.
4. Roll or reinforce exterior faces and edges.
5. Ensure mitered joints and butt connections mate within 0.010-inch maximum crack.
6. Surface finish: Smooth within 0.005-inch at welds, joints, clamping points and splices.
7. Offsets and bends: Mitered.
8. Mate devices with the associated duct, plenum or boot to form an airtight joint.

B. Provide as scheduled on Drawings.

2.02 SUPPLY OR RETURN REGISTERS

A. Register Type: Adjustable single or double-deflection type, formed steel or extruded aluminum, as indicated on the Drawings; noise levels of NC 20 or less.

B. Bars: Provide adjustable or fixed face bars and fixed rear bars, as indicated by types on Drawings.

C. Frames: Provide stamped or rolled steel or extruded aluminum frames fitted with felt, neoprene or plastic gaskets.

D. Dampers: If indicated on drawings provide register dampers of formed steel, cadmium plated, gang key operated, opposed blade type, and arranged so that the operating mechanism does not project through any part of the register face.

E. Mounting Hardware: Provide round or countersunk head Phillips screws.

F. Air Extractors: Provide 18 gage frames, 22 gage curved steel blades, fixed pattern, screwed to the duct collar, and sized to match register dimensions.

G. Manufacturer: Subject to compliance with requirements, provide registers of one of the following:

1. Titus Products.
2. Anemostat Products Division, Dynamics Corp.
3. Carnes Co., Division of Wehr Corp.

2.03 RETURN GRILLES

A. Construction: Construct as specified for registers, except omit register damper.

B. Bars: Provide fixed horizontal face bars with 1/2-inch spacing and 35 degree downward blade angle.

C. Filters: If indicated on drawings provide 1-inch throw-away filters for return grilles.

D. Manufacturer: Subject to compliance with requirements, provide grille units of one of the following:

1. Titus Products.
2. Anemostat Products Division, Dynamics Corp.
3. Carnes Co., Division of Wehr Corp.

2.04 CEILING DIFFUSERS

A. Ceiling Diffusers: Provide circular, square or rectangular, as indicated on the Drawings; noise levels as indicated on drawings.

B. Diffuser Edge and Framing Details: Compatible with the type of ceilings in which the diffuser is installed. For plaster ceiling provide plaster frames or plaster rings, set flush with finished ceiling.

C. Materials: Refer to drawings.

D. Access: Provide removable internal parts of circular, square or rectangular diffusers, including volume regulators, diffuser face, dampers and equalizing devices.

1. Allow removal of parts, including internal assembly, without the use of special tools.
2. Do not allow removal of diffuser face to disturb the distribution pattern.

E. Finish: Provide baked enamel finish on visible face. Coordinate color with Architect.

1. Interior and concealed parts: Flat black or dark gray.

F. Adjustable Pattern: Provide adjustable pattern diffuser cones to vary the distribution from horizontal parallel to the ceiling to a downward distribution pattern into the space, not on exposed face.

G Pressure Range: Design to allow equal distribution pattern, both horizontal and vertical, for diffusers with pressure drops from 0.10 to 0.40 inches water gage.

H. Dampers, Diffusers, and Extractors: Products of the same manufacturer.

I. Extractors: Provide adjustable extractors, furnished by the diffuser manufacturer, in each ceiling diffuser where indicated on drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Coordination: Coordinate the location of grilles, registers and diffusers with other trades. Examine areas and conditions under which inlets and outlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

1. Examine architectural floor plans, reflected ceiling plans and elevations and arrange for duct taps to be so placed that the installation of air outlets will present a uniform relationship with architectural features, lighting, sprinkler heads, speakers and smoke detectors.
2. On plain walls, if not otherwise indicated, locate sidewall registers approximately 8 inches down from the finished ceilings.
3. Adjust the face and rear bars of supply registers to provide a diffusion pattern such that the terminal velocity point is approximately 70 percent of the "room" width and 5 to 6 feet above the finished floor, at a velocity of 20 to 50 fpm.
4. On projects with reflected ceiling plans, locate outlets to conform to that plan.
5. If no reflected ceiling plans are included in the Contract Documents, coordinate the location of air outlets with other trades before cutting in ceiling and sidewall taps. Provide coordination drawing in shop drawings.

END OF SECTION

DIVISION 15 – MECHANICAL

SECTION 15990 – HVAC TESTING, ADJUSTING AND BALANCING

PART 1 – GENERAL

1.01 SUMMARY OF ITEMS INCLUDED

A. Scope: Extent of HVAC testing, adjusting and balancing work required by this Section is indicated on the drawings, in schedules, and by the requirements of this Section.

B. Testing, Adjusting and Balancing (TAB) contractor to meet or exceed all uniform code testing requirements. (e.g. ASHRAE, ASME, IMC, Etc.)

C. Systems: Testing, adjusting and balancing specified in this Section includes the following systems:

1. Air systems including supply, return and exhaust.
2. Hydronic systems including heating, chilled water.

D. Related Sections: Refer to other Division 15 sections for:

1. Fans
2. Air Terminal Units
3. Pumps
4. Hydronic Piping Systems
5. Ductwork
6. Boilers
7. Chillers and Cooling Towers

1.02 QUALITY ASSURANCE

A. Agency Qualifications

1. The qualifications of the TAB contracting firms shall be submitted, within 30 days of notice to proceed. Recent projects shall be listed and described for the company. Names and telephone numbers of the project contractors and facility managers will be provided.

2. The Owner must approve in writing the qualifications of both the company and the lead technician.

3. Qualifications of TAB Firm Personnel:

1. A minimum of one professional engineer with current registration is required to be in the permanent employment of the firm for supervision and direction in the work performed. This engineer shall be totally responsible for developing job site data as required for test procedures.

2. All personnel used on job site shall be either professional engineer or technicians, who shall have been permanent, full-time employees of firm for a

minimum of six (6) months prior to start of work for that specified project.

3. The qualifications of the TAB lead site technician who will remain on site during all TAB work, within 30 days of notice to proceed. Recent projects shall be listed and described for the company. Names and telephone numbers of the project contractors and facility managers will be provided.

4. The Owner must approve in writing the qualifications of both the company and the lead technician.

B. Tester's Qualifications: A specialist certified by the National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC) with at least 3 years of experience in those testing, adjusting and balancing requirements similar to those required for this project, who is not the installer of the system to be tested and is otherwise independent of the project.

C. Codes and Standards: Provide testing, adjusting and balancing conforming to American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), American National Standards Institute (ANSI), and either NEBB or AABC the following:

1. American National Standards Institute (ANSI): Comply with the following:

a. S1.4Specification For Sound Level Meters
b. S1.11Specification for Octave-Band and Fractional-Octave-Band Analog and Digital Filters

2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): Comply with ASHRAE recommendations pertaining to measurements, instruments, and testing, adjusting, and balancing.

3. NEBB or AABC: Comply with NEBB'S "Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems" or comply with AABC MN-1 "National Standards," as applicable to mechanical air and hydronic distribution systems, and associated equipment and apparatus.

D. Calibration of Testing Instruments: All measurement instruments used for testing, adjusting, balancing, and commissioning shall be calibrated. The time between the most recent calibration data and the final test report date shall not be over 1 year.

1.03 SUBMITTALS

A. Test Reports: Provide certified test reports, signed by the test and balance supervisor who performed the work. The final reports shall include identification and types of instruments used, and their most recent calibration date and calibration date.

B. Standards: Deliver a copy of either NEBB or AABC standards for testing and balancing work associated with the project. This document shall serve as specific guidance to balancers as to minimum requirements.

C. Maintenance Data: Include, in maintenance manuals, copies of balance test reports and identification of instruments.

D. Qualifications: Submit the individual qualifications of all persons responsible for supervising and performing the actual work.

1.04 AGENDA

A. Agenda: A preliminary report and agenda shall be submitted and approved prior to the start of testing and balancing work.

1. Review Drawings and Specifications prior to installation of any of the affected systems, and submit a report indicating any deficiencies in the systems that would preclude the proper adjusting, balancing, and testing of the systems.

2. The agenda shall include a general description of each air and water system with its associated equipment and operation cycles for heating, intermediate, and cooling.

3. The agenda shall include a list of all air and water flow and air terminal measurements to be performed.

4. The agenda shall incorporate the proposed selection points for sound measurements, including typical spaces as well as sound sensitive areas.

5. The agenda shall also include specific test procedures and parameters for determining specified quantities (e.g. flow, drafts, sound levels) from the actual field measurements to establish compliance with contract requirements. Samples of forms showing application of procedures and calculations to typical systems shall be submitted.

6. Specific test procedures for measuring air quantities at terminals shall specify type of instrument to be used, method of instrument application (by sketch) and factors for:

a. Air terminal configuration.
b. Flow direction (supply or exhaust).
c. Velocity corrections.
d. Effective area applicable to each size and type of air terminal.
e. Density corrections.

7. The agenda shall include identification and types of measurement instruments to be used, and their most recent calibration date and calibration date.

1.05 JOB CONDITIONS

A. General: Do not proceed with testing, adjusting and balancing work until the following conditions have been met.

1. Work has been completed and is operable. Ensure that there is no latent residual work yet to be completed on the tested equipment.

2. Work scheduled for testing, adjusting and balancing is clean and free from debris, dirt and discarded building materials.

3. All architectural openings (doors, windows, and other openings) which may affect the operation of the system to be tested, adjusted, and balanced shall at their normal states.

4. All related mechanical systems which may affect the operation of the system to be tested, adjusted, and balanced shall be at their normal operating conditions. Coordinate tests with Controls Contractor.

5. Air handling unit filters are not "loaded"; Mechanical Contractor shall replace, if required, prior to balancing.

PART 2 - PRODUCTS

2.01 PATCHING MATERIALS

A. Material: Seal, patch and repair ductwork, piping and equipment drilled or cut for testing purposes.

1. Plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.

2. Piping shall be capped with materials the same as the piping system.
3. Insulation shall be neatly hemmed with metal or plastic

2.02 TEST INSTRUMENTS

A. Standards: Utilize instruments and equipment of type, precision, and capacity as recommended in the following standards:

1. NEBB "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

2. AABC Manual MN-1, "AABC National Standards".

B. Test Instruments: All instruments used for measurements shall be accurate and calibration histories for each instrument shall be available for examination. Each test instrument shall be calibrated by an approved laboratory or by the manufacturer. Owner's representative has the right to request instrument recalibration, or the use of other instruments and test methodology, where accuracy of readings is questionable.

C. Additional Instruments: Permanently installed measuring instruments , such as temperature and pressure gauges, shall be checked against transfer standard instruments. Any instrument which does not meet specification requirement shall be replaced or recalibrated.

D. Cone Instruments: Employ manufactured enclosure type cones, capable of air volume direct readings, for all diffuser air flow measurements. The readout meters shall meet calibration requirements.

PART 3 - EXECUTION

3.01 PROCEDURES AND INSTRUMENTS, GENERAL

A. Requirements: All systems and components thereof shall be adjusted to perform as required by drawings and specifications.

B. Test Duration: Operating tests of heating and cooling coils, fans, and other equipment shall be of not less than four hours duration after stabilized operating conditions have been established. Capacities shall be based on temperatures and air and water quantities measured during such tests.

C. Instrumentation: Method of application of instrumentation shall be in accordance with the approved agenda.

1. All instruments shall be applied in accordance with the manufacturer's certified instructions.

2. All labor, instruments, and appliances required shall be furnished by the balancer. Permanently installed instruments used for the tests (e.g., flow meters and Btu meters) shall not be installed until the entire system has been cleaned and ready for operation.

3.02 AIR SYSTEM PROCEDURES

A. Adjustments: Adjust all air handling systems to provide approximate design air quantity to or through, each component, and to maintain stable and comfortable interior temperatures, free of drafts or stagnant conditions. Adjusting and balancing of all systems shall be conducted during periods of the year approximating maximum seasonal operation. Verify operating parameters prior to start of balancing. Laboratory doors shall be closed and fume hood sashes full open, and all other ancillary systems in simultaneous operation. Coordinate with automatic control system operation.

B. Balance: Flow adjusting (volume control) devices shall be used to balance air quantities (i.e., proportion flow between various terminals comprising system) to the extent that their adjustments do not create objectionable air motion or sound (i.e., in excess of specified limits).

1. Balancing between runs (submains, branch mains, and branches) generally shall be accomplished by flow regulating devices at, or in, the divided-flow fitting.

2. Restriction imposed by flow regulating devices in or at terminals shall be minimal. Final measurements of air quality shall be made after the air terminal has been adjusted to provide the optimum air patterns of diffusion.

C. Fan Adjustment: Total air system quantities, generally, shall be varied by adjustment of fan speeds or axial-flow fan wheel blade pitch. Damper restriction of a system's total flow may be used only for systems with direct-connected fans (without adjustable pitch blades), provided system pressure is less than 1/2-inch W.G. and sound level criteria is met.

D. Air Measurement: Where air quantity measuring devices are specified in other sections such systems shall be used as a cross-check of portable measuring equipment.

1. Except as specifically indicated herein, pitot tube traverses shall be made of each duct to measure air flow therein. Pitot tubes, associated instruments, traverses, and techniques shall conform to the ASHRAE "Handbook Fundamentals Inch Pound Edition."

2. For ducts serving modular office areas with movable partitions, which are subject to change, pitot tube traverses may be omitted provided the duct serves only a single room or space and its design volume is less than 2000 cfm. In lieu of pitot tube traverses, air flow in the duct shall be determined by totalling volume of individual terminals served, measured as described herein.

3. Where duct's design velocity and air quantity are both less than 1000 (fpm/cfm), air quantity may be determined by measurements at terminals served.

E. Test Holes: Test holes shall be in a straight duct, as far as possible downstream from elbows, bends, take-offs, and other turbulence generating devices, to optimize reliability of flow measurements.

F. Air Terminal Balancing: Generally, measurement of flow rates by means of velocity meters applied to individual terminals, with or without cones or other adapters, shall be used only for balancing. Measurement of air quantities at each type of air terminal (inlet and outlet) shall be determined by the method approved for the balancing agenda.

G. Air Motion: Air motion and distribution shall be as specified and indicated on Drawings.

3.03 WATER SYSTEM PROCEDURES

A. Adjustment: All heating, cooling and condensing water systems shall be adjusted to provide required quantity to or through each

component. Verify operating parameters prior to start of balancing.

B. Metering: Water quantities and pressures shall be measured with calibrated meters.

1. Venturi tubes, orifices, or other metering fittings and pressure gauges shall be used to measure water flow rates and balance systems. Systems shall be adjusted to provide the approved pressure drops through the heat transfer equipment (coils [except room units], converters, etc.) prior to the capacity testing.

2. Where flow metering fittings are not installed, in air/water type heat transfer equipment, flow balance shall be determined by measuring the air side energy differential across the heat transfer equipment. Measurement of water temperature differential shall be performed with the air system, adjusted as described herein, in operation.

C. Automatic Controls: Automatic control valves shall be positioned for full flow through the heat transfer equipment of the system during tests.

D. Flow: Flow through bypass circuits at three-way valves shall be adjusted to equal that through the supply circuit, when the valve is in the bypass position.

E. Distribution: Adjustment of distribution shall be effected by means of balancing devices (cocks, valves, and fittings) and automatic flow control valves as provided; service valves shall not be used.

1. Where automatic flow control valves are utilized in lieu of Venturi tubes, only pressure differential need be recorded, provided that the pressure is at least the minimum applicable to the tag rating.

F. Special Procedures: Where available pump capacity (as designed) is less than total flow requirements of individual heat transfer units of system served, full flow may be simulated by the temporary restriction of flow to portions of the system; specific procedures shall be delineated in the agenda.

3.04 HEAT EXCHANGER CAPACITY VERIFICATION

A. Air coil capacities shall be verified from air side measurement data. Capacities of coils shall be the difference of the energy carried by the air between the up stream and down stream of the coils.

B. The measured air flow rate for the fan may be used for air coil capacity calculations providing no ducted bypassing of coil is occurring.

C. Capacity verifications shall be performed after air and water systems have been balanced. Heat exchangers using steam as the

exchange medium shall have the steam measured and adjusted to the specified pressure.

D. False load shall be applied if the upstream air or water does not meet the specified conditions at the time of test.

3.05 REPORTS

A. Submittals: Three copies of the reports described herein, covering air and water system performance, air motion (fpm), and sound pressure levels, shall be submitted prior to final tests and inspection.

B. Instrument Records: Types, serial numbers, and dates of calibration of all instruments shall be included.

C. Reports: Reports shall conspicuously identify items not conforming to contract requirements, or obvious malfunction and deficiencies.

3.06 AIR SYSTEM DATA

A. Report: The report shall include for each air handling system the data listed below.

1. Equipment (Fan or Factory Fabricated Station Unit):

a. Installation data

1. Manufacturer and model
2. Size
3. Arrangement, discharge and class
4. Motor hp, voltage, phase, cycles, and full load amps
5. Location and local identification data

b. Design data

1. Data listed in schedules on drawings and specifications.

c. Fan recorded (test) data

1. cfm
2. Static pressure
3. rpm
4. Motor operating amps motor operating bhp

2. Duct Systems:

a. Duct air quantities (maximum and minimum) - main, submains, branches, outdoor (outside) air, total air, and exhaust

1. Duct size(s)
2. Number of Pitot tube (pressure measurements)

3. Sum of velocity measurements (Note: Do not add pressure measurements)
4. Average velocity
5. Recorded (test) cfm design cfm

b. Individual air terminals

1. Terminal identification supply or exhaust, location and number designation
2. Type size, manufacturer and catalog identification applicable factor for application, velocity, area, etc., and designated area
3. Design and recorded velocities- fpm (state "core," "inlet," etc., as applicable)
4. Design and recorded quantities -cfm deflector vane or diffusion cone settings

3.07 WATER SYSTEM DATA

A. Report: The certified report for each water system shall include the data listed below.

1. Pumps:

a. Installation data

1. Manufacturer and model
2. Size
3. Type drive
4. Motor hp, voltage, phase, and full load amps

b. Design data

1. gpm
2. Head
3. rpm, bhp, and amps

c. Recorded data

1. Discharge pressures (full-flow and no-flow)
2. Suction pressures (full-flow and no-flow) operating head
3. Operating gpm (from pump curves if metering is not provided) no-load amps (where possible)
4. Full-flow amps
5. No-flow amps

2. Air Heating and Cooling Equipment:

a. Design data

1. Load in Btu or MBh
2. gpm

3. Entering and leaving water temperature
4. Entering and leaving air conditions (DB and WB)

b. Recorded data

1. Type of equipment and identification (location or number designation)
2. Entering and leaving air conditions (DB and WB)
3. Entering and leaving water temperatures

3. Water Chilling Units:

a. Installation data

1. Manufacturer and model
2. Motor hp, voltage, cycles, phase, and full load amps
3. Part load amperes
4. gpm - chiller and condenser
5. Water pressure drop - chiller and condenser
6. Entering and leaving water temperature - chiller and condenser

b. Recorded data (chiller and condenser)

1. gpm
2. Water pressure drop
3. Entering and leaving water temperature
4. Amperes

3.08 FINAL COMMISSIONING TESTS, INSPECTIONS AND ACCEPTANCE

A. Scope: Test shall be made to demonstrate that capacities and performance of air and water systems comply with contract requirements.

1. At the time of final inspection, recheck random selection of data (water and air quantities, air motion, and sound levels) recorded in the balancing report. All laboratories shall be rechecked for satisfactory air flow and motion on vicinity of and through hoods.

2. Points and areas for recheck shall be selected by the Owner's Representative.

3. Measurement and test procedures shall be the same as approved for work forming basis of certified report.

4. Selections for recheck (specific plus random), in general, will not exceed 25 percent of the total number tabulated in the report, except that special air systems may require a complete recheck for safety reasons.

B. Retests: If random tests elicit a measured flow deviation of 10 percent or more from, or a sound level of 2 db or more greater than, that recorded in the report listings, as 10 percent or more of the rechecked selections, the report shall be automatically

rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, new certified reports submitted, and new inspection tests made, all at no additional cost.

C. Marking of Settings: Following final acceptance of balance reports, the settings of all valves, splitters, dampers, and other adjustment devices shall be permanently marked so that adjustment can be restored if disturbed at any time. Devices shall not be marked until after final acceptance.

END OF SECTION

DIVISION 15 - MECHANICAL

SECTION 15995 MECHANICAL SYSTEMS COMMISSIONING

PART 1 – GENERAL

1.01 DESCRIPTION

A. The purpose of this section is to specify Division 15 responsibilities in the commissioning process.

B. The systems to be commissioned are listed in Section 01810 Commissioning.

C. Commissioning requires the participation of Division 15 to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Division 17. Division 15 shall be familiar with all parts of Division 17 and the commissioning plan issued by the CA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.02 RESPONSIBILITIES

A. Mechanical, Controls and TAB Contractors. The commissioning responsibilities applicable to each of the mechanical, controls and TAB contractors of Division 15 are as follows (all references apply to commissioned equipment only):

1. Construction and Acceptance Phases

a. Include and itemize the cost of commissioning in the contract price.

b. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.

c. Attend a commissioning scoping meeting and other meetings necessary to facilitate the Cx process.

d. Contractors shall provide the CA with normal cut sheets and shop drawing submittals of commissioned equipment.

e. Provide additional requested documentation, prior to normal O&M manual submittals, to the CA for development of start-up and functional testing procedures.

1. Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and

checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent.

2. The Commissioning Agent may request further documentation necessary for the commissioning process.

3. This data request may be made prior to normal submittals.

f. Provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the CA for review and approval.

g. Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

h. Provide limited assistance to the CA in preparing the specific functional performance test procedures. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

i. Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the construction checklists from the CA for all commissioned equipment. Submit to CA for review and approval prior to startup. Refer to Section 01810 Commissioning for further details on start-up plan preparation.

j. During the startup and initial checkout process, execute the mechanical-related portions of the construction checklists for all commissioned equipment.

k. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CA.

l. Address current A/E punch list items before functional testing. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.

m. Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

n. Provide skilled technicians to perform functional performance testing under the direction of the CA for specified equipment in Section 01810. Assist the CA in interpreting the monitoring data, as necessary.

o. Correct deficiencies (differences between specified and observed performance) as interpreted by the CA, OR and A/E and retest the equipment.

p. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.

q. During construction, maintain as-built red-line drawings for all drawings and final CAD as-builts for contractor-generated coordination drawings. Update after completion of commissioning (excluding deferred testing).

r. Provide training of the Owner's operating staff using expert qualified personnel, as specified.

s. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

2. Warranty Period

a. Execute seasonal or deferred functional performance testing, witnessed by the CA, according to the specifications.

b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

B. Mechanical Contractor. The responsibilities of the HVAC mechanical contractor, during construction and acceptance phases in addition to those listed in (A) are:

1. Provide startup for all HVAC equipment, except for the building automation control system.

2. Assist and cooperate with the TAB contractor and CA by:

a. Putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.

b. Including cost of sheaves and belts that may be required by TAB.

c. Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Providing an approved plug.

d. Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.

3. Install a P/T plug at each water sensor, which is an input point to the control system.

4. List and clearly identify on the as-built drawings the locations of all airflow stations.

5. Prepare a preliminary schedule for Division 15 pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the CA. Update the schedule as appropriate.

6. Notify the OR or CA depending on protocol, when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify the OR or CA, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the CA has the scheduling information needed to efficiently execute the commissioning process.

C. Temperature Controls Contractor. The commissioning responsibilities of the Temperature Controls Contractor, during construction and acceptance phases in addition to those listed in (A) are:

1. Sequences of Operation Submittals. The Temperature Controls Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:

a. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.

b. All interactions and interlocks with other systems.

c. Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable.

d. Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative).

e. Start-up sequences.

f. Warm-up mode sequences.

g. Normal operating mode sequences.

h. Unoccupied mode sequences.

i. Shutdown sequences.

j. Capacity control sequences and equipment staging.

k. Temperature and pressure control: setbacks, setups, resets, etc.

l. Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.

m. Effects of power or equipment failure with all standby component functions.

n. Sequences for all alarms and emergency shut downs.

o. Seasonal operational differences and recommendations.

p. Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.

q. Schedules, if known.

r. To facilitate referencing in testing procedures, all sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered.

2. Control Drawings Submittal

a. The control drawings shall have a key to all abbreviations.

b. The control drawings shall contain graphic schematic depictions of the systems and each component.

c. The schematics will include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.

d. Provide a full points list with at least the following included for each point:

1. Controlled system
2. Point abbreviation
3. Point description
4. Display unit
5. Control point or setpoint (Yes / No)
6. Monitoring point (Yes / No)
7. Intermediate point (Yes / No)
8. Calculated point (Yes / No)

a. Key:
b. Point Description: DB temp, airflow, etc.
c. Control or Setpoint: Point that control equipment and can have its setpoint changed (OSA, SAT, etc.)

d. Intermediate Point: Point whose value is used to make a calculation which then controls equipment (space temperatures that are averaged to a virtual point to control reset).

e. Monitoring Point: Point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification.

f. Calculated Point: "Virtual" point generated from calculations of other point values.

The Temperature Controls Contractor shall keep the CA informed of all changes to this list during programming and setup.

3. An updated as-built version of the control drawings and sequences of operation shall be included in the final controls O&M manual submittal.

4. Assist and cooperate with the TAB contractor in the following manner:

   a. Meet with the TAB contractor prior to beginning TAB and review the TAB plan to determine the capabilities of the control system toward completing TAB. Provide the TAB any needed unique instruments for setting terminal unit boxes and instruct TAB in their use (handheld control system interface for use around the building during TAB, etc.).

   b. For a given area, have all required construction checklists, calibrations, startup and selected functional tests of the system completed and approved by the CA prior to TAB.

   c. Provide a qualified technician to operate the controls to assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.

5. Assist and cooperate with the CA in the following manner:

   a. Using a skilled technician who is familiar with this building, execute the functional testing of the controls system. Assist in the functional testing of all equipment. Provide two-way radios during the testing.

   b. Execute all control system trend logs.

6. The Temperature Controls Contractor shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the control system prior to functional performance testing, according to the process in Section 01810 Commissioning. At minimum, the plan shall include for each type of equipment controlled by the automatic controls:

   a. System name.

b. List of devices.

c. Step-by-step procedures for testing each controller after installation, including:

1. Process of verifying proper hardware and wiring installation.

2. Process of downloading programs to local controllers and verifying that they are addressed correctly.

3. Process of performing operational checks of each controlled component.

4. Plan and process for calibrating valve and damper actuators and all sensors.

5. A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.

d. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has "passed" and is operating within the contract parameters.

e. A description of the instrumentation required for testing.

f. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the CA and TAB contractor for this determination.

7. Provide a signed and dated certification to the CA and OR upon completion of the checkout of each controlled device, equipment and system prior to functional testing for each piece of equipment or system, that all system programming is complete as to all respects of the Contract Documents, except functional testing requirements.

8. Beyond the control points necessary to execute all documented control sequences, provide monitoring, control and virtual points as specified in Section 15950.

9. List and clearly identify on the as-built duct and piping drawings the locations of all static and differential pressure sensors (air, water and building pressure).

D. TAB Contractor. The duties of the TAB contractor, in addition to those listed in (A) are:

1. Six weeks prior to starting TAB, submit to the OR the qualifications of the site technician for the project, including the name of the contractors and facility managers of recent projects the technician on which was lead. The Owner will approve the site technician's qualifications for this project.

2. Submit the outline of the TAB plan and approach for each system and component to the CA, OR and the Temperature Controls Contractor six weeks prior to starting the TAB. This plan will be developed after the TAB has some familiarity with the control system.

3. The submitted plan will include:

   a. Certification that the TAB contractor has reviewed the construction documents and the systems with the design engineers and contractors to sufficiently understand the design intent for each system.

   b. An explanation of the intended use of the building control system. The Temperature Controls Contractor will comment on feasibility of the plan.

   c. All field checkout sheets and logs to be used that list each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.

   d. Discussion of what notations and markings will be made on the duct and piping drawings during the process.

   e. Final test report forms to be used.

   f. Detailed step-by-step procedures for TAB work for each system and issue: terminal flow calibration (for each terminal type), diffuser proportioning, branch / submain proportioning, total flow calculations, rechecking, diversity issues, expected problems and solutions, etc. Criteria for using air flow straighteners or relocating flow stations and sensors will be discussed. Provide the analogous explanations for the water side.

   g. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.

   h. Details of how *total* flow will be determined (Air: sum of terminal flows via BAS calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations. Water: pump curves, circuit setter, flow station, ultrasonic, etc.).

   i. The identification and types of measurement instruments to be used and their most recent calibration date.

   j. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and provide methods to verify this.

   k. Confirmation that TAB understands the outside air ventilation criteria under all conditions.

l. Details of whether and how minimum outside air cfm will be verified and set, and for what level (total building, zone, etc.).

m. Details of how building static and exhaust fan / relief damper capacity will be checked.

n. Proposed selection points for sound measurements and sound measurement methods.

o. Details of methods for making any specified coil or other system plant capacity measurements.

p. Details of any TAB work to be done in phases (by floor, etc.), or of areas to be built out later.

q. Details regarding specified deferred or seasonal TAB work.

r. Details of any specified false loading of systems to complete TAB work.

s. Details of all exhaust fan balancing and capacity verifications, including any required room pressure differentials.

t. Details of any required interstitial cavity differential pressure measurements and calculations.

u. Plan for hand-written field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).

v. Plan for formal progress reports (scope and frequency).

w. Plan for formal deficiency reports (scope, frequency and distribution).

4. A running log of events and issues shall be kept by the TAB field technicians. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the CA and OR at least twice a week.

5. Communicate in writing to the Temperature Controls Contractor all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.

6. Provide a draft TAB report within two weeks of completion. A copy will be provided to the CA. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. The report should follow the latest and most rigorous reporting recommendations by AABC, NEBB or ASHRAE Standard 111.

7. Provide the CA with any requested data, gathered, but not shown on the draft reports.

8. Provide a final TAB report for the CA with details, as in the draft.

9. Conduct functional performance tests and checks on the original TAB.

E. Mechanical Designer. Refer to Section 01810 Commissioning for the (reference only) responsibilities of the mechanical designer.

1.03 RELATED WORK

A. Refer to Section 01810 Commissioning, for a listing of all sections where commissioning requirements are found.

B. Refer to Section 01810 Commissioning for systems to be commissioned and Section 01810 Commissioning.

PART 2 - PRODUCTS

2.01 TEST EQUIPMENT

A. Division 15 shall provide all test equipment necessary to fulfill the testing requirements of this Division.

B. Refer to Section 01810 Commissioning for additional Division 15 requirements.

PART 3 - EXECUTION

3.01 SUBMITTALS

A. Division 15 shall provide submittal documentation relative to commissioning as required in this Section Part 1, Section 01300 and Section 01810 Commissioning.

3.02 STARTUP

A. The HVAC mechanical and Temperature Controls Contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 17100. Division 15 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning agent or Owner.

B. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CA and OR. Beginning system testing before full completion, does not relieve the Contractor from fully completing the system, including all construction checklists as soon as possible.

3.03 TAB

A. Refer to the TAB responsibilities in Part 1.2 above.

3.04 FUNCTIONAL PERFORMANCE TESTS

A. Refer to Section 01810 Commissioning for a list of systems to be commissioned and for a description of the process.

3.05 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

A. Refer to Section 01810 Commissioning for specific details on non-conformance issues relating to construction checklists and tests.

B. Refer to Section 01810 Commissioning for issues relating to functional performance tests.

3.06 OPERATION AND MAINTENANCE (O&M) MANUALS

A. The following O&M manual requirements do not replace O&M manual ` documentation requirements elsewhere in these specifications.

B. Division 15 shall compile and prepare documentation for all equipment and systems covered in Division 15 and deliver this documentation to the GC for inclusion in the O&M manuals, according to this section and Section 01730, prior to the training of owner personnel.

C. The CA shall receive a copy of the O&M manuals for review.

D. Special Control System O&M Manual Requirements. In addition to documentation that may be specified elsewhere, the Temperature Controls Contractor shall compile and organize at minimum the following data on the control system in labeled 3-ring binders with indexed tabs.

1. Four copies of the controls training manuals in a separate manual from the O&M manuals.

2. Operation and Maintenance Manuals containing:

a. Specific instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. These instructions shall be step-by-step. Indexes and clear tables of contents shall be included. The detailed technical manual for programming and customizing control loops and algorithms shall be included.

b. Full as-built set of control drawings (refer to Submittal section above for details).

c. Full as-built sequence of operations for each piece of equipment.

d. Full points list. In addition to the updated points list required in the original submittals (Part 1 of this section), a listing of all rooms shall be provided with the following information for each room:

1. Floor
2. Room number
3. Room name
4. Air handler unit ID
5. Reference drawing number
6. Air terminal unit tag ID

7. Heating and/or cooling valve tag ID
8. Minimum cfm
9. Maximum cfm

e. Full print out of all schedules and set points after testing and acceptance of the system.

f. Full as-built print out of software program.

g. Electronic copy on disk of the entire program for this facility.

h. Marking of all system sensors and thermostats on the as-built floor plan and mechanical drawings with their control system designations.

i. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.

j. Control equipment component submittals, parts lists, etc.

k. Warranty requirements.

l. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).

3. The manual shall be organized and subdivided with permanently labeled tabs for each of the following data in the given order:
   a. Sequences of operation
   b. Control drawings
   c. Points lists
   d. Controller / module data
   e. Thermostats and timers
   f. Sensors and DP switches
   g. Valves and valve actuators
   h. Dampers and damper actuators
   i. Program setups (software program printouts)

4. Field checkout sheets and trend logs should be provided to the CA for inclusion in the Commissioning Record Book.

E. Special TAB Documentation Requirements. The TAB will compile and submit the following with other documentation that may be specified elsewhere in the *Specifications.*

1. Final report containing an explanation of the methodology, assumptions, test conditions and the results in a clear format with designations of all uncommon abbreviations and column headings.

2. The TAB shall mark on the drawings where all traverse and other critical measurements were taken and cross reference the location in the TAB report.

F. Review and Approvals. Review of the commissioning related sections of the O&M manuals shall be made by the A/E and by the CA. Refer to Section 01810 Commissioning, Part 3.8 for details.

3.07 TRAINING OF OWNER PERSONNEL

A. The GC shall be responsible for training coordination and scheduling and ultimately to ensure that training is completed. Refer to Section 01810 Commissioning for additional details.

B. The CA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 01810 Commissioning for additional details.

C. Mechanical Contractor. The mechanical contractor shall have the following training responsibilities:

1. Provide the CA with a training plan two weeks before the planned training according to the outline described in Section 01810 Commissioning.

2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC equipment including, but not limited to, pumps, boilers, furnaces, chillers, heat rejection equipment, air conditioning units, air handling units, fans, terminal units, controls and water treatment systems, etc.

3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.

4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor or manufacturer’s representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment are required. More than one party may be required to execute the training.

6. The Temperature Controls Contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

7. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.

8. Training shall include:

a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.

b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.

c. Discussion of relevant health and safety issues and concerns.

d. Discussion of warranties and guarantees.

e. Common troubleshooting problems and solutions.

f. Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.

g. Discussion of any peculiarities of equipment installation or operation.

h. The format and training agenda in *The HVAC Commissioning Process, ASHRAE Guideline 1-1989R*, 1996 is recommended.

i. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.

9. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.

10. The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not *controlled* by the central control system.

11. Training shall occur after functional testing is complete, unless approved otherwise by the Project Manager.

12. Duration of Training. The mechanical contractor shall provide training on each piece of equipment according to the following schedule.

Hours	System
8	Chillers and System
8	Boilers and System
3	Piping Systems
4	Chemical Treatment
12	Air Handler Units
1	Spot Unit Heaters
2	Air Terminal Units
1	Central Exhaust Systems
2	Supplementary Fans
2	Pumps
16	Controls System
16	Control system Follow-up
4	Humidifiers
4	Water Heaters

D. Temperature Controls Contractor. The Temperature Controls Contractor shall have the following training responsibilities:

1. Provide the CA with a training plan four weeks before the planned training according to the outline described in Section 01810 Commissioning, Part 3.9.

2. The Temperature Controls Contractor shall provide designated Owner personnel training on the control system in this facility. The intent is to clearly and completely instruct the Owner on all the capabilities of the control system.

3. Training manuals. The standard operating manual for the system and any special training manuals will be provided for each trainee, with three extra copies left for the O&M manuals. In addition, copies of the system technical manual will be demonstrated during training and three copies submitted with the O&M manuals. Manuals shall include detailed description of the subject matter for each session. The manuals will cover all control sequences and have a definitions section that fully describes all relevant words used in the manuals *and* in all software displays. Manuals will be approved by the CA. Copies of audiovisuals shall be delivered to the Owner.

4. The trainings will be tailored to the needs and skill-level of the trainees.

5. The trainers will be knowledgeable on the system and its use in buildings. For the on-site sessions, the most qualified trainer(s) will be used. The Owner shall approve the instructor prior to scheduling the training.

6. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

7. The Temperature Controls Contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

8. There shall be three training sessions:

    1. Training I. Control System. This training may be held on-site or in the supplier's facility. If held off-site, the training may occur prior to final completion of the system installation. Upon completion, each student, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
    2. Training II. Building Systems. The second session shall be held on-site and will consist of actual hands-on training after the completion of system

commissioning. The session shall include instruction on:

a. Specific hardware configuration of installed systems in this building and specific instruction for operating the installed system, including HVAC systems, lighting controls and any interface with security and communication systems.

b. Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing set points and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.

c. All trending and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends. Trainees will actually set-up trends in the presence of the trainer.

d. Every screen shall be completely discussed, allowing time for questions.

e. Use of keypad or plug-in laptop computer at the zone level.

f. Use of remote access to the system via phone lines or networks.

1. Setting up and changing an air terminal unit controller.
2. Graphics generation
3. Point database entry and modifications
4. Understanding DDC field panel operating programming (when applicable)

3. Training III. The third training (Follow-up Training) will be conducted on-site six months after occupancy. The session will be structured to address specific topics that trainees need to discuss and to answer questions concerning operation of the system.

E. TAB The TAB contractor shall have the following training responsibilities:

1. TAB shall meet for 2 hours with facility staff after completion of TAB and instruct them on the following:

a. Go over the final TAB report, explaining the layout and meanings of each data type.

b. cuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.

c. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.

d. Discuss any temporary settings and steps to finalize them for any areas that are not finished.

e. Other salient information that may be useful for facility operations, relative to TAB.

3.08 DEFERRED TESTING

A. Refer to Section 01810 Commissioning, Part 3.10 for requirements of deferred testing.

3.09 WRITTEN WORK PRODUCTS

A. Written work products of Contractors will consist of the start-up and initial checkout plan described in Section 01810 Commissioning and the filled out start-up, initial checkout and construction checklists.

END OF SECTION

DIVISION 15 - MECHANICAL

SECTION 15997 MECHANICAL TESTING REQUIREMENTS

PART 1 – GENERAL

1.01 INCLUDED SYSTEMS AND EQUIPMENT

A. The following is a partial list of the equipment and system test requirements included in this section:

1 Air handler systems
2. Building management control system & energy management
3. Hydronic piping and HVAC Pumps
4. Exhaust fans
5. Indoor air climate control--misc. systems
6. Indoor air quality (IAQ)
7. Terminal unit
8. Test and balance (TAB) work
9. Air Conditioning Equipment

1.02 DESCRIPTION

A. This section specifies the functional testing requirements for Division 15 systems and equipment. From these requirements, the Commissioning Authority (CA) shall develop step-by-step procedures to be executed by the Subs or the Commissioning Authority. The general functional testing process, requirements and test method definitions are described in Section 01810 Commissioning. The test requirements for each piece of equipment or system contain the following:

1. The contractors responsible to execute the tests, under the direction of the CA.
2. A list of the integral components being tested.
3. Construction checklists associated with the components.
4. Functions and modes to be tested.
5. Required conditions of the test for each mode.
6. Special procedures.
7. Required methods of testing.
8. Required monitoring.
9. Acceptance criteria.
10. Sampling strategies allowed.

1.03 PREREQUISITES

A. The following applicable generic prerequisite checklist items are required to be listed on each written functional test form and be completed and checked off by CA prior to functional testing.

B. All related equipment has been started up and start-up reports and construction checklists submitted and approved ready for functional testing.

C. All control system functions for this and all interlocking systems are programmed and operable per contract documents,

including final set points and schedules with debugging, loop tuning and sensor calibrations completed.

1. Piping system flushing complete and required report approved.
2. Water treatment system complete and operational.
3. Vibration control report approved (if required).
4. Test and balance (TAB) complete and approved for the hydronic system.
5. All A/E punch list items for this equipment corrected. These functional test procedures reviewed and approved by installing contractor.
6. Safeties and operating ranges reviewed by the CA.
7. Test requirements and sequences of operation attached.
8. Schedules and set points attached.
9. False loading equipment, system and procedures ready.
10. Sufficient clearance around equipment for servicing.
11. Record of all values for pre-test set points changed to accommodate testing has been made and a check box provided to verify return to original values (control parameters, limits, delays, lockouts, schedules, etc.).
12. Other miscellaneous checks of the pre-functional checklist and start-up reports completed successfully.

1.04 MONITORING

A. Monitoring is a method of testing as a stand-alone method or to augment manual testing.

B. All points listed in the required monitoring section of the test requirements which are control system monitored points shall be trended by the Temperature Controls Contractor. Other points shall be monitored by the CA using data loggers. At the option of the CA, some control system monitoring may be replaced with data logger monitoring. At the CA's request, the Temperature Controls Contractor shall trend up to 20% more points than listed herein at no extra charge.

C. Hard copies of monitored data must be in columnar format with time down the left column and at least 5 columns of point values on the same page.

D. Graphical output is desirable, and will be required for all output, if the system can produce it.

PART 2 - PRODUCTS

(NOT APPLICABLE)

PART 3 - EXECUTION

The following Sample test procedures are representative of the level of detail required for this project. The Owner reserves the right to work with the Contractor to amend these data sheets as necessary at no extra cost to the Owner.

3.01 AIR HANDLER UNITS (AHU / RTU)

A. Parties Responsible to Execute Functional Test

1. Temperature Controls Contractor: operate the controls to activate the equipment as needed.

2. CA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested
Construction Checklist ID PC-_____
PC-_____

1. AHU/RTU and components (fans, coils, valves, ducts, VFD)
2. Heat recovery coil, humidifier or evaporative cooling sections.

C. Prerequisites The applicable prerequisite checklist items listed in the beginning of Section 15997 shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the construction checklists previously completed by the installer, before the beginning of functional testing.

D. Functions/Modes Required To Be Tested, Test Methods and Seasonal Test Requirements

The following testing requirements are an addition to and do not replace any testing requirements elsewhere in this Division.

Function / Mode	Test Method Manual, Monitoring, Either or Both[3]	Required Seasonal Test[1]
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks with which it is associated.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Mixed & supply air, & reset temperature control functions.	Both	
3. Economizer functions.	Both	Cooling
4. SF, and exhaust fan interlocks.	Either	
5. No CCV flow when there is HCV flow.	Both	
6. CCV & HCV modulation & positive shutoff (no leak-thru).	Manual	
7. Duct static pressure (SP) control.	Both	
8. Exhaust fan tracking and building SP.	Monitoring	

	Function / Mode	Test Method Manual, Monitoring, Either or Both[3]	Required Seasonal Test[1]
9.	VFD (or inlet vanes) operation on SF and RF: modulation to minimum, control system PID, proportional band of speed vs controlling parameter, constancy of static pressure, verification of program settings, alarms, etc.	Both	[2]
10.	Damper interlocks and correct modulation in all modes, including smoke and fire dampers.	Manual	
11.	Temperature difference across HC & CC per specifications.	Manual	
12.	Verification of minimum OSA control through varying VAV box positions.	Either	[2]
13.	Heating and cooling coils freeze protection.	Manual	[2]
14.	Branch duct control damper control.	Manual	
15.	Night low limit, morning warm-up cycle.	Either	
16.	Heat recovery operation.	Monitoring	
17.	Verify TAB reported SF cfm with control system reading.	Manual	[2]
18.	All alarms (low limits, high static, etc.).	Manual	
19.	Heating and cooling coil capacity test, optional.	Manual	Design
20.	Sensor and actuator calibration checks: on duct static pressure sensor on SAT, MAT, OSAT, OSA & RA damper and valve positions, SF cfm reading with TAB, and other random checks (EMS readout against hand-held calibrated instrument or observation must be within specified tolerances)	Manual	
21.	Verify schedules and setpoints to be reasonable and appropriate		

[1]Cooling season, Heating season or Both. "Design" means within 5°of season design (ASHRAE 2 1/2%), or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.

[2]Seasonal test not required if seasonal conditions can be adequately simulated.

[3]Refer to Special Procedures

E. Special Procedures (other equipment to test with, etc.; reference to function ID)

1. Reduced Testing for Smaller Units. For standard application AHU's less than 15 tons, the following modifications to the testing requirements apply: 1) either Manual or Monitoring will satisfy the verification

requirement--where both is listed, choose one. 2) Testing Modes 6, 8, 11, 13 and 16 is not required.

F. Required Monitoring

1. All points listed below which are control system monitored points shall be trended by the Temperature Controls Contractor. Other points shall be monitored by the CA using data loggers. Refer to the Monitoring section at the beginning of Section 15997 for additional monitoring details.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
For each AHU being tested:					
RAT	5	5 days incl. weekend	Y	Y	1-3, 5
SAT	5	5 days incl. weekend	Y	Y	1-3, 5
CC LAT (optional)	5	5 days incl. weekend	Y	Y	1-3, 5
HC LAT (optional)	5	5 days incl. weekend	Y	Y	1-3, 5
MAT	5	5 days incl. weekend	Y	Y	1, 3
Indoor WB or enthalpy, if enthalpy economizer	5	5 days incl. weekend	Y	Y	1, 3
SF speed, if variable, else status	5	5 days incl. weekend	Y	Y	1, 5-9
RF speed, if variable, else status	5	5 days incl. weekend	Y	Y	1, 5-9
Duct SP	5	5 days incl. weekend	Y	Y	1, 7, 9
Building SP differential	5	5 days incl. weekend	Y	Y	8
OSAT	5	5 days incl. weekend	Y	Y	All
OSA-WB or enthalpy, if enthalpy economizer	5	5 days incl. weekend	Y	Y	1, 3
Indoor dry-bulb zones (expected to be most problematic)	5	5 days incl. weekend	Y	Y	All

Remarks:

CCV position (optional)
HCV position (optional)
SF cfm not required if not monitored
RF cfm not required if not monitored

G. Acceptance Criteria (referenced by function or mode ID)

1. 1-21. For the conditions, sequences and modes tested, the AHU/RTU, integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

2. AHU/RTU with supporting systems shall be able to maintain the SA temperature within 1.0F either side of the deadband of the current setpoint without excessive hunting.

3. AHU/RTU and controls shall control the duct static pressure so that it does not drift more than an amount equal to 10% of the setpoint value either side of the deadband without excessive hunting.

H. Sampling Strategy for Identical Units

1. All identical AHU's/RTU's over 15 tons shall not have any sampling--test all units. However, 25% of the units may have monitoring be the verification method for modes listed with Monitoring or Both as testing methods, with no less than three units being fully tested per the above requirements.

2. All identical AHU's/RTU's equal to or less than 15 tons shall be sampled: Randomly test at least 50% of each group of identical equipment (the 1st sample) per the above tests. In no case test less than three units in each group. If 20% of the units in the first sample fail the functional performance tests, test another the remaining 50%, fully at the contractor's expense. This sampling applies to the testing subsections. That is, if calibration is off on more than 10% of the tested piece of equipment, then another sample shall have calibrations checked, but not all other tests need to be done on the second sample.

3. All units not included in the sampling testing and monitoring shall be fully monitored for the monitoring modes listed above in the monitoring section.

3.02 BOILER SYSTEM (HEATING WATER)

A. Parties Responsible to Execute Functional Test

1. Temperature Controls Contractor: operate the controls, as needed.

2. HVAC mechanical contractor or vendor: assist in testing sequences.

3. CA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested

		Construction Checklist ID
1.	Boiler	PC-____
2.	Primary HW supply pumps	PC-____
3.	Heating water piping system	PC-____
4.	Secondary HW supply pumps	PC-____
5.	VFD on secondary pumps	PC-____

C. Prerequisites The applicable prerequisite checklist items listed in the beginning of Section 15997 shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the construction checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements
The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this Division.

Function / Mode	Test Method Manual, Monitoring, Either or Both	Required Seasonal Test[1]
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unnoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks that it is associated with.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Primary Side. Lead/lag staging of boilers, optimization, capacity modulation, and primary HW supply pumps.	Both	Heating
3. Secondary Side. Secondary WH supply pump staging, bypass valve operation, if no VFD and HWT reset. VFD operation: modulation to minimum, control system PID, proportional band of speed vs controlling parameter, verification of program settings,, alarms, etc.	Both	Heating
4. Check all alarms and safeties (high and low pressure and temperature, etc.), PRV and flow switch functions	Manual	
5. Test each possible lead boiler as lead boiler, and each pump as lead pump. Test pump lockouts.	Manual	
6. Flue gas analysis verification, optional	Manual	
7. Efficiency and capacity tests, optional	Manual	Heating

Function / Mode	Test Method Manual, Monitoring, Either or Both	Required Seasonal Test[1]
8. Verify boiler inlet/outlet pressures with startup report and manufacturer's recommendations	Manual	
9. Sensor and actuator calibration checks on: HWST, HWRT, pressure sensor controlling pump speed, mixing valve and other random checks (EMS readout against hand-held calibrated instrument must be within 0.5°F for temps. or within a tolerance equal to 10% of the pressure setpoint, with a test gage)	Manual	
10. Constancy of differential pressure (pump control parameter)	Monitoring	Heating
11. Verify schedules and setpoints to be reasonable and appropriate		

[1]Cooling season, Heating season or Both. "Design" means within 5°of season design (ASHRAE 2 1/2%), or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.

E. Special Procedures (other equipment to test with, etc.; reference to function ID)

1. False load boiler, if necessary.

F. Required Monitoring

1. All points listed below which are control system monitored points shall be trended by the Temperature Controls Contractor. Other points shall be monitored by the CA using data loggers. Refer to the Monitoring section at the beginning of Section 15997 for additional monitoring details.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
For each boiler and pump:					
Boiler current or status	5	5 days incl. weekend	Y	Y	1-3
HWST	5	5 days incl. weekend	Y	Y	1, 3
HWRT	5	5 days incl. weekend	Y	Y	1, 3
OSAT-DB	5	5 days incl. weekend	Y	Y	1-3
HWS primary pump current or status	5	5 days incl. weekend	Y	Y	1, 2

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
HWS secondary pump speed, if variable	5	5 days incl. weekend	Y	Y	1, 3
HWS secondary pump flow rate, if in EMS	5	5 days incl. weekend	Y	Y	1, 3
HWS secondary pump speed controlling parameter value	5	5 days incl. weekend	Y	Y	1, 3, 10

Remarks:

G. Acceptance Criteria (referenced by function or mode ID)

1. 1-11. For the conditions, sequences and modes tested, the boilers, integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

2. Boiler shall maintain the supply water set point to within +/- 1.0F of set point dead band without excessive hunting.

3. 9.-10. Pumping system and controls shall maintain the current desired pressure set point to within an amount equal to 10% of the set point value either side of the dead band without excessive hunting.

H. Sampling Strategy for Identical Units

1. No sampling, test all.

3.03 BUILDING AUTOMATION SYSTEM (BAS)

A. Parties Responsible to Execute Functional Test

1. Temperature Controls Contractor: operate the controls to activate the equipment.

2. CA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested

	Construction Checklist ID
1. Building Automation System	PC-_____

2. All construction checklists of controlled equipment

C. Prerequisites The applicable prerequisite checklist items listed in the beginning of Section 15997 shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the construction checklists previously completed

by the installer, before the beginning of functional testing.

D. A significant part of the BAS functional testing requirements is the successful completion of the functional tests of equipment the BAS controls or interlocks with. Uncompleted equipment functional tests or outstanding deficiencies in those tests lend the required BAS functional testing incomplete.

E. Integral or stand-alone controls are functionally tested with the equipment they are attached to, including any interlocks with other equipment or systems and thus are not covered under the BAS testing requirements, except for any integrated functions or interlocks listed below.

F. In addition to the controlled equipment testing, the following tests are required for the BAS, where features have been specified. The following testing requirements are in addition to and do not replace any testing requirements elsewhere in the specifications.

Function / Mode	Test Method Manual (demonstration), Monitoring, Either or Both
MISC. FUNCTIONS	
1. All specified functions and features are set up, debugged and fully operable	Verbal discussion of features
2. Power failure and battery backup and power-up restart functions	Demonstration
3. Specified trending and graphing features demonstration	See equipment trends
4. Global commands features	Demonstration
5. Security and access codes	Demonstration
6. Occupant over-rides (manual, telephone, key, keypad, etc.)	Demonstration
7. O&M schedules and alarms	Demonstration
8. Scheduling features fully functional and setup, including holidays	Observation in terminal screens or printouts
9. Date and time setting in central computer and verify field panels read the same time	Demonstration
10. Included features not specified to be setup are installed (list)	Demonstration
11. Occupancy sensors and controls	Demonstration
12. Demonstrate functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad	Demonstration of 100% of panels and 10% of ports
13. All graphic screens and value readouts completed	Demonstration
14. Setpoint changing features and functions	Done during equipment testing
15. Communications to remote sites	Demonstration
16. Sensor calibrations	Sampled during equipment tests
17. “After hours” use tracking and billing	

Function / Mode	Test Method Manual (demonstration), Monitoring, Either or Both
18. Final as-builts or redlines (per spec) control drawings, final points list, program code, setpoints, schedules, warranties, etc. per specs, submitted for O&Ms.	Observation
19. Verify that points that are monitored only, having no control function, are checked for proper reporting to BAS.	Observation
INTEGRATED TESTS	
20. Fire alarm interlocks and response	Demonstration
21. Duty cycling (if specified)	Monitoring
22. Demand limiting (including over-ride of limiting)	Monitoring
23. Sequential staging ON of equipment	Either
24. Optimum start-stop functions	Monitoring
25. All control strategies and sequences not tested during controlled equipment testing	Either
26. Other integrated tests specified in the contract documents	
27. Security system interlocks	Demonstration
28. Fire protection and suppression systems	Demonstration

G. Special Procedures (other equipment to test with, etc.; reference to function ID) None

H. Additional Required Monitoring

1. Besides the trending and monitoring required with the functional testing of equipment, all points listed below which are control system monitored points shall be trended by the Temperature Controls Contractor. Other points shall be monitored by the CA using data loggers. Refer to the Monitoring section at the beginning of Section 15997 for additional monitoring details.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
Misc. equipment current or status for duty cycling and demand limiting	5	5 days incl. weekend	Y	Y	21-22

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
Equipment or building kW or current for demand limiting	5	5 days incl. weekend	Y	Y	21-22
Optimum start/stop equip.	5	5 days incl. weekend	Y	Y	24

Remarks:

I. Acceptance Criteria (referenced by function or mode ID)

1. All For the conditions, sequences and modes tested, the BAS, integral components and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

J. Sampling Strategy for Identical Units

1. Sample 10% of the field panels for procedure 9, and 10% of the local ports for procedure 12. If 10% fail, test another 10%. If 10% of those fail, test all remaining units at the contractor's expense.

3.04 EXHAUST FANS

A. The testing requirements apply to the following fans (check all that apply): central restroom, mechanical room.

B. Parties Responsible to Execute Functional Test

1. Temperature Controls Contractor: operate the controls to activate the equipment, if BAS controlled.

2. CA: to witness, direct and document testing.

C. Integral Components or Related Equipment Being Tested

	Construction Checklist ID
1. Exhaust fans	PC-_____

D. Prerequisites The applicable prerequisite checklist items listed in the beginning of Section 15997 shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the construction checklists previously completed by the installer, before the beginning of functional testing.

E. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements
The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this Division.

Function / Mode	Test Method Manual, Monitoring, Either or Both[1]	Required Seasonal Test
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unnoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks that it is associated with.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Verify schedules and setpoints to be reasonable and appropriate		
3. Function at fire alarm (off, depressurization, etc.)	Manual	
4. Interlocks to building pressurization control	Manual	
5. Speed controls	Either	
6. Check TAB report record of sound power level tests and space pressures and compare to specifications	Review	
7. Sensor calibration checks on any controlling temperature or pressure sensor	Manual	

[1]Refer to Special Procedures

F. Special Procedures (other equipment to test with, etc.; reference to function ID)None

G. Required Monitoring

1. All points listed below which are control system monitored points shall be trended by the Temperature Controls Contractor. Other points shall be monitored by the CA using dataloggers. Refer to the Monitoring section at the beginning of Section 15997 for additional monitoring details.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
For each fan:					
Do be determined					

Remarks:

H. Acceptance Criteria (referenced by function or mode ID)

1. 1-6. For the conditions, sequences and modes tested, the fans, integral components and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

I. Sampling Strategy for Identical Units of the same type and function, but different in size, are considered identical for sampling purposes.

1. Randomly test at least 10% of each group of identical equipment (the 1st sample). In no case test less than three units in each group. If 10% of the units in the first sample fail the functional performance tests, test another 10% of the group (the 2nd sample). If 10% of the units in the 2nd sample fail, test all remaining units in the whole group, fully at the contractor's expense. This sampling applies to the testing subsections. That is, if calibration is off on more than 10% of the tested piece of equipment, then another sample shall have calibrations checked, but not all other tests need to be done on the second sample.

3.05 INDOOR AIR CLIMATE CONTROL--MISC. SYSTEMS

A. At least 10% of all space zones shall be verified to be maintaining proper climate control. Specific test requirements for this may have been identified elsewhere in this specification (e.g., under terminal units). For all areas not specifically specified, otherwise, the following tests shall be conducted.

B. Parties Responsible to Execute Functional Test

1. Temperature Controls Contractor: operate the controls and provide trend logs

2. CA: to witness, direct and document testing.

C. Integral Components or Related Equipment Being Tested

1. Cooling plant (entire system)
2. Heating plant (entire system)
3. Air, water distribution system
4. Control system

D. Prerequisites All listed systems in Part B, above, shall have had successful functional tests completed prior to this test.

E. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements
This is a performance test to verify that the HVAC systems can provide and maintain the temperature and relative humidity levels specified, during normal and extreme weather and occupancy conditions. The test consists of monitoring, via trend logs, of various points during the cooling season when temperatures reach to within 5°F of season design (ASHRAE 2 1/2%).

F. Special Procedures (other equipment to test with, etc.; reference to function ID)

1. Building should be normally occupied during the test.

G. Required Monitoring

1. All points listed below which are control system monitored points shall be trended by the Temperature Controls Contractor. Refer to the Monitoring section at the beginning of Section 15997 for additional monitoring details.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
Space temperature control:					
Space temperature	5	5 days incl. weekend	Y	Y	1-3
OSAT-DB	5	5 days incl. weekend	Y	Y	1-3

Remarks:

H. Acceptance Criteria (referenced by function or mode ID)

1. Space temperature during occupied modes shall average within +/- 1°F of set point and always remain within 1°F of the ends of the dead band without excessive hunting of either the applicable damper or coil valve, or complaints of drafts or stuffiness from occupants.

I. Sampling Strategy for Identical Units of the same type and function, but different in size, are considered identical for sampling purposes.

1. Randomly test at least 10% of each group of identical equipment (the 1st sample). In no case test less than three units in each group. If 10% of the units in the first sample fail the functional performance tests, test another 10% of the group (the 2nd sample). If 10% of the units in the 2nd sample fail, test all remaining units in the whole group, fully at the contractor's expense. This sampling applies to the testing subsections. That is, if calibration is off on more than 10% of the tested piece of equipment, then another sample shall have calibrations checked, but not all other tests need to be done on the second sample.

3.06 SERVICE HOT WATER SYSTEM

A. Parties Responsible to Execute Functional Test

1. CA: perform and document testing.

B. Integral Components or Related Equipment Being Tested
Construction Checklist ID

1. Hot water heaters (heaters, mixing valves) PC-_____

2. Recirculating pumps PC-_____

C. Prerequisites The applicable prerequisite checklist items listed in the beginning of Section 15997 shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the construction checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements
The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this Division.

Function / Mode	Test Method Manual, Monitoring, Either or Both	Required Seasonal Test
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, shutdown, unnoccupied & manual modes and power failure. Test functionality of this piece of equipment or system in all control strategies or interlocks that it is associated with.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Verify schedules and setpoints to be reasonable and appropriate		
3. Unoccupied pump operation	Either	
4. Mixing valve operation and temperature control	Either	
5. Sensor calibration checks on hot water temperature	Manual	

E. Special Procedures (other equipment to test with, etc.; reference to function ID) None

F. Required Monitoring None

G. Acceptance Criteria (referenced by function or mode ID)

1. 1-6. For the conditions, sequences and modes tested, the fan's integral components and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

H. Sampling Strategy for Identical Units

1. No sampling. Test all units.

3.07 TERMINAL UNITS

(This applies to standard applications, critical applications will have additional tests and a higher fraction tested.)

A. Parties Responsible to Execute Functional Test

1. Temperature Controls Contractor: operate the controls to activate the equipment.

B. Integral Components or Related Equipment Being Tested

	Construction Checklist ID
1. Terminal unit (TU)	PC-_____

C. Prerequisites The applicable prerequisite checklist items listed in the beginning of Section 15997 shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the construction checklists previously completed by the installer, before the beginning of functional testing.

D. Functions / Modes Required To Be Tested, Test Methods and Seasonal Test Requirements
The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this Division.

Function / Mode	Test Method Manual, Monitoring, Either or Both[3]	Required Seasonal Test[1]
General 1. Test each sequence in the sequence of operations, and other significant modes and sequences not mentioned; including startup, warmup, shutdown, unnoccupied & manual modes and power failure and restoration. Test functionality of this piece of equipment or system in all control strategies or interlocks that it is associated with, including all damper, valve and fan functions.	Manual	
In addition to, or as part of (1) above, the following modes or tests are required:		
2. Sensor activator calibration checks on: SAT, MAT, zone air temperature damper position and other random checks (EMS readout against visual or hand-held calibrated instrument must be within 0.5°F for temps. or within a tolerance equal to 10% of static pressure setpoint, with an inclined manometer)	Manual	
3. Device and actuator calibration and stroke checks for heating coil valve and non-DDC dampers	Manual	

Function / Mode	Test Method Manual, Monitoring, Either or Both[3]	Required Seasonal Test[1]
4. For the TU's tested, check the construction checklist items.	Observation	
5. Verify control parameters and setpoints to be reasonable and appropriate by reviewing the full program of 5% of all the TU's with each other for consistency. Verify the max. and min. cfm setpoints of all tested TU's against the control drawing and TAB values. Verify other TU programming parameters such as K-factors, deadbands, setpoints, stroke times, etc.	Observation	
6. Verify no CCV flow when there is HCV flow	Either	
7. Verify no hunting or significant overshoot by damper or valves.	Either	
8. Verify by measurement, CCV & HCV positive shutoff (no leak-thru)	Manual	
9. Verification of minimum OSA control through varying VAV box positions, if applicable	Either	[2]
10. All alarms (fan status, low limits, high static, etc.)	Manual	
11. Verify that TU is maintaining space setpoint temperatures	Monitoring	Both Design
12. Verify airflows and pressures (this random test is part of the TAB test)	--	

NOTES:

[1]Cooling season, Heating season or Both. "Design" means within 5°F of season design (ASHRAE 2 1/2%), or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.

[2]Seasonal test not required if seasonal conditions can be adequately simulated.

[3]Refer to Special Procedures

E. Special Procedures (other equipment to test with, etc.; reference to function ID) None

F. Required Monitoring

1. All points listed below which are control system monitored points shall be trended by the Temperature Controls Contractor. Other points shall be monitored by the CA using dataloggers. Refer to the Monitoring section at the beginning of Section 15997 for additional monitoring details.

Point	Time Step (min.)	Minimum Time Period of Trend	Hard Copy? (Y/N)	ASCII File? (Y/N)	Function Being Tested
For each zone thermostat and space sensor and other critical areas, monitor:					
Space temperature	10	3 weekdays, summer design	Y	Y	11
Space temperature	10	3 weekdays, winter design	Y	Y	11
Space temperature	2	8 hours, occupied	Y	Y	7
Heating coil valve	2	8 hours, occupied	Y	Y	7
Damper position or cfm	2	8 hours, occupied	Y	Y	7

Remarks:

G. Acceptance Criteria (referenced by function or mode ID)

1. 1-11. For the conditions, sequences and modes tested, the TU, integral components and related equipment respond to varying loads and changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

2. 10. Space temperature during occupied modes shall average within +/- 1°F of setpoint and always remain within 1°F of the ends of the deadband without excessive hunting of either the damper or coil valve, or complaints of drafts or stuffiness from occupants.

H. Sampling Strategy for Identical Units of the same type and function, but different in size, are considered identical for sampling purposes.

1. Testing. Randomly test at least 10% of each group of identical equipment (the 1st sample). In no case test less than three units in each group. If 10% of the units in the first sample fail the functional performance tests, test another 10% of the group (the 2nd sample). If 10% of the units in the 2nd sample fail, test all remaining units in the whole group, fully at the contractor's expense. This sampling applies to the testing subsections. That is, if calibration is off on more than 10% of the tested piece of equipment, then another sample shall have calibrations checked, but not all other tests need to be done on the second sample.

2. Monitoring. Ten percent of the total number of zones in the building, chosen by the Owner, shall be monitored. Within this 10%, shall be included a distribution of all air handlers, zones expected to have the greatest heating and cooling demand, perimeter and core zones and zones identified from the commissioning process that have exhibited potential problems.

3.08 TEST AND BALANCE WORK (TAB)

A. Parties Responsible to Execute Functional Test

1. TAB contractor: perform checks using test instruments.

2. Temperature Controls Contractor: operate the controls to activate the equipment.

3. CA: to witness, direct and document testing.

B. Integral Components or Related Equipment Being Tested

	Construction Checklist ID
1. TAB water-side	PC-_____
2. TAB air-side	PC-_____

C. Prerequisites The applicable prerequisite checklist items listed in the beginning of Section 15997 shall be listed on each functional test form and checked off prior to functional testing. The commissioning agent will also spot-check misc. items and calibrations on the construction checklists previously completed by the installer, before the beginning of functional testing.

D. Purpose. The purpose of this test is to spot check the TAB work to verify that it was done in accordance with the contract documents and acceptable practice and that the TAB report is accurate.

E. The following tests and checks will be conducted. The following testing requirements are in addition to and do not replace any testing requirements elsewhere in this Division.

	Test or Check	Test Method	Required Seasonal Test[3]
	A random sample of up to 25 % the TAB report data shall be selected for verification (air velocity, air or water flow rate, pressure differential, electrical or sound measurement, etc.). The original TAB contractor will execute the checks, witnessed by the commissioning authority. The TAB contractor will use the same test instruments as used in the original TAB work. A failure[1] of more than 10% of the selected items of a given system[2] shall result in the failure of acceptance of the system TAB report and the TAB contractor shall be responsible to rebalance the system, provide a new system TAB report and repeat random verifications of the new TAB report. The testing will include the verification of minimum outdoor air intake flows at minimum, maximum and intermediate total airflow rates for 100% of the air handlers. Other selected data to be verified will be made known upon day of testing.	Demonstration	
2.	Verify that final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked by the TAB Contractor.	Demonstration	
3.	Verification that the air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity. This shall include a review of TAB methods, control setpoints established by TAB and a physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all TUs taking off downstream of the static pressure sensor, the TU on the critical leg has its damper 90% or more open.	Demonstration	
4.	Verification that the water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity. This shall include a review of TAB methods, control setpoints established by TAB and a physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90% or more open.	Demonstration	

[1]Failure of an item is defined as follows:
For air flow of supply and return: a deviation of more than 10% of instrument reading

For minimum outside air flow: 20% of instrument reading (30% for reading at intermediate supply flow for inlet vane or VFD OSA compensation system using linear proportional control)

For temperatures: a deviation of more than 1°F

For air and water pressures: a deviation of more than 10% of full scale of test instrument reading

For sound pressures: a deviation of more than 3 decibels. (Variations in background noise must be considered)

[2]Examples of a "system" are: the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system. Systems can be defined smaller if inaccuracies in TAB work within the smaller defined system will have little or no impact on connected systems.

[3]Cooling season, Heating season or Both. "Design" means within 5°of season design (ASHRAE 2 1/2%), or 95% of loading design. A blank cell denotes no special seasonal test is required and that test can be executed during any season, if condition simulation is appropriate.

F. Special Procedures (other equipment to test with, etc.; reference to function ID) None

G. Required Monitoring None

H. Acceptance Criteria (referenced by function or mode ID)

1. Provided in footnote to test table above.

I. Sampling Strategy for Identical Units

1. Described in test table above.

END OF SECTION