

1.13 COORDINATION

- A. Coordinate work under the provisions of Divisions 20, 21, 22, 23, 25.
- B. Coordinate the work with the structural system, wall framing and device installations, and above ceiling installations of other trades.

PART 2 - PRODUCTS

2.1 MATERIALS AND PRODUCTS

- A. Materials and products shall be new unless otherwise noted.
- B. Materials designated or required to be "Oxygen Clean" shall be purchased as "Oxygen Clean" and delivered to the project site in the original packing.
  - 1. This material shall be stored in such a manner as to remain "Oxygen Clean".
  - 2. Contractor is not allowed to clean "Oxygen Clean" material which has been contaminated, except as allowed in this specification and with Owner pre-approval.
- C. Provide products, equipment, and components by a single manufacturer.

2.2 PIPE AND FITTINGS

- A. Pipe (except DV): Pipe shall be hard drawn seamless medical gas tubing, ATM B819, factory prewashed and capped for oxygen service. Use type L for medical gases and dental compressed air. All piping shall be labeled with the ASTM number. Category 3 gas powered, nonmedical air, devices shall meet the above requirements for medical air.
- B. Fittings (except DV): Fittings shall be wrought copper brazed fittings ASTM B16.50 or cut ASTM B16.22 solder fittings for brazing, cleaned and bagged for oxygen service. Soldered connections are not allowed. Cast copper alloy fittings shall not be permitted.
- C. Mechanically formed, drilled, or extruded tree-branch connections are not allowed.
- D. Pipe - Dental Vacuum (DV):
  - 1. Category 3 Dental Vacuum wet systems:
    - a. CPVC plastic piping iron pipe size (IPS) schedule 40 or schedule 80, ASTM F 441.
      - 1). Pipe and fittings shall be suitable for installation in return air plenums per the IMC, shall meet the 25/50 flame and smoke requirements in accordance with ASTM E84 or UL 723.
    - b. CPVC plastic piping copper tube size (CTS) 1/2" through 2" SDR 11, ASTM D 2846.

- 1). Pipe and fittings shall be suitable for installation in return air plenums per the IMC, and shall meet the 25/50 flame and smoke requirements in accordance with ASTM E84 or UL 723.
  - c. Manufacturer: Spears Manufacturing, EVERTUFF CPVC pipe and fittings, or approved equal.
- E. Fittings - DV:
1. Level III wet systems: Piping meeting Level I or Level II requirements and the following for corrosive resistant system segments:
    - a. CPVC plastic pipe fittings to match pipe schedule/diameter.
      - 1). Pipe and fittings shall be suitable for installation in return air plenums per the IMC, and shall meet the 25/50 flame and smoke requirements in accordance with ASTM E84 or UL 723.
    - b. Manufacturer: Spears Manufacturing, EVERTUFF CPVC pipe and fittings, or approved equal.
- F. Joints:
1. Brazed joints shall use Sil-Fos or other self-fluxing silver brazing alloy with a 1,190 degrees F minimum melting point per ANSI/AWS A5.8 and NFPA 99. All brazing shall be done utilizing a nitrogen purge.
  2. Where threaded joints are required for connection of equipment and or gauges, a Teflon tape shall be used; pipe thread dope is not allowed. The tape shall be a special oil free PTFE oxygen thread green seal tape as manufactured by the Mill Rose Company.
  3. Stainless tube shall be welded using metal inert gas (MIG) welding, or tungsten inert gas (TIG) welding. Welders shall be qualified to ASME BPVC Section IX.
  4. Plastic pipe joints shall be made with solvent cement.
- G. Pipe and Fittings for Dental Air Compressor Intake and Dental Vacuum Exhaust to Exterior Building Penetration:
1. Pipe 3" and under: Provide type L copper tubing and fittings with brazed joints.
  2. Pipe 4" and over: Provide type L copper tubing, copper fittings with mechanical joints or brazed joints.
- H. Dielectric Fittings shall be permitted only required by the manufacturer of special medical equipment to electrically isolate the equipment from the system distribution piping.

## 2.3 VALVES

- A. Manufacturers: Hill-Rom, Allied Health Care, Tri-Tech Medical, Beacon Medical Products, Nibco, Stockham, Grinnell, Milwaukee, and Apollo.
- B. Ball Valves (4" and under) (Except DV): Brass or bronze body 3 piece bolted construction, full port, 600 PSIG WOG, dual bleed ports, TFE seats and seals, chrome plated brass ball with brass



blow-out proof stem. Handles shall be equipped with mechanism to lock valve open utilizing an Owner-furnished padlock. Valves shall be cleaned for oxygen service. Valves shall have copper tubing extensions brazed to valve sweat connection ends. The downstream tubing extension bleed port shall have a FPT gauge port with plug.

- C. Ball Valve for DV: CPVC full port ball valve compatible with piping system and suitable for vacuum service.
- D. Dental air shutoff valve for dental equipment connection at treatment rooms: Provide full port ball isolation valve with threaded outlet at each level 1 stub up for connection to dental equipment. Coordinate outlet connection type, valve type, and valve orientation with dental equipment supplier.
- E. Oxygen and Nitrous Oxide shutoff valves for dental equipment connection: Shut-off valves for connection to dental equipment at each level 1 stub up in closed dental treatment rooms are furnished by dental equipment supplier and installed by plumbing contractor. Valves shall meet 2012 NFPA-99 criteria for category 1 medical gas systems and shall include demand check and DISS threaded outlet for connection to dental equipment hose connection; coordinate with dental equipment supplier and include the proposed shut-off valves in medical gas product submittals.
- F. Zone Valve Box (OFCI):
  - 1. Manufacturers: Parker/Porter.
  - 2. Refer to Sjoquist Architects Dental Equipment 'EQ' Drawings for additional information.

#### 2.4 LAB AIR OUTLETS

- A. At each compressed air outlet in the dental lab, provide a three-outlet manifold with quarter-turn isolation valve on each outlet. Coordinate with lab equipment requirements for equipment connection types; provide fittings, quick connect couplers, and threaded connectors to connect equipment to compressed air outlets. Provide cap or plug for any unused outlets not connected to lab equipment.
- B. Basis of design for lab compressed air outlets: Amflo, or approved equal.

#### 2.5 MEDICAL GAS OUTLETS AND INLETS, TERMINAL DEVICES

- A. Medical gas outlets and inlets are furnished and installed by dental equipment supplier. Refer to Sjoquist Architects Dental Equipment 'EQ' Drawings for additional information.

#### 2.6 MEDICAL GAS MANIFOLD (OFCI)

- A. Combination Oxygen and Nitrous Oxide medical gas manifold is furnished by dental equipment supplier and installed by Contractor. Refer to Sjoquist Architects Dental Equipment 'EQ' Drawings for additional information.
- B. Manufacturer: Parker/Porter.

## 2.7 MEDICAL GAS ALARM PANEL (OFCI)

- A. Combination Oxygen and Nitrous Oxide medical gas alarm panel is furnished by dental equipment supplier and installed by Contractor. Refer to Sjoquist Architects Dental Equipment 'EQ' Drawings for additional information.
- B. Manufacturer: Parker/Porter.

## 2.8 DENTAL COMPRESSED AIR SOURCE EQUIPMENT (OFCI)

- A. Project includes addition of one new dental air compressor to the two existing units to serve the dental clinic. The two existing dental air compressors will be reconfigured. Dental compressed air system equipment is Owner Furnished, Contractor Installed (OFCI).
- B. Dental compressed air system equipment to be added under this project includes: One dental air compressor unit. Remote alarm/monitoring panel to be relocated to the dental clinic reception area on level 1.
- C. Provide all required piping, fittings, and appurtenances for a complete and operating system. Refer to Sjoquist Architects Dental Equipment 'EQ' Drawings for additional information.
- D. Manufacturer: Ramvac, No substitutions. Refer to schedules for equipment model numbers.

## 2.9 DENTAL VACUUM SOURCE EQUIPMENT (OFCI)

- A. Project includes addition of new dental vacuum system equipment to serve the new dental clinic. Dental vacuum system equipment is Owner Furnished, Contractor Installed (OFCI).
- B. Dental vacuum system equipment to be added under this project includes: Three dental vacuum pumps with vacuum pump exhaust filters, one separator tank, one infini-tank with washdown, one amalgam separator, and one dental vacuum system main controller. Main control panel is located in basement dental utilities room and remote alarm/monitoring panel to be relocated in the dental clinic reception area on level 1.
- C. Provide all required piping, fittings, and appurtenances for a complete and operating system. Refer to Sjoquist Architects Dental Equipment 'EQ' Drawings for additional information.
- D. Manufacturer: Ramvac, No substitutions. Refer to schedules for equipment model numbers.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Cleaning: Handle piping to prevent entry of dirt and contaminants. Factory-cleaned and sealed piping, cleaned as specified herein, shall have ends kept sealed until immediately ready for use. Provide temporary caps for pipes and stations during construction. Comply with NFPA 99 regarding special washing, cleaning, and flushing required before installation.

B. System Installation:

1. Install medical oxygen and medical nitrous oxide systems in accordance with 2015 NFPA-99 criteria for Category 2 medical gases.
2. Install dental air systems in accordance with 2015 NFPA-99 criteria for Category 3 Gas Powered Device Supply Systems (Dental Compressed Air). Joints shall be brazed utilizing a nitrogen purge.
3. Install dental vacuum systems in accordance with 2015 NFPA-99 criteria for Category 3 Dental Vacuum Systems.
4. Cutting and Fitting: Cut tubing with a tubing cutter (sawing is not permitted), ream end of tubing and deburr any chips. Blow out tube with nitrogen prior to assembly into the system.
5. Pipe Bending: Field bends in piping are not permitted.
6. Pipe Isolation: Isolate copper tubing from contact with dis-similar metal contact using tape or plastic grommets. Medical gas piping shall not be used as a part of an electrical grounding system.
7. Hanger Spacing: Tubing shall be hung on the following hanger spacing dimensions.

1/2"	6 feet
3/4"	7 feet
1"	8 feet
1-1/4"	9 feet
1-1/2" & larger	10 feet

8. Riser Supports: Tubing risers shall be supported at each floor but in no case shall the support distance exceed 15 feet. In such cases provide additional support.
9. Joint Preparation: Clean surfaces to be brazed with a clean stainless steel brush or emery cloth. Do not use steel wool as it may contain oil. After mechanical cleaning the surfaces shall be wiped using a clean, lint-free white cloth. Joints shall be brazed within one hour of being cleaned.
10. Brazing: Joints shall be brazed by qualified brazers. A nitrogen purge shall be used during brazing and until the joints are cool to the touch. After brazing wash the outside of each joint with a wet rag and a wire brush. The use of flux is prohibited.
11. Dielectric Fittings shall be permitted only required by the manufacturer of special medical equipment to electrically isolate the equipment from the system distribution piping.
12. The following joins shall not be used throughout the medial gas and vacuum distribution system:
  - a. Flared and compression type connections, including connections to station outlets, inlets, alarm devices, and other components.
  - b. Other straight threaded connections, including unions.
  - c. Pipe-crimping tools used to permanently stop the flow.
  - d. Removable and nonremovable push-fit fittings that employ a quick assembly push fit connector.
13. Plastic pipe shall not be installed in air plenums unless it meets the 25/50 flame and smoke ratings required by the IMC or the pipe is protected by an approved 1-hour fire barrier.
14. Pipe sizes shall meet the minimum requirements:

- a. Mains and branches in medical gas piping systems - 1/2".
  - b. Drops to individual station inlets and outlets - 1/2".
15. Two or more medical gas or vacuum piping systems shall not be interconnected for installation, testing, or any other reason.
  16. After installation of the piping and before installation of outlets, pipes shall be blown clean with nitrogen.
  17. Piping Identification: Apply pipe labeling during installation process and not after installation is completed.
  18. Purge Ports: At mainline shutoff valves which serve more than 1 room, and which are not located in a zone valve box, install a 1/2" tee with ball valve just downstream of the shutoff valve to facilitate purging during initial installation of future system changes. Finish open end of purge valve with a female adapter and a brass plug.
  19. Shutoff and service valves installed in ceiling space shall be provided with handle locks to secure valve in open position. Handle lock shall be provide with means to be padlocked.
  20. Shutoff and service valves shall be accessible when installed in ceiling spaces. Accessible is defined as immediately adjacent to an access panel or above suspended acoustic tile system on which the tiles are not secured or restricted in removal.
  21. Terminal Support: Provide backing as required to firmly attach outlets to wall and/or ceiling framing. Ceiling backing shall be sturdy enough to support a 10 pound load on the outlet without noticeable deflection of the ceiling or the outlet.
  22. Piping protection: Exposed piping in areas subject to physical damage by carts, stretchers, portable equipment, or vehicles shall be protected with stainless steel barriers. Piping shall be protected against freezing, corrosion, and physical damage.
  23. Shutdowns: Prior to submitting a shutdown request determine the areas affected by the valves(s) being shut down. Submit the shutdown request for approval.
  24. Install equipment in accordance with manufacturer's recommendations.
  25. Connections to existing systems: Final tie-in connections to existing systems shall be leak tested with source gas at normal operating pressures. Maintain pressure while each new joint is examined for leakage with soapy water. Do not connect to existing system until the installer's tests are complete and verification are complete up to and including piping purity test.
  26. Coordinate pipe floor and wall penetrations and provide materials to maintain assembly fire ratings.

### 3.2 LABELING AND IDENTIFICATION

- A. Piping labels shall be provided during installation, before testing.
  1. Piping, both exposed and concealed, shall be labeled with the gas/vacuum system name or chemical system and color code per NFPA 99. Medical gas piping shall not be painted. Labels shall be located as follows:
    - a. Operating pressure shall be include with gas name where positive pressure gas operate at pressures other than NFPA 99 standards.
    - b. At intervals of not more than 20 feet.
    - c. At least once in or above every room.
    - d. On both sides of walls, partitions, or floors penetrated by the piping.
    - e. At least once in every story height on risers.

- B. Valve and equipment tags shall be provided during installation, before testing.
  - 1. Shutoff valves shall be identified with the following:
    - a. Name or symbol of the specific system.
    - b. Name of the room(s) or area(s) served.
    - c. Caution to not close (or open) the valve except in an emergency.
- C. Outlets and inlets shall be identified with the name or symbol of the specific system.
  - 1. Operating pressure shall be included with gas name where positive pressure gas operate at pressures other than NFPA 99 standards.
- D. Zone Valve Box Map: Provide a medical gas zone valve box control floor plan area drawing located at each zone valve box. Obtain an ACAD background of the area served by the zone valves. Draw as-built locations of rooms served and the zone valve box location. Symbols shall be colored to match existing placards. Install zone valve box control floor plan area drawing in 8-1/2" x 11" clear sign holder next to the zone valve.
  - 1. Provide nameplate next to area drawing (or below if insufficient space) which says, "Warning: Medical Gas Valves In case of fire or other emergency, these valves may be closed to shut off medical gases to rooms: (see map above).
- E. Area Alarm Panel Map: Provide a drawing (similar to zone valve box) showing the zone valves and the rooms covered by that alarm. Install the drawing in an 8-1/2" x 11" sign holder next to the area alarm panel. If the zone valve box and area alarm panel are installed in the same location only one map is required showing zone valve box and area alarm panel.
- F. Valves: Provide a typed list of the areas served and the valve number. Chain the tag to the valve with a metallic chain.

### 3.3 CONTRACTOR'S INSTALLER TESTS

- A. Do not interconnect medical gas pipelines. Perform pressure testing with individual charging and measurement for each system.
- B. Provide testing in accordance with NFPA 99 requirements.
- C. After installation of shutoff valves and outlets, but before installation of system components (switches, gauges, alarms, manifolds, etc.) each section of the piping system shall be subjected to a test pressure of 1.5 times the working pressure, but not less than 150 PSIG, by means of oil free, dry nitrogen. This test pressure shall be maintained until each joint has been examined for leakage by means of soapy water. Leaks shall be repaired and the section retested.
- D. After completion of the above test procedure, the finishing assemblies of station outlets, alarms, and other components (e.g. pressure switches, gauges, relief valves, etc.), except those for Vacuum, shall be installed and medical gas piping systems shall be subjected to a 24 hour standing pressure test at 20 percent above the normal operating line pressure. Use oil free, dry nitrogen for test gas. The source shutoff valve shall be closed during this test. Pressure gas systems are to remain leak free. Vacuum is to be subjected to a test pressure of 60 PSIG. Vacuum test

pressure at the end of 24 hours is to be within 5 PSIG of initial test pressure. Any leaks shall be located, repaired, and systems retested.

- E. Blowdown each pressure gas system in order to remove particulate matter in pipelines. A high flow, intermittent purge shall be put on each outlet using appropriate adapters. Continue until purge produces no discoloration in a white cloth.
- F. Determine that no cross connections to other pipeline systems exist, reduce systems to atmospheric pressure. Disconnect sources of test gas from of the system with the exception of the one system to be checked. Pressure this system with oil-free dry nitrogen to a pressure of 50 PSIG. With appropriate adapters matching outlet labels, check each individual station outlet of all systems installed to determine that test gas is being dispensed from only the outlets of this system.
- G. Disconnect the source of test gas and reduce the system tested to atmospheric pressure. Proceed to test each additional pipeline system in accordance with the procedure outlined above. Vacuum systems can be tested with vacuum instead of pressure.
- H. Pressure tests should be witnessed by an Owner's representative. The installing contractor shall supply written documentation that the pressure tests have been completed and the systems meet these specifications.
- I. After 24 hour standing leakage testing is completed, allow piping to remain pressurized with test gas until certification agency performs final tests.
- J. Vacuum Vent Pipe Test: Cap pipes at the vacuum pumps and fill with water to the roof terminus. There shall be no perceptible drop in water level over a 2 hour period.
- K. Dental Air Compressor suction piping test: Test with nitrogen at 25 PSIG for 24 hours with no perceptible drop in pressure.

### 3.4 SYSTEM VERIFICATION, CERTIFICATION, AGENCY TESTS

- A. System verification shall be performed by the approved medical gas certification agency. Verify that systems as installed, meet or exceed the requirements of NFPA 99 and this specification and operate as required. Contractor's installer tests shall have been successfully completed as required by NFPA before verification activities start.
- B. Certification shall be performed by an independent testing agent. Certification shall be performed after closing of walls and after completion of required testing. Coordinate timing of system verification activities with Owner; notify Owner a minimum of 2 weeks prior to readiness.
- C. Hoses are to be installed in rail systems and hose drops for certifier's outlet tests.
- D. Medical gas concentration analysis is to be performed with instruments designed to measure the specific gas dispensed.
- E. Perform and document tests and verification requirements per NFPA 99 including:
  - 1. Cross connection.

2. Valve test.
  3. Outlet flow and pressure drop.
  4. Master alarms.
  5. Area alarms.
  6. Piping purge with a 0.45-micron filter.
  7. Piping purity.
  8. Final tie-in and blowdown of existing piping.
  9. Operational pressure test with source gas.
  10. Medical gas concentration.
  11. Labeling of outlets, valves, and alarms.
  12. Source equipment operation.
- F. Discrepancies discovered during the inspection shall be noted and corrected. All portions of the system affected by corrective action shall be retested and findings recorded after retest.
- G. Installer and verifier test reports shall be submitted for review prior to use of medical gas systems. Systems shall not be considered in service until satisfactory test results are obtained.
- H. Verified final results shall be incorporated in the operations and maintenance manuals as separate indexed item.

END OF SECTION 226300

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## PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes: Ductwork and ventilation system equipment cleaning, servicing, and adjustment.
- B. Related Sections:
  - 1. 200000 - Mechanical General Requirements
  - 2. 200700 - Mechanical Insulation
  - 3. 233100 - Ducts and Accessories
  - 4. 233400 - HVAC Fans
  - 5. 233600 - Air Terminal Units
  - 6. 233700 - Air Outlets and Inlets
  - 7. 237413 - Packaged Rooftop Units

### 1.2 REFERENCES

- A. Codes and Standards:
  - 1. See Section 200000 - Mechanical General Requirements.
  - 2. ACR the National Air Duct Cleaners Association (NADCA) Standard for Assessment, Cleaning and Restoration of HVAC Systems, 2013.
  - 3. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.

### 1.3 SYSTEM DESCRIPTION

- A. Design Requirements: This section describes specific requirements and methods for cleaning existing ventilation ductwork and equipment.
- B. Performance Requirements:
  - 1. Install new and replace existing duct access doors as required.
  - 2. Clean supply air diffusers and return air grilles to remain.
  - 3. Clean existing terminal air units to include fans and reheat coils.
  - 4. Clean supply, return and exhaust ductwork from fan connection points to each air discharge point.
  - 5. Clean central air handling unit internal surfaces and components.
  - 6. Clean outside air louvers, plenums, and dampers.

### 1.4 PRE-INSTALLATION MEETINGS

- A. See Section 200000 - Mechanical General Requirements.

## 1.5 SUBMITTALS

- A. See Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.
- B. Product Data: Submit material safety data sheets (MSDS) for chemical products proposed to be used in cleaning process
- C. Shop Drawings:
  - 1. Select and document new duct access point/door locations and sizes on a clean set of Contract Drawings during cleaning preparation, using the access door symbol provided in the Legend.
  - 2. Submit for approval by the Contracting Agency prior to installing duct access points/doors.
- D. Test and Evaluation Reports:
  - 1. Preliminary Report:
    - a. Prior to any cleaning or duct repair work, provide a formal written preliminary report which:
      - 1). Defines the physical limits/boundaries of the existing central air distribution system ductwork and equipment to be cleaned.
      - 2). Provides a general assessment of the condition of the existing ductwork and equipment to be cleaned.
      - 3). Includes “before” digital photographs for each section of ductwork and equipment to be cleaned which clearly documents the existing condition of the ductwork. Include a key map (floor plan(s)) which clearly shows the location and direction of each photograph taken.
      - 4). Includes official laboratory analysis report of representative duct contamination samples. Indicate where samples were taken on key map (floor plans).
      - 5). Provides recommendations regarding the most appropriate cleaning method(s) for each portion of the duct system and equipment to be cleaned. Use cleaning methods selected from the National Air Duct Cleaners Association (NADCA) Industry Standard for Mechanical Cleaning of Non-Porous Air Conveyance System Components.
      - 6). Includes a copy of the specific recommended cleaning procedures to be implemented.
  - 2. Final Condition Report:
    - a. Within 15 days of completed duct and equipment cleaning, provide a formal written final condition report which:
      - 1). Demonstrates that there is no visible dirt, contamination, or bacterial growth, at any point within the systems which were cleaned.
      - 2). Includes “after” digital photographs next to each “before” digital photograph for each section of ductwork and each piece of equipment which clearly

documents the cleaning process. Take the “after” photograph from the same orientation as the previously submitted “before” photograph.

- E. Quality Control Submittals: Submit references for a minimum of five recently successfully duct cleaning projects.

#### 1.6 CLOSEOUT SUBMITTALS

- A. See Section 200000 - Mechanical General Requirements.

#### 1.7 QUALITY ASSURANCE

- A. See Section 200000 - Mechanical General Requirements.
- B. Qualifications: Duct cleaning work shall be performed by a firm with three years of continuous, documented experience with similar work.
- C. Certifications: The HVAC system cleaning contractor shall have a minimum of one Air System Cleaning Specialist (ASCS) certified by NADCA on a full time basis, or shall have staff certified by a nationally recognized certification program and organization dedicated to the cleaning of HVAC systems.

### PART 2 - PRODUCTS

#### 2.1 CLEANING EQUIPMENT AND CLEANING PERSONNEL

- A. Provide equipment and materials for cleaning, inspection and repair work including scaffolding, wire brushes, rotary brushes, filters, air lances, mechanical agitators, fiber-optic bore scopes, vacuums, and other equipment and materials necessary for workmen to perform the specified work.
- B. Cleaning personnel shall be properly supervised by a qualified, experienced foreman. Foreman shall be prepared to discuss work in progress, at any time with the Contracting Agency.
- C. Provide HEPA systems which are self-contained units with appropriate components and appurtenances, to adequately prevent dirt and debris loosed from duct mains and branches during cleaning operations from entering sensitive locations. Utilize industrial grade HEPA filter elements labeled and certified for 99.9 percent efficiency (0.3 micron particles at rated air flow). Wherever practicable, do not discharge air from HEPA systems to clean spaces. Size volumetric capacity of HEPA filter system to match CFM rating of diffuser, mixing box, ductwork section or device to which unit is being connected.

#### 2.2 ACCESS DOORS

- A. Refer to Section 233100 - Ducts and Accessories.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Study the Contract Documents and facility record drawings provided by the Contracting Agency to become familiar with the general layout of the existing systems to be cleaned.
2. Conduct site visit(s) to verify the scope of work, accessibility to ductwork and equipment and existing conditions.

3.2 PREPARATION

A. Protection of In-Place Conditions:

1. Prior to cleaning, provide temporary 30 percent filters fitted and sealed at supply grilles and diffusers.
2. Protect openings to avoid particulate contamination and debris from falling into conditioned air spaces.

3.3 INSTALLATION

- A. Install access points/doors as needed at locations throughout supply, return and exhaust air ductwork to clean systems.
- B. Where existing access doors are missing or poorly fitted, report condition to the Contracting Agency.

3.4 DUCT CLEANING

- A. Control access for cleaning personnel and equipment through installed access points, existing ceiling tiles, access doors, diffusers or grilles. Replace items removed for access to their original state upon completion of work.
- B. Upon satisfactory laboratory analyses of duct contamination samples and with temporary filters installed, remove loose contaminants from the interior ductwork surfaces. Perform visual inspections throughout the entire process to ensure that no area(s) are left untreated.
- C. By inserting special air lances, mechanical agitators and rotary brushes through the installed access points, gently loosen and remove contaminants from the interior surfaces of the ductwork. Utilize temporary filters and blanking pieces to protect areas that are not currently being treated.
- D. Utilize specialized fan-powered, HEPA filtered dust and particulate collection systems in areas designated as being sensitive and as directed by the Contracting Agency. Take precautions to prevent dirt and debris greater or equal to 0.5 microns from entering these sensitive areas.

- E. Hand wash duct mounted coils (using air or water) on both coil faces carefully to avoid damage to tubes and fins. Hand brush and vacuum clean coil frames to remove corrosion from around coil frames. Paint exposed metal frame surfaces to match existing coatings. Comb coil fins to restore them to original alignment.
- F. Mark duct mounted dampers at their current setting. Then inspect and clean dampers by manually hand scraping, sanding or wire brushing. Lubricate external moving parts with an approved dry lubricant material (Aerolox Dry Moly or equal). After cleaning, repair damaged dampers to provide proper operation and return and lock dampers at original setting positions.
- G. Whenever supply/diffusers and return/exhaust grilles are removable, mark existing damper settings (as applicable) and remove them prior to cleaning. Vacuum clean, wash, dry and reinstall diffusers and grilles. Clean welded grilles in place. Return dampers to original setting positions after reinstallation.

### 3.5 ROOF TOP AIR HANDLING UNITS

- A. Shutdown/restart central roof top air handling systems based upon a pre-arranged schedule approved in advance by the Contracting Agency. Once cleaning is complete, restore central air handling equipment to their normal operating mode.
- B. Clean and repair central air handling units located in mechanical rooms or equipment areas as follows:
  - 1. Remove existing filter bank elements.
  - 2. Hand wire brush interior sides, ceiling and floor areas to loosen surface contaminants and vacuum clean.
  - 3. Hand scrape/wire brush, vacuum clean, prime and paint filter holding frames with a chromate based primer and a gray epoxy paint top coat. Replace holding frame rubber seals.
  - 4. Utilizing a high pressure water cleaning system with a suitable cleaning agent to thoroughly clean heating/cooling coil faces.
  - 5. Hand scrape/wire brush, vacuum clean, prime and paint coil frames and drain pans with a chromate based primer and a gray epoxy paint top coat. Replace holding frame rubber seals.
  - 6. Vacuum clean and hand wash control dampers. Replace damaged rubber seals.
  - 7. Vacuum clean and hand wash fan casing and motors to remove grease debris.
  - 8. Hand scrape/wire brush, vacuum clean, fan impellers and casings.
  - 9. Repair/replace existing damaged duct insulation. If existing insulation is exposed without neoprene, foil or approved facing, coat surface with sealer. See Section 20 0700 - Mechanical Insulation, for sealer requirements.
  - 10. After interior surfaces and equipment are cleaned and refurbished, sanitize the air handling unit interiors with an approved broad spectrum biocide.
  - 11. Grease and repack fan bearings. Provide new belts. Align drive belts and adjust tension.
  - 12. Provide new filter bank elements.
  - 13. Hand wash and rinse exterior air handler surfaces.
- C. Prior to reactivating of air handler system:
  - 1. Verify that painted surfaces are properly dried and cured.

2. Verify that air handler surfaces are thoroughly cleaned and dried.
3. Filter elements are installed.
4. Fan belt guards are installed.
5. Notify the Contracting Agency prior to restart of air handler and coordinate system restart with facility operation.

### 3.6 REPAIR/RESTORATION

- A. Upon completion of the ductwork and equipment cleaning, carefully remove filters from the ceiling diffusers to avoid spilling loose contamination onto room surfaces. Dispose of filters in sealed containers.
- B. Shut and latch access doors. Adjust as necessary for a tight air seal.

### 3.7 CLEANING

- A. Upon completion of work, and at the end of each shift, clean work area of trash, rubble, rags, containers, materials and equipment resulting from the work and remove from site. Broom clean Contracting Agency designated work/storage areas.
- B. When cleaning procedures are completed, return electrical switches, detection devices and system components to an operable state by qualified personnel.
- C. Plug access ports with plugs specifically designed for the intended purpose.

### 3.8 SITE TESTS AND INSPECTIONS

- A. Provide Contracting Agency with 48 hours advanced notice prior to site inspection.
- B. Visually inspect cleaned duct interior surfaces, ductwork accessories and air handlers as identified in the project's scope of work.
- C. Inspect ductwork interior surfaces and non-accessible ductwork components within the air stream via the installed access points/doors, utilizing the fiber optic bore scope with dedicated light source.
- D. Photo document post cleaning conditions and submit with Final Condition Report. See Submittals - Test and Evaluation Reports for specific report requirements.

END OF SECTION 230131

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: General requirements and methods of execution relating to the testing and balancing of the mechanical systems provided on this project.
- B. Related Sections:
  - 1. 019100 - Commissioning
  - 2. 200000 - Mechanical General Requirements
  - 3. 221100 - Domestic Water Piping and Specialties
  - 4. 232113 - Hydronic Piping and Specialties
  - 5. 232123 - Hydronic Pumps
  - 6. 233100 - Ducts and Accessories
  - 7. 233400 - HVAC Fans
  - 8. 233600 - Air Terminal Units
  - 9. 233700 - Air Outlets and Inlets
  - 10. 238200 - Terminal Heating Units
  - 11. 259000 - Sequence of Operations

1.2 REFERENCES

- A. Codes and Standards:
  - 1. See Section 200000 - Mechanical General Requirements.
  - 2. National Environmental Balancing Bureau - Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
  - 3. National Environmental Balancing Bureau - Testing, Adjusting, Balancing Manual for Technicians.
  - 4. SMACNA - HVAC SYSTEMS Testing, Adjusting, and Balancing.
- B. Abbreviations and Acronyms:
  - 1. Refer to Division 01 for general abbreviations, acronyms, and definitions.
  - 2. Refer to Mechanical Drawings legend sheet for general mechanical related abbreviations.
  - 3. TAB: Testing, Adjusting, and Balancing.
  - 4. NEBB: National Environmental Balancing Bureau
- C. Definitions:
  - 1. Refer to Section 200000 - Mechanical General Requirements for general mechanical related definitions.
  - 2. Accuracy: Capability of an instrument to indicate the true value of a measured quantity.

3. Adjusting: Varying of system flows by partially closing balancing devices, such as dampers, and valves, and varying fan speeds to achieve optimum system operating conditions within design and installation limitations.
4. Balancing: Methodical proportioning of air and hydronic flows through the system main, branches, and terminal devices using acceptable procedures to achieve the specified air or hydronic flow with testing and design limitations.
5. Calibrate: The act of comparing an instrument of unknown accuracy with a standard of known accuracy to detect, correlate, report, or eliminate by adjustment any variation in the accuracy of the tested instrument.
6. NEBB Certified TAB Firm: A Firm that has met and maintains all the requirements of the NEBB for Firm certification in TAB and is currently certified by NEBB. A NEBB Certified Firm shall employ at least one NEBB Qualified TAB Supervisor in the full time management position.
7. NEBB Certified TAB Report: Data presented in a NEBB Certified TAB Report accurately represents system measurements obtained in accordance with the current edition of the *NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems*. Variances from design quantities that exceed NEBB or contract document tolerances are to be noted in the TAB report project summary.
8. NEBB Qualified TAB Supervisor: Full time employee of the TAB Firm in a management position who has successfully passed the supervisor level written and practical qualification examinations and maintains the Supervisor re-qualification requirements of NEBB.
9. NEBB Qualified Technician: Full time employee of the TAB Firm who has met the technician level experience requirements of NEBB and has successfully passed the technician level written and practical qualification examinations. A NEBB Qualified TAB Technician shall be supervised by a NEBB Qualified TAB Supervisor. Supervision does not infer constant oversight; a NEBB Qualified Technician is capable of performing assigned tasks with periodic supervision.
10. Precision: Ability of an instrument to produce repeatable readings of the same quantity, or a tightly grouped set of values, under the same conditions.
11. Range: Upper and lower limits on an instrument's ability to measure the value of a quantity for which the instrument is calibrated.
12. Resolution: Smallest change in a measured variable that an instrument can detect.
13. Testing: Use of specialized and calibrated instruments to measure temperatures, pressures, rotational speeds, electrical characteristics, velocities, and air and hydronic quantities for an evaluation of flow conditions.
14. Testing and Balancing: As used in these specifications, testing and balancing refers to testing, adjusting, and balancing (TAB) as described in the above references.
15. TAB: A systematic process or service applied to heating, ventilating and air-conditioning (HVAC) systems and other environmental systems to achieve and document air and hydronic flow rates. The standards and procedures for providing these services are referred to as "Testing, Adjusting, and Balancing" and are described in this document.

### 1.3 SYSTEM DESCRIPTION

- A. Design Requirements: This section describes specific requirements, products and methods of execution for the testing, adjusting and balancing of the project.



- B. Performance Requirements: Furnish the services of a qualified and approved TAB Firm to perform the work of this specification section.
- C. The work of this section includes but is not necessarily limited to:
  - 1. Test and balance fans and supply, exhaust, and relief ventilating systems.
  - 2. Test and balance hydronic heating systems.
  - 3. Test and balance domestic hot water recirculation flow rate.
  - 4. Test and balance room air pressure relationships.
  - 5. Work directly with the control subcontractor to obtain proper system adjustments. This includes, but is not limited to:
    - a. VAV box controller airflow coefficient adjustments.
    - b. Airflow measuring device calibration adjustments.
    - c. Fluid flow measuring device calibration adjustments.
  - 6. Measure sound power levels if so directed.
  - 7. Provide a final report.
- D. The work of this section does not include:
  - 1. Adjusting burners for proper combustion operation.
  - 2. Liquid waste transfer system adjustment.
  - 3. Refrigeration work.
  - 4. Control system adjustments, unless noted otherwise herein.

#### 1.4 PRE-BALANCING MEETING

- A. Coordinate TAB work with other trades and requirements of other related sections of the Project Manual prior to commencing work.
- B. Schedule a pre-balancing meeting one week prior to commencing work of this Section. Refer to Section 200000 - Mechanical General Requirements.

#### 1.5 SUBMITTALS

- A. See Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.
- B. Product Data: Sample report forms and outlines indicating adjusting, balancing, and equipment data required prior to commencing work.
- C. Certificates:
  - 1. Submit the name and qualifications of TAB Firm for approval with general product submittals. Submit copy of TAB Firm's NEBB certification.
  - 2. Submit the names and certifications of the Firm's NEBB Qualified TAB Supervisor and NEBB Certified Technician.

## D. Balancing Report:

1. Submit a complete report of the testing and balancing of all devices in a format equivalent to that shown in the SMACNA HVAC Systems Testing, Adjusting and Balancing manual. Compile the test data and submit eight copies of the complete test data for acceptance and/or analysis and recommendations.
2. Provide report in soft cover, letter size, comb bound binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include drawings within report.
3. Report Cover Sheet. Include the following data:
  - a. Project Name.
  - b. Project Address.
  - c. Names of Architect and Engineer.
  - d. Names of General Contractor and HVAC Contractor.
  - e. Report date.
  - f. Names of TAB technicians responsible for the measurements and report.
4. System Review Sheet:
  - a. List air and hydronic systems balanced, with systems highlighted that were found to be performing outside design tolerances.
  - b. Include a summary of problems encountered, deviations from design, deficiencies in performance, remaining problems, recommendations, and comments.
5. Instrument Calibration Report:
  - a. Include a complete list of test equipment used, including apparatus manufacturer's name, model number, serial number, and date last calibrated.
  - b. List the instruments used on the project during the balancing work, on a NEBB "Instrument Calibration Report" form, or equivalent form. This includes flow measuring hoods and other related devices.
6. Air Systems Report: Prepare a report for each air system balanced. Tabulate data separately for each system. Describe balancing method used for each system. At minimum, include the following:
  - a. System Diagram: Include locations of air terminal units and pitot tube traverses. Include appropriate notes, static pressure reading locations, etc., taken during testing and balancing.
  - b. Air Apparatus or Fan Test Report: Include pertinent data on the test report forms. If test data could not be measured, or is not applicable, indicate such on report forms. List how each actual cfm measurement was obtained (duct traverse, total of outlet airflows, or a combination).
  - c. Duct Pitot Tube Traverse Reports: Include actual temperature and pressure readings recorded at the time of testing and balancing.
  - d. Air Outlet Test Reports: Include applicable  $A_k$  factors and terminal device sizes. If flow measuring hoods are used, indicate their use in the remarks column.

- e. Include complete identification of elements. Identify by box number, room name and number, air outlet symbol, orientation in room, etc., as necessary to clearly and positively identify the location of each element.
7. Hydronic Heating System Reports. Prepare a report for each hydronic system balanced. Tabulate data separately for each system. Describe balancing method used for each system. At minimum, include the following:
    - a. Schematic Diagram: Include heat exchange equipment and locations of flow measuring devices.
    - b. Pump Test Report: Confirm test data was recorded and properly entered on form. Attach manufacturer's pump capacity curves, with the actual pump operating point plotted, to the test report form. List how the actual pump flow rate was determined (flow meter, pump curve, etc.).
    - c. Primary Heat Exchange Equipment: Confirm that appropriate test data has been recorded for the boilers, heat exchangers, chillers, and other primary heat exchange equipment. List how the actual flow rate(s) of each item was determined.
    - d. Terminal Heat Exchange Equipment: Confirm that heating coil and terminal unit temperatures and pressures were recorded and properly entered on form. List how each terminal unit flow rate was determined.
    - e. Include complete identification of elements. Identify by equipment tag number, room name and number, baseboard symbol, orientation in room, etc., as necessary to clearly and positively identify the location of each element.
  8. Reduced Size Drawings: Provide with air outlets and equipment identified to correspond with data sheets. Record actual locations of thermostats, flow measuring stations, and balancing valves with settings.
  9. Reduced Sized Pressure Maps and/or Environmental Drawings: Provide marked up record drawings, recording actual room by room airflows, pressure relationships, and /or equipment offsets as indicated on contract drawings.

## 1.6 QUALITY ASSURANCE

### A. Qualifications:

1. The work described in this section shall be performed by a Firm certified by the National Environmental Balancing Bureau for air and hydronic balancing.
2. The Firm shall have a record of operation within Alaska for at least three years prior to bid date of this project and shall have demonstrated satisfactory completion of five projects of similar size and scope in the State of Alaska. Provide references if requested.
3. The Firm's Technician and Supervisor for this project shall be NEBB certified for their respective positions.
4. Bids by suppliers, contractors or any Firm whose principal business is not that of testing, adjusting, and balancing HVAC systems are not acceptable.

### B. Balancing Standards:

1. Perform total system balance in accordance with NEBB Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

2. Maintain one copy of balancing procedural document on site.
3. Use standard NEBB forms.

C. Timing of Work:

1. Sequence work to commence after completion of systems. Do not begin balancing and testing until the systems are complete and in full working order.
2. Schedule the testing and balancing work in cooperation with other trades.
3. Schedule completion of testing and balancing before Substantial Completion of Project.

D. Construction team responsibility to TAB Agency: Refer to 200000 - Mechanical General Conditions.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 GENERAL SUMMARY OF BALANCING WORK

A. Provide TAB for the systems and equipment revised under this project including, but not limited to:

1. RTU-1.
2. Existing glycol heating loop serving RTU heating coils, including replacement piping.
3. Hydronic balancing for revised and new terminal heating units and air terminal units.
4. Hydronic heating system circulation pump balancing and revised performance verification.
5. New exhaust fan system for level 1 dental clinic and general building.
6. New exhaust fan system for and medical gas storage room.
7. Existing, new, and revised exhaust air inlets, connected to existing exhaust fan systems, in the areas of work.
8. Existing, new, and revised supply air terminal units and air outlets in the areas of work.
9. Domestic hot water circulation system. Entire system to be rebalanced to accommodate project revisions.
10. Provide room pressure measurements for the following spaces:
  - a. Closed dental treatment rooms (rooms designed to be negative pressure).
  - b. Sterile supply/Hygiene Supply (room designed to be positive pressure).
  - c. Lab (room designed to be negative pressure).

B. Commissioning Support:

1. TAB Agency shall provide support for commissioning services including office and field support; refer to Section 019100 Commissioning.
2. TAB Agency shall provide commissioning support for field support for verification/spot checking of TAB report values and commissioning field adjustments.
3. Upon completion of commissioning activities, TAB Agency shall provide an updated and final TAB report incorporating any field adjustments during commissioning.

3.2 EXAMINATION

- A. Verify systems are complete and operable before commencing work.
- B. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- C. Report defects and deficiencies that may preclude proper TAB of systems and equipment.

3.3 PREPARATION

- A. Schedule work under the provisions of Section 200000 - Mechanical General Conditions.
- B. Provide calibrated instruments required for testing, adjusting, and balancing operations.
- C. Prior to starting work, review drawings and actual field conditions for additional balancing devices or components required for correct balance. Coordinate provision of additional balancing devices as required elsewhere in these specifications. Refer to Related Sections above.
- D. Preliminarily adjust grille, register, and diffuser blades or pattern controllers per drawings. If airflow blow patterns are not shown on drawings, adjust for uniform diffusion pattern(s) or diffusion into long dimension of room.

3.4 SPECIAL TECHNIQUES:

- A. Use instrumentation in accordance with NEBB requirements, calibrated to the accuracy standards specified by this organization.
- B. Flow measuring hoods are acceptable for measurement of ceiling diffuser performance if used in a manner as recommended by the manufacturer and calibration and accuracy data is provided with the balancing report.
- C. Upon request, make available to the Contracting Agency copies of current calibration certificates.

3.5 ACCEPTABLE CRITERIA

- A. Systems will be considered balanced in accordance with NEBB *Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems* when the following conditions are satisfied:
  - 1. Air Handling Systems:
    - a. Measured airflow quantities are within plus or minus 10 percent of design quantities. Deficiencies shall be noted in the TAB report.
    - b. There is at least one direct path with fully open dampers from the fan or terminal unit device to an air inlet or outlet. Additionally, if a system contains branch dampers, there will be at least one wide open path downstream of every adjusted branch damper.

2. Air Outlets and Inlets:
    - a. Measured airflow quantities total to within plus or minus 10 percent of design to space and individual outlets and inlets in space to within plus or minus 10 percent of design.
    - b. Grilles, registers, and diffusers blades or pattern controllers are adjusted for uniform diffusion in the space. Re-adjust airflow patterns that result in airflow velocities greater than 50 FPM (feet per minute) at 5 feet above finish floor (AFF).
  3. Hydronic Systems:
    - a. Manually balanced systems:
      - 1). Measured fluid flow quantities are within plus or minus 10 percent of design.
      - 2). There is at least on direct path with fully open balancing valves from the pump discharge balancing valve (if present) to a terminal device. Additionally, if a system contains branch balancing valves, there will be at least one wide open path downstream of every adjusted branch balancing valve.
    - b. Automatically balanced systems: Pressure drops across a sample of system's automatic balance valves are within the manufacturer's recommended operating range for the device.
- B. If systems or components cannot be adjusted to within specified tolerances:
1. Coordinate the replacement of sheaves, belts, or other components or devices needed for correct balance as required elsewhere in these specifications.
  2. Note deficiencies in the TAB report.

### 3.6 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on equipment sheaves, belts, dampers, valves, air outlets and inlets and each system according to the procedures contained in the current edition of the NEBB *Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems* and this section.
- B. Adjustments shall be made with air handler filters blanked off to create a filter pressure drop of 60 percent of the manufacturer's recommended filter final pressure. Where multiple filters are encountered each set shall be individually blanked off, for a cumulated pressure drop of 60 percent of each filters final pressure.
- C. Ensure recorded data represents actual measured or observed conditions.
- D. Permanently mark final settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Contracting Agency.
- H. Schedule and provide assistance in final adjustment and test of fire alarm system with Authority Having Jurisdiction.

3.7 SITE QUALITY CONTROL

- A. Make calibrated test instruments available to Contracting Agency to facilitate spot checks during testing and commissioning as appropriate.
- B. Re-balance components or systems found to be out of tolerance at no additional expense to the Owner.

END OF SECTION 230593

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Commissioning objectives and scope.
2. Definitions of commissioning team members.
3. Definitions of commissioning terminology.
4. Description of the commissioning process.
5. Sample Commissioning Master Equipment and Systems Log.

B. Related Sections:

1. 200000 - Mechanical General Requirements
2. 200529 - Mechanical Hangers and Supports
3. 200548 - Mechanical Vibration and Seismic Control
4. 200553 - Mechanical Identification
5. 204100 - Mechanical Demolition
6. 230593 - Testing, Adjusting and Balancing
7. 232113 - Hydronic Piping and Specialties
8. 232123 - Hydronic Pumps
9. 233100 - Ducts and Accessories
10. 233400 - HVAC Fans
11. 233600 - Air Terminal Units
12. 233700 - Air Outlets and Inlets
13. 236300 - Refrigerant Condensers
14. 238200 - Terminal Heating and Cooling Units
15. 253000 - Building Automation System Field Devices
16. 255000 - Building Automation System
17. 259000 - Sequence of Operations
18. 260943 - Network Lighting Controls
19. 272010 - Telecom Distribution System
20. 281300 - Security Access System

1.2 RELATED DOCUMENTS

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

1.3 REFERENCES

A. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):

1. Standard 202-2018 - Commissioning Process for Buildings and Systems.
2. Guideline 0-2013 - The Commissioning Process.

3. Guideline 1.1 - 2007 - The HVAC Commissioning Process.

B. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) HVAC Systems Commissioning Manual.

#### 1.4 SCOPE

A. Provide commissioning, as defined by Article 1.3 References, reference A., for the systems, subsystems, and equipment as identified in Divisions 20, 23, 25, 26, 27, and 28 using the commissioning process outlined by this section. Phased commissioning of the work may be necessary to accommodate construction sequencing.

B. Systems to be commissioned include:

1. RTU-1.
2. Zone temperature controls and VAV boxes serving the areas affected by this project.
3. New fire-smoke dampers (FSD).
4. New Med Gas Room heating and ventilation (EF-3, UH-2).
5. New Dental Clinic central exhaust fan (EF-2).
6. New terminal heating units (radiant panels).
7. New Boiler Room unit heater (UH-1).
8. Fire alarm system for level 2 and the Med Gas rooms, including mechanical shutdowns.
9. Lighting controls serving the areas of work.
10. Access control for doors serving the areas of work.
11. Telecom system revisions.

C. Complete the following commissioning objectives to the satisfaction of the Commissioning Authority:

1. Furnish, install, adjust, operate, and test systems, subsystems, and equipment to meet the design intent of the Contract Documents.
2. Document the installation, starting, and testing of the systems, subsystems, and equipment.
3. Provide complete and annotated installation, operation, and maintenance manuals, and red line drawings which accurately reflect the actual installed systems, subsystems, and equipment configurations.
4. Provide complete project record documents which accurately reflect the actual installation of systems, sub systems and equipment.
5. Coordinate the commissioning process with all parties involved in the project in order to maintain project schedule, documentation, and quality control.
6. Coordinate with contractors, sub-contractors, and equipment manufacturer's authorized representative, to provide the appropriate field and office support for commissioning activities, including but not limited to, the following anticipated support:
  - a. Documentation and submittal of completed commissioning forms (PC and FC) to CA prior to the CA's verification site visit.
  - b. Building Automation System sub-contractor shall provide support for obtaining trend BAS data and information as requested by the Commissioning Authority (CA) or Contracting Agency.
  - c. Building Automation System sub-contractor shall provide field support for commissioning activities during the CA's verification site visit.

- d. Mechanical and electrical contractors and sub-contractors shall provide field support for commissioning activities during the CA's verification site visit.
  - e. TAB contractor shall provide field support for commissioning activities, including spot-checking of TAB report values and verification of room pressure relationships during the CA's verification site visit.
  - f. Equipment manufacturer's authorized representative for start-up and adjustment.
7. Complete commissioning activities including items identified by CA and Contracting Agency during FC prior to project closeout.

## 1.5 DEFINITIONS

- A. Commissioning Authority (CA): The person(s) or company responsible, on the Contracting Agency's behalf, for verifying that the commissioning process is properly executed and completed in accordance with the Contract Documents. The CA reviews and approves the scope, planning, scheduling, execution, documentation, training, and final completion of the overall commissioning process. The CA works directly for the Contracting Agency's Project Manager.
- B. Contractor's Commissioning Representative (CCR): The Contractor's representative is responsible for planning, scheduling, managing, executing, and documenting the required commissioning activities. The CCR must be experienced in basic design, operation, installation and testing of HVAC and electrical systems and must have strong administrative, planning, organizational and communication skills. The primary duty of the CCR is to oversee the commissioning process. The CA approves the selection of the CCR.
- C. Contractors Commissioning Team: Members of the Contractor's team responsible for commissioning activities. These team members include, but are not limited to:
1. The CCR and designated support staff.
  2. Mechanical and electrical coordinators.
  3. Subcontractors.
  4. Sub-subcontractors.
  5. Product and System Vendors.
  6. Manufacturer's Representatives.
- D. Commissioning Master Equipment and System Log: A tabulated list of equipment and systems that are required to be commissioned as identified in Divisions 20, 23, 25, 26, 27 and 28 of the specifications. A sample log is provided in Part 3 of this section.
- E. Pre-Functional Installation Checklist (PC): A list of equipment inspections and elementary component tests required for verification of proper installation of equipment. These will be prepared by the CA. Pre-functional checklist items include static inspections and procedures to prepare the equipment or system for initial operation (e.g., supports, hangers, and seismic restraint installed, belt tension, fluid levels, labels and tags affixed, sensors and gages correctly located and calibrated, etc.) and simple testing of component or system function, (such as measuring the voltage imbalance on a three phase pump motor of a chiller system). Pre-functional checklists augment and are combined with the manufacturer's start-up checklist. The CCR field verifies that the pre-functional checks are completed and processed. The Contracting Agency and CA may elect to witness the execution of selected parts of the PC.

- F. Functional Performance Test (FT): Systematic testing of the dynamic function and operation of equipment and systems using direct observation and monitoring equipment methods. Functional testing includes dynamic testing of systems under full operation, including interaction with related systems (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through the control system's sequences of operation and components are verified to be responding as stated in the sequences. Functional Performance Tests are performed after PCs, equipment startups, and Testing, Adjusting and Balancing (TAB) are complete. The CCR field verifies that the functional performance tests are completed.
- G. Functional Performance Test Checklist (FC): A list of performance tests required to document the proper performance of the dynamic function and operation of equipment and systems using direct observation and monitoring equipment methods. These will be prepared by the CA. The CCR and the Contracting Agency field verify that the FTs take place. The CA will witness the execution of selected parts of the FT. The Contracting Agency may elect to witness the execution of selected parts of the FT. The CCR field verifies that the functional performance test checklists are completed and processed.
- H. Deferred Functional Tests: FTs that are performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, or other site conditions that disallow the test from being performed at an earlier date. Only those functional tests pre-approved by the Contracting Agency and the CA may be deferred.
- I. Functional Completion: Completion of the commissioning activities required by the Contract Documents prior to Substantial Completion.

## 1.6 COMMISSIONING PROCESS

- A. Commissioning Master Equipment and System Log:
  - 1. Within 90 days after receipt of conformed documents, the CA will provide the Commissioning Master Equipment and System Log to the CCR.
  - 2. The CA will advise the CCR regarding any reorganization and/or reformatting of the Commissioning Master Equipment and System Log to support construction.
- B. Construction Schedule:
  - 1. The CCR shall incorporate the items from the Commissioning Master Equipment and System Log into the Construction Schedule.
  - 2. Use of Phased Commissioning may be necessary and shall be pre-approved by the CA and Contracting Agency.
- C. Commissioning Meetings:
  - 1. The CCR shall plan, schedule, coordinate, and attend the commissioning meetings. The CCR shall record, maintain, and distribute the minutes for each meeting. The CA will conduct each meeting.

2. Within 30 days after award of the Contract, hold an initial commissioning meeting at the job site. All members of the commissioning team shall be present at the meeting. The purpose of the meeting is to:
  - a. Identify the commissioning team members and provide contact information.
  - b. Provide an overview of the commissioning process.
  - c. Discuss administrative requirements, responsibilities and scheduling.
  - d. Discuss the status of the Commissioning Master Equipment and System Log.
3. Regularly scheduled commissioning status meetings are not required.

D. Installation, Operation and Maintenance Data:

1. Upon approval of submittals, the CCR shall oversee the timely preparation and submission of product installation, operation and maintenance data, pre-functional installation examination checklists and functional performance test checklists in accordance with the Construction Schedule and submittal requirements.
2. The Contracting Agency will approve the installation, operation and maintenance data and checklists for conformance to the design intent.
3. The CA will provide final approval for installation, operation and maintenance data and associated checklists for completeness and suitability to support commissioning activities.

E. Commissioning Binders:

1. The CCR shall maintain the master copy of the approved installation, operation and maintenance data and checklists. Neatly arrange and label the data by specification section in the commissioning binders. Include a copy of the Commissioning Master Equipment and System Log at the front of the binders. Annotate this log to accurately reflect the status of completeness.
2. The CA will periodically review the master commissioning binders.
3. The CA will maintain a second copy of the approved installation, operation and maintenance data and the checklists. This copy will serve as the formal O&M manual submittal to the Contracting Agency.

F. Equipment Installation:

1. The CCR provides written approval prior to the start of installation for each item listed on the Commissioning Master Equipment and System Log. Equipment shall not be installed unless approved installation, operation and maintenance data, and PC and FC forms are on file in the master commissioning binders.
2. The CCR updates the Construction Schedule to indicate actual installation start date.
3. The installer obtains a copy of the installation information and PC from the CCR. The equipment is installed using a copy of the approved installation instructions and the associated PC.
4. The installer signs off each step of the PC and submits the completed PC to the subcontractor responsible for the work.
5. The subcontractor reviews the PC, physically verifies that the equipment is properly installed and signs the subcontractor review block of the PC.
6. The CCR reviews the PC provided by the subcontractor, observes the work and signs the CCR review block.

7. The CCR files the completed PC in the commissioning binder and signs off the Commissioning Master Equipment and System Log to indicate the equipment is installed.
8. The CCR updates the Construction Schedule to indicate that the equipment installation is complete.
9. The CCR forwards a copy of the completed PC to the CA.
10. The CA files the PC in the CA copy of the commissioning binders.

G. Functional Performance Testing:

1. The CCR provides written approval prior to the start of functional testing for each item listed on the Commissioning Master Equipment and System Log. Functional testing of equipment is not allowed unless the approved PC has been completed and is on file in the master commissioning binder.
2. The CCR updates the Construction Schedule to indicate the actual functional testing start date.
3. The equipment or system is functionally tested using a copy of the approved installation, operation and maintenance data and FC.
4. The operator obtains a copy of the approved installation, operation and maintenance data and FC from the CCR. The operator signs off each step of the FC and forwards the completed FC form to the applicable subcontractor responsible for the work.
5. The subcontractor reviews the FC, physically verifies proper equipment operation with the operator and signs the subcontractor review block of the FC and informs the CCR that the equipment FC is complete and the equipment is ready for final checkout.
6. The CCR informs the CA that the equipment is ready for final checkout and provides a date and time for a site visit observation of the operating equipment (48 hours minimum notification time is required).
7. The CA will notify the Contracting Agency and arrangements will be made to include maintenance staff personnel at final equipment checkouts as much as possible to support effective field training.
8. Upon satisfactory completion of the final checkout, the CCR and CA shall sign appropriate review blocks of the FC.
9. The CCR files the completed FC in the commissioning binder and signs off the Commissioning Master Equipment and System Log to indicate that equipment functional tests for that item are complete.
10. The CCR updates the Construction Schedule to indicate that the equipment functional testing is complete.

H. Record Drawings:

1. The CCR shall oversee the maintenance of master “as-built” mark-ups of the Contract Documents as the work progresses. To accurately reflect actual installation conditions, document addendum items, field changes, and installation modifications on the “as-built” mark-ups. Update the master “as-built” mark-ups a minimum of once a week.
2. The Contracting Agency will review the “as-built” mark-ups during each site visit and provide a specific comment on each field report indicating the status of “as-built” drawings with regard to completeness and design intent.
3. Upon completion of construction, the “as-built” drawings shall be drafted using AutoCad to produce the project Record Drawings.
4. The CCR shall verify that the completed Record Drawings accurately reflect the constructed project and forward to the CA for final approval.
5. The CA will review the Record Drawings for final approval.

1.7 SUBMITTALS

- A. Commissioning Report: Submit a written Cx report which documents the field Cx and project documentation effort of the testing, adjusting and balancing effort, and the review of installation, operation and maintenance manuals have been completed.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 COMMISSIONING MASTER EQUIPMENT AND SYSTEMS LOG (SAMPLE)

- A. The following sample Commissioning Master Equipment and Systems Log is provided to show general format only and does not include all the equipment, systems, and subsystems to be commissioned. Refer to Divisions 20, 23, 25, 26, 27, and 28 for specific systems, subsystems, and equipment to be commissioned.

3.2 COMMISSIONING MASTER EQUIPMENT AND SYSTEMS LIST

PRODUCTS	System/Equipment Tag	System/Equipment Description	Equipment Submittal Approved	I/O&M Approved	PC and FT Checklists Approved		PC Completed	FT Completed	
<b>Divisions 20, 23, 25 - Mechanical</b>									
1	PMP-1 thru PMP-3 AS-1/ET-1	Central Heating System							
4	CU-1	Condensing Unit							
5	RTU-1	Central Ventilation System							
6	EF-3	Med Gas Room Ventilation							
7	VAV-101 thru VAV-135	VAV Terminals AHU-1							
8	UH-1 thru UH-5	Unit Heaters							
9	CUH-1 thru CUH-6	Cabinet Unit Heaters							

<b>Divisions 26, 27 and 28 - Electrical</b>									
10	MS	Motor Starters							
11	LF	Lighting Fixtures							
12	LC	Lighting Control Systems							
13	FA	Fire Alarm System							
14	SA	Security Alarm							
16	PA	PA System							

END OF SECTION 019100



PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Supplemental requirements in addition to Division 1 - General Requirements applicable to all Divisions 20, 21, 22, 23, 25 - Mechanical specification sections.

B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 200529 - Mechanical Hangers and Supports
4. 200548 - Mechanical Vibration and Seismic Control
5. 200553 - Mechanical Identification
6. 200700 - Mechanical Insulation
7. 204100 - Mechanical Demolition
8. 211000 - Water Based Fire Suppression Systems
9. 221100 - Domestic Water Piping and Specialties
10. 221300 - Sanitary Waste and Vent Piping and Specialties
11. 224000 - Plumbing Fixtures
12. 226300 - Medical Gas Systems
13. 230593 - Duct Cleaning
14. 230593 - Testing, Adjusting and Balancing
15. 231123 - Fuel Gas Piping and Specialties
16. 232113 - Hydronic Piping and Specialties
17. 232123 - Hydronic Pumps
18. 233100 - Ducts and Accessories
19. 233400 - HVAC Fans
20. 233600 - Air Terminal Units
21. 233700 - Air Outlets and Inlets
22. 237416 - Breechings, Chimneys, and Stacks
23. 238123 - Condensing Boilers and Accessories
24. 237416 - Packaged Rooftop Units
25. 238123 - Dedicated Air-Conditioning Units
26. 238200 - Terminal Heating Units
27. 253000 - Building Automation System Field Devices
28. 254000 - Building Variable Speed Drives
29. 255000 - Building Automation System
30. 259000 - Sequence of Operations

1.2 REFERENCES

A. Codes and Standards:

1. Perform work in accordance with the legally enacted editions of applicable international, state, and local codes with locally accepted amendments to include:

- a. 2018 International Building Code (IBC).
  - b. 2018 International Mechanical Code (IMC).
  - c. 2018 International Fuel Gas Code (IFGC).
  - d. 2018 Uniform Plumbing Code (UPC).
  - e. 2018 International Fire Code (IFC).
  - f. 2017 NFPA 70, National Electric Code (NEC).
  - g. ASCE 7-16, Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
  - h. Standard for Accessible and Usable Buildings and Facilities (ANSI A117.1-2009).
2. Standards: Reference to the following standards infers that installation, equipment and material shall be within the limits for which it was designed, tested and approved, in conformance with the current publications and standards of the following organizations:
- a. American Gas Association - AGA.
  - b. American National Standards Institute - ANSI.
  - c. American Society of Heating Refrigerating and Air Conditioning Engineers - ASHRAE.
  - d. American Society of Mechanical Engineers - ASME.
  - e. American Society for Testing and Materials - ASTM.
  - f. National Electrical Manufacturers' Association - NEMA.
  - g. National Fire Protection Association - NFPA.
  - h. Sheet Metal and Air Conditioning Contractors National Association, Inc. - SMACNA.

B. Definitions:

1. "Accessible" means arranged so that an appropriately dressed man 6'-2" tall, weighing 250 pounds, may approach the area in question with the tools and products necessary for the work intended; and may then position himself to properly perform the task to be accomplished, without disassembly or damage to the surrounding installation.
2. "Authority Having Jurisdiction" is the individual official, board, department, or agency established and authorized by the political subdivision created by law to administer and enforce the provisions of the Code as adopted or amended.
3. "As Specified" denotes a product, system, or installation that:
  - a. Includes salient characteristics identified in the Drawings and Specifications.
  - b. Meets the requirements of the "Basis of Design".
  - c. Is produced by a manufacturer listed as acceptable on the Drawings or in the Specifications.
4. "Basis of Design" refers to products around which the design was prepared. Some or all of the particular characteristics of Basis of Design products may be critical to the fit or performance of the completed installation. Such characteristics are often subtle. Where substitutions are made to products that are the Basis of Design, the Contractor is alerted that nominally acceptable substitutions may produce undesirable side effects such as products that no longer fit the space due to increased product dimensions. The Contractor is responsible for resolving impacts of substitutions. Approval of a substitution request does not relieve the Contractor of complying with the design intent and applicable Codes. Reference to a specific manufacturer's product (even as "Basis of Design") does not

- necessarily establish acceptability of that product without regard to compliance with other provisions of these specifications.
5. "Contracting Agency" is the Owner as defined in the General Conditions of the Contract.
  6. "Demolish" means to permanently remove a component, equipment, or system and its appurtenances with no intent for reuse and to properly disposal of it.
  7. "Furnish" means to purchase material as shown and specified and cart the material to an approved location at the site or elsewhere, as noted or agreed, to be installed by supporting crafts.
  8. "Install" means to set in place and connect, ready for use and in complete and properly operating finished condition, material that has been furnished.
  9. "Product" is a generic term that includes materials, equipment, fixtures and any physical item used on the project.
  10. "Provide" means furnish products, labor, subcontracts, and appurtenances required and install to a complete and properly operating, finished condition.
  11. "Remove" means to remove a component, equipment, or system and its appurtenances and either store it for re-installation/reuse, or turn it over to the Contracting Agency.
  12. "Rough-in and Connect" means provide an appropriate system connection such as water services with stops, continuous wastes with traps, shutoff valves, and piping connections, testing, etc., for proper operation, ready for furnished products to be installed. Equipment furnished is received, uncrated, assembled and set in place by supporting crafts unless prior arrangements are made to hire the rough-in installer for this work.
  13. "Serviceable" means arranged so that the component or product in question may be properly removed and replaced without disassembly, destruction or damage to the surrounding installation. "Serviceable" components shall be "accessible".
  14. "Shop Drawings" are dimensioned working construction drawings drawn to scale to show an entire area of work in sufficient detail to demonstrate service and maintenance clearances and coordination of all trades.
  15. "Substitution" is a product, system or installation that is not by a listed manufacturer or does not conform to all salient characteristics identified in the Project Manual, but that the Contractor warrants meets specific requirements listed in the Project Manual.
  16. "System Drawing" is a diagrammatic engineered drawing that shows the interconnection and relationship between products to demonstrate how the products interact to accomplish the function intended. Examples of system drawings include plumbing diagrams, control and instrumentation diagrams, and wiring diagrams. Some drawings, such as dimensioned and complete Fire Suppression Drawings may be both System Drawings and Shop Drawings.

### 1.3 SYSTEM DESCRIPTION

#### A. Performance Requirements:

1. Provide labor, products and services required for the complete installation, checkout, and startup of mechanical systems shown and specified. Coordinate related work, including the work of other crafts, to provide each system complete and in proper operating order.
2. Cooperate with others involved in the project; with due regard to their work, to promote rapid completion of the entire project.
3. Become thoroughly familiar with the local conditions under which the work is to be performed. Schedule work with regard to seasons, weather, climatic conditions, and other local conditions that may affect the progress and quality of the work.

4. Coordinate and perform demolition in support of the project whether or not such requirements are described on the Drawings. Restore systems that are to remain but that are affected in any way by demolition work. Conduct a site visit prior to bid to determine Scope.
5. In general, the mechanical, electrical, and building automation systems are interrelated. Coordinate the interface and operation of systems so that interrelated systems operate in proper synchronization and balance.
6. Provide labor, materials, and equipment to facilitate the commissioning process of systems and equipment within this scope of work. Perform tests and verification procedures required for the commissioning process as requested by the Contracting Agency.
7. Work and materials shall be in accordance with requirements of the applicable State and local Codes, regulations and ordinances, and the rules and regulations of other Authorities Having Jurisdiction. Nothing in drawings and specifications shall be construed to permit work not in conformance with applicable codes, rules, and regulations.
8. Where drawings or specifications call for a material or construction of a better quality or larger sizes than required by the above-mentioned Codes, rules and regulations, the provision of the specifications shall take precedence.
9. Furnish without any extra charge any additional material and labor when required for compliance with the listed codes, rules and regulations, even though the work may not be mentioned in the specifications or shown on the drawings. It is the responsibility of the successful bidder to bid in accordance with the minimum requirements of the applicable codes, rules, and regulations.

#### 1.4 CONSTRUCTION PHASING REQUIREMENTS

- A. The facility will remain operational throughout the project construction. Project will require construction phasing to minimize impacts to facility operations. Contractor will be required to develop and coordinate construction phasing plans with Owner. Refer to Architectural and Division 1 for additional information.

#### 1.5 PRE-INSTALLATION MEETINGS

- A. Meet with and coordinate Divisions 20, 21, 22, 23, 25 work with the interrelated work of other trades including Architectural, Structural, Mechanical and Electrical to identify and resolve potential conflicts.
- B. Prior to installation of any Division 20, 21, 22, 23, and 25 component, coordinate installation with trades responsible for portions of other related sections of the Project Manual.

#### 1.6 SUBMITTALS

- A. Refer to Division 1 for general submittal requirements for the items listed below, supplemented with the additional requirements listed. In addition, prepare Divisions 20, 21, 22, 23, 25 submittals in accordance with the following, to include any supplemental requirements listed in the specific specification section:
  - B. General:

1. The Contracting Agency's obligation to review submittals and to return them in a timely manner is conditioned upon the prior review and approval of the submittals by the Contractor as required by the Construction Contract.
2. Submittal review is for general design and arrangement only and does not relieve the Contractor from any of the requirements of the Project Manual.
  - a. Submittals will not be checked for quantity, dimension, fit, or for proper technical design of manufactured equipment.
  - b. Provision of a complete and satisfactory working installation is the responsibility of the Contractor.
3. Furnish suppliers with the applicable portions of the Project Manual and review and verify that the suppliers' submittals clearly represent products which comply with the Project Manual.
4. Master Submittal Log
  - a. Create and maintain a master submittal log for items submitted in Divisions 20, 21, 22, 23, 25, including test results, certifications, record drawings, etc.
  - b. Submit master submittal log, independent of other submittals, as the first submittal for review and approval by the Contracting Agency.
  - c. Update submittal log with each submittal action.
  - d. Share an electronic copy with Contracting Agency and Engineer at two week intervals, or as requested by the Contracting Agency.

C. Coordination:

1. Prior to a submittal's submission for approval, hold a meeting of all construction trades to review shop drawings and submittals. Each trade shall cross-check shop drawings and submittals for conflicts, clearances, physical space allocation and routing, discrepancies, dimensional errors, omissions, contradictions, departures from the Contract requirements, correct electrical/mechanical services and connections, and provisions for commissioning.
2. Review, revise, correct, and appropriately annotate submittals prior to submission for approval.
3. Keep a current copy of approved submittals and the submittal log at the job site.

D. Electronic Submittals:

1. Provide electronic submittals in PDF format in addition to hard copy submittal. Maximum file size to be coordinated with Contracting Agency.
2. Follow the organization and formatting required for paper submittals.
3. Provide electronic bookmarks within the PDF document in place of tabs and sub-tabs.
4. If individual PDF files are provided for a product or shop drawing sheet(s), organize files into folders and name files and folders to correspond with applicable specification sections or drawing titles.
5. Create PDF documents without security, to be searchable, and to allow copy and paste. For scanned documents, run the optical character recognition (OCR) function to ensure the document is searchable and can be copied and pasted.
6. Reduce PDF file size by removing data and file creation elements not needed for final file presentation.

## E. Product Data:

## 1. General:

- a. This section describes in detail the preparation of mechanical product submittals. Submittals not provided as described shall be rejected without review. This procedure is designed to accelerate and improve the accuracy of the technical review process, as well as, simplify the preparation of the Installation, Operation, and Maintenance Manuals (IO&Ms).
- b. Product data for each specification section shall be submitted in one complete package, except as noted in this section.

## 2. Submittal Organization:

- a. Organize product submittal information in the same order as the products are specified. Provide a separate tabbed divider for each Divisions 20, 21, 22, 23, 25 specification section. Provide the typed section number on each tab.
- b. Within each section, organize product information in the same order as products are specified in Part 2 of each applicable specification section. Provide sub-tabs within each section for each separate product article. Provide the typed product article number on each tab.
- c. Provide product submittal information for each product specified in 8-1/2" x 11" format. Fold-out 11" x 17" format is also acceptable.
- d. If a particular specified product is being omitted from the product submittal or will not be used for the project, provide a single sheet within the article tab identifying the product and annotated with a brief reason why the product is not being submitted, for example: "NOT USED," "NO SUBMITTAL REQUIRED," "TO BE SUBMITTED BY (PROVIDE DATE)," etc. This will inform the reviewer that the product was not overlooked.
- e. Partial submittals from individual subcontractors may be provided which cover a particular sub-contractor's scope of work. In this case, arrange partial submittals by system classification such as: PLUMBING, HEATING, FIRE SUPPRESSION, VENTILATION, BUILDING AUTOMATION SYSTEM, etc. Within each system classification, arrange product submittals by specification section, as described, such that each specification section can easily be reorganized into a master set of Divisions 20, 21, 22, 23, 25 product submittals organized by specification section. This will greatly simplify the preparation of IO&M manuals as described below.
- f. Bind product submittal information in identical 3 inch wide, hard-backed, loose-leaf, 3 ring binders with clear front and spine insert pockets. Divide information into multiple volumes so that the pages in each binder rest naturally on one side of rings.
- g. Provide a master table of contents at the front of each volume which lists the Divisions 20, 21, 22, 23, 25 specification sections and indicates which sections are located within each volume.
- h. Provide a table of contents within each section which lists the Part 2 products for that section in the same order as the applicable specification section.
- i. Provide identical cover and spine inserts for each product submittal volume, to include the following typed information:
  - 1). The Contracting Agency Name.
  - 2). Project Name.

- 3). Contractor Name.
  - 4). Subcontractor Name preparing the submittal.
  - 5). Date that the submittal or resubmittal was initiated.
  - 6). "Mechanical Product Submittals" or "Plumbing Product Submittals" etc. as appropriate.
  - 7). "Volume 1 of X, Volume 2 of X," etc.
3. Product Information:
- a. Indicate manufacturer's name and address, and local supplier's name, address, phone number.
  - b. Indicate each product as "Basis of Design", "Specified Equal" or "Proposed Substitution."
  - c. Identify catalog designation and/or model number.
  - d. Provide manufacturer's product literature. Neatly annotate to indicate specified salient features, appurtenances and performance criteria for each product specified to demonstrate compliance with the Project Manual to include scheduled information, drawing information and specified information.
  - e. Indicate product deviations from the Project Manual and mark out non-applicable items on generic "cut-sheets."
  - f. Include manufacturer provided dimensioned equipment drawings with rough-in mechanical and electrical connections.
  - g. Include operation characteristics, performance curves and rated capacities.
  - h. Include motor characteristics and wiring diagrams.
  - i. Include weight of equipment. Including accessories.
  - j. Provide basic manufacturer's installation instructions.
4. Product Substitutions:
- a. Clearly indicate both in the section table of contents and on the individual product submittal information each proposed substitution, deviation or change from the product as described in the Project Manual.
  - b. Submittal approval does not include substitutions, deviations or changes from the requirements of the Project Manual unless they are specifically itemized and approved. The term "No Exceptions Taken" will not apply to substitutions, deviations or changes not clearly identified.
  - c. Provision of a satisfactory working installation of equal quality to the system as described in the Project Manual shall be the responsibility of the Contractor.
  - d. Correct unapproved deviations from the Project Manual discovered in the field as directed by and at no additional cost to the Contracting Agency.
  - e. Cost of any design modifications as a result of proposed product substitutions shall be borne by the Contractor.
- F. System Drawings:
1. Submit System Drawings for dynamic elements/systems of the project which are performance specified to include but not limited to: Fire Suppression Systems, Building Automation Systems and stand-alone packaged equipment.
  2. Prepare system drawings on full sized sheets of the same size as the original construction drawings.

3. Include with each system a sequence of operation narrative which describes each mode of system operation in sufficient detail to demonstrate compliance with the Project Manual to the satisfaction of the Contracting Agency.

G. Shop Drawings:

1. General:

- a. The Project Manual documents are not intended for nor are they suitable for use as shop drawings. Project Manual documents shall not be utilized for the actual fabrication or installation of products or equipment.
- b. The Drawings are partly diagrammatic and do not show all offsets in piping or ducts and may not show in minute detail all features of the installation; however, provide systems complete and in proper operating order.
- c. Locations of products are approximate unless dimensioned.
- d. Divisions 20, 21, 22, 23, 25 products and systems shall not be installed without shop drawings approved by the Contracting Agency.
- e. Rework, changes or additional engineering support required as a result of the installation of products and systems prior to the approval of applicable shop drawings by the Contracting Agency shall be provided at the Contractor's expense.
- f. Drawing symbols used for basic materials, equipment and methods are commonly used by the industry. Special items are identified by a supplementary list of graphical illustrations, or identified on the drawings or specifications.

2. Preparation:

- a. Review each Divisions 20, 21, 22, 23, 25 specification section and identify the shop drawing requirements.
- b. Combine the shop drawing requirements first by system (i.e. ventilation system, heating system, plumbing system, etc.) and then by area (i.e. fan room, boiler room, etc.).
- c. Prepare shop drawings on full sized sheets of the same size as the original construction drawings.
- d. Arrange shop drawings to scale, showing dimensions where accuracy of location is necessary for coordination or communication purposes.
- e. Incorporate the actual dimensions and configurations of the products and systems approved through the product submittal process into the shop drawings.
- f. Provide dimensioned maintenance clearance areas around each product as recommended by the manufacturer.
- g. Coordinate Divisions 20, 21, 22, 23, 25 work with the interrelated work of other trades including Architectural, Civil, Structural, and Electrical.
- h. Identify and provide recommendations to resolve major conflicts which may impact the design of the systems as shown. Such conflicts will be resolved during the shop drawing review process.
- i. Identify locations where field coordination between various trades is necessary to avoid conflicts.
- j. Indicate elevation of piping, ductwork and equipment above or below finished floor at various locations and in sufficient detail to demonstrate clearance from structural elements and the work of other trades.



- k. Coordinate placement of openings and holes through structure, walls, floors, ceilings, and roof with Structural and Architectural.
3. Submittal:
    - a. Submit dimensioned shop drawings as specified to demonstrate proper planning and sequencing of the applicable trades for the installation and arrangement of Divisions 20, 21, 22, 23, 25 with respect to other interrelated work.
    - b. Partial shop drawings submittals (i.e. heating system only) will be rejected without review, as the interrelationship with other related work and overall system fit cannot be evaluated.
    - c. It is assumed that shop drawings submitted for review have been thoroughly prepared and coordinated and that the products and systems can and shall be installed as shown. Conflicts which are not clearly identified and annotated on the submitted shop drawings are assumed not to exist.
    - d. Installation conflicts arising from the failure to properly coordinate the work of related trades shall be provided at the Contractor's expense.
- H. Certificates:
1. Review the submittal requirements for Certificates for each Divisions 20, 21, 22, 23, 25 specification section.
  2. Submit copies of certificates as specified. This information may be included within the Installation, Operations and Maintenance (IO&M) Manuals as determined by the Contracting Agency.
- I. Test and Evaluation Reports:
1. Review the submittal requirements for Test and Evaluation Reports for each Divisions 20, 21, 22, 23, 25 specification section.
  2. Submit copies of reports as specified. Also include these reports within the Installation, Operations and Maintenance (IO&M) Manuals as determined by the Contracting Agency.
- J. Installation, Operations and Maintenance (IO&M) Manuals:
1. Review the submittal requirements for IO&M manuals for each Divisions 20, 21, 22, 23, 25 specification section.
  2. Begin the preparation of the mechanical IO&M manuals with a complete and fully approved set of mechanical product data submittals organized, annotated and with the product information as indicated within the "Product Data" submittals article above and in each Divisions 20, 21, 22, 23, 25 section.
  3. Next, augment each individual product submittal with the written installation, operations and maintenance information for each approved product. This type of information is not applicable (or available) for bulk commodity or simplistic products such as copper pipe, basic pipe hangers or equipment tags, etc.
  4. Annotate the installation, operations and maintenance information to indicate applicable information for the specific equipment model(s) installed.
  5. Maintenance information shall include:

- a. Preventive maintenance requirements for each product, including the recommended frequency of performing each preventive maintenance task.
  - b. Instructions for troubleshooting, minor repair and adjustments required for preventive maintenance routines, limited to repairs and adjustments that may be performed without special tools or test equipment and that require no extensive special training or skills.
  - c. Information of a maintenance nature covering warranty items, etc., that have not been discussed in the manufacturers' literature.
  - d. Information on the spare and replacement parts for each product and system. Properly identify each part by part number and manufacturer.
  - e. Recommended spare parts list.
6. Organize the IO&M manual information by specification section (not by sub-contractor) with a tabbed divider separating each section. Provide the typed section number on each tab.
  7. Within each section, organize the product information in the same order as the products are specified in Part 2 of each applicable section. Provide sub-tabs within each section for each product. Provide the typed product article number on each tab.
  8. Bind the information in identical 3 inch wide; hard-backed, loose-leaf, 3 ring binders with clear front and spine insert pockets. Divide information into multiple volumes so that the pages in each binder rest naturally on one side of rings.
  9. Provide a master table of contents at the front of each volume which lists the Divisions 20, 21, 22, 23, 25 specification sections and indicates which sections are located within each volume.
  10. Provide a table of contents within each section which lists the Part 2 products for that section in the same order as the applicable specification section.
  11. Provide identical cover and spine inserts for each IO&M manual volume, to include the following typed information:
    - a. The Contracting Agency Name.
    - b. Project Name.
    - c. "Mechanical Installation, Operations and Maintenance Manual".
    - d. "Volume 1 of X, Volume 2 of X," etc.
  12. Submit copies of Operation and Maintenance Manuals in electronic format (Adobe PDF).

## 1.7 CLOSEOUT SUBMITTALS

### A. Warranty Documentation:

1. Review the manufacturer's warranty requirements for each Divisions 20, 21, 22, 23, 25 specification section. Unless stated otherwise, provide 1-year warranty.
2. Submit required warranty documentation to the applicable Manufacturer's Representative to validate standard manufacturer's warranty for each required product. Obtain written confirmation of receipt from each applicable Manufacturer's Representative.
3. Provide Contracting Agency one copy of submitted warranty documentation and written confirmation of receipt for each applicable Manufacturer's Representative. This information may be included within the Operations and Maintenance (IO&M) Manuals as determined by the Contracting Agency.

4. Provide statement of Contractor's warranty of workmanship, labor, and materials, as described under Article 1.12 Warranty below.

B. Record Documentation:

1. General: As the Work progresses, neatly annotate a designated and otherwise unused set of Divisions 20, 21, 22, 23, 25 Contract Drawings to show the actual locations and routing of Divisions 20, 21, 22, 23, 25 Work and the terminal connection points to related Work. As a minimum, include the following:
  - a. Annotate record drawings to incorporate each applicable addendum.
  - b. Annotate record drawings as directed by each applicable Request for Information (RFI) and accepted Change Order Proposal.
  - c. Modify record drawings to show actual equipment sizes and locations and pipe and duct routing. Revise pipe and duct sizes as appropriate.
  - d. Provide dimensioned locations for permanently concealed piping and ductwork (i.e. piping cast in concrete or buried underground/underslab).
  - e. Show the actual locations of system isolation valves, especially valves which are concealed above ceilings and behind access panels.
2. Preparation:
  - a. Neatly annotate record drawings to provide clear interpretation to support electronic drafting by a third party.
  - b. Tape electronic sketches from addendums and/or RFIs directly to the record drawings as overlays.
  - c. Annotate the record drawings in colored pencil using the same symbols and abbreviations as indicated in the Divisions 20, 21, 22, 23, 25 legends and schedules of the Contract Drawings.
    - 1). Red to add information.
    - 2). Green to delete information.
    - 3). Blue to provide additional clarifying information which is not to be drafted.
  - d. After submittal to the Contracting Agency, provide additional clarification, information or rework as necessary to support the accurate interpretation and electronic drafting of the record drawings.
3. Submittals:
  - a. Provide complete record drawings for concealed areas (i.e. above lay-in and hard ceilings and inside walls) to the Contracting Agency prior to concealment.
  - b. Provide the remaining portion of the record drawings for exposed areas to the Contracting Agency prior to the final completion of the project.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts:

1. Furnish spare parts for systems and equipment as listed in applicable sections of Divisions 20, 21, 22, 23, 25.
2. Clearly label each part with name, manufacturer's part number, system and/or equipment where used and location.
3. Deliver parts to location and person designated by the Contracting Agency, in durable storage boxes.
4. Group cartons containing smaller items by system or application and deliver in an appropriate number of storage boxes.

B. Extra Stock Materials:

1. Furnish extra stock as listed in applicable sections of Divisions 20, 21, 22, 23, 25.
2. Clearly label with name, manufacturer's part number, system and/or equipment where used and location.
3. Deliver to location and person designated by the Contracting Agency, in durable storage boxes.

C. Tools: Provide three sets of special tools and testing and monitoring equipment as listed in applicable sections of Divisions 20, 21, 22, 23, 25.

1.9 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers: Companies specializing in manufacturing the Products specified in the Divisions 20, 21, 22, 23, 25 sections with minimum 3 years documented experience.
2. Fabricators: Companies specializing in fabricating the Products specified in the Divisions 20, 21, 22, 23, 25 sections with minimum 3 years documented experience.
3. Installers: Perform the Work using qualified workmen that are experienced and usually employed in the trade.
4. Testing Agencies: Products requiring electrical connection shall be listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and as indicated.

B. Product Testing and Certification:

1. Nationally Recognized Testing Laboratory (NRTL) Labeling: Electrical equipment and conductors shall be "Approved," "Certified," "Identified," or "Listed" and "Labeled" to establish that the electrical equipment is safe, free of electrical shock and fire hazard, and suitable for the purpose for which it is intended to be used. The manufacturer shall have the specific authorization of one of the Occupational Safety and Health Administration (OSHA) approved Nationally Recognized Testing Laboratories (NRTLs) in accordance with the applicable national standards to label the equipment as suitable.
2. Where the words Listed, UL Listed, UL Labeled, Underwriters Laboratories, Inc., UL, or variations of this terminology, appear under this Division of the Specifications or the associated drawings, it is understood that a comparable testing agency as defined by NRTL above is acceptable.
3. Such testing and certification is generally applicable to products within the following categories:

- a. Life safety and fire suppression.
  - b. Fuel burning equipment, except certain classes of power or industrial equipment for which other recognized certification applies as well.
  - c. Factory fabricated and wired electrical control panels and packaged equipment with factory installed electrical controls or panels.
  - d. Components for life safety systems, fuel systems and medical gas systems.
4. The listing under Paragraph '3' above is provided for illustration of requirements and is not exclusive. Provide products that have been tested and listed for the intended application when such products are available unless the Contracting Agency has provided written exemption on an itemized basis.
  5. Provide electrical products listed and labeled by UL, FM, ETL or other approved NRTL. If listing and labeling is not available, stamp the submittal for these products by an Alaska Registered Professional Engineer approved by the Authority Having Jurisdiction, at no additional cost.
  6. Where interpretation is required, the Contracting Agency will provide direction and will be the sole judge in cases of compliance with this subsection.

#### 1.10 DELIVERY, STORAGE AND HANDLING

##### A. Delivery and Acceptance Requirements:

1. Verify products are new and delivered in original factory packaging/crating and are free from damage and corrosion.
2. Replace products delivered to job site that does not comply with above requirements at no expense to Owner.
3. Remove damaged, or otherwise unacceptable, products from the project site when directed by the Contracting Agency.

##### B. Storage and Handling Requirements:

1. Store products in covered storage area protected from the elements, outside the general construction area until installed. Maintain ambient conditions required by manufacturer of each product.
2. Store products in original factory packaging until actual installation.
3. Handle items carefully to avoid breaking, chipping, denting, scratching, or other damage.
4. Replace damaged items with same item in new condition.

#### 1.11 WARRANTY

##### A. See Division 1 for general warranty requirements.

- ##### B. Warranty workmanship, labor, and materials for a period of one year from the date of final acceptance, without limitation, except where longer warranty periods are specified in a specific Section under this Division, or in the General Conditions of the Contract. Promptly coordinate and perform Warranty work at the Contractor's sole expense.

- C. Submit necessary documentation to each appropriate Manufacturer's Representative to validate manufacturer's warranty.
- D. Provide one copy of warranty documentation and confirmation receipt from the Manufacturer's Representative.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:

- 1. Cover and protect open ends and individual components of the ventilation and piping systems during construction when dust, dirt, debris, overspray, or other potential construction contaminants could enter the air distribution system or elements (ducts, fans, VAV boxes, silencers, etc.).
- 2. Provide temporary construction filters over return airshaft openings and at air handling unit return air dampers.

B. Demolition/Removal:

1. Examination:

- a. Drawings involving existing conditions are based on building record drawings and limited field observation.
- b. Conduct a site inspection prior to submission of Bid to become thoroughly familiar with the Scope of Work.
- c. Report discrepancies to the Contracting Agency before disturbing existing installation.
- d. Verify field measurements, locations, sizes, and routing arrangements and site conditions.
- e. Commencement of demolition implies Contractor accepts existing conditions.

2. Preparation:

- a. This facility will remain occupied during construction. Coordinate with the Contracting Agency in advance before scheduling disruption of services.
- b. Accommodate the Contracting Agency's normal business schedule to the maximum extent possible.
- c. Provide temporary mechanical systems to maintain existing systems in service during construction. Submit plan for providing temporary services for approval.
- d. Cover and protect open ends and individual components of the ventilation and piping systems during construction when dust, dirt, debris, overspray, or other potential construction contaminants could enter the air distribution system or elements (ducts, fans, VAV boxes, silencers, etc.).

- e. Provide temporary construction filters over return air openings and at air handling unit return air dampers.
- f. When work must be performed on operating equipment or systems, use personnel experienced in the operation of the specific equipment affected.
- g. Submit work plan and schedule for approval prior to beginning work.
- h. Notify the Contracting Agency and the Fire Department Agencies at least 24 hours before partially or completely disabling Fire Suppression, Alarm, or Notification Systems.
- i. Notify the Contracting Agency at least 24 hours before beginning welding or other 'hot' work.

3. Execution:

- a. Remove, relocate, and extend existing installations to accommodate new construction as shown and as required for phasing or final systems operations.
- b. Disconnect and remove abandoned fixtures, terminal units, and other products. Remove abandoned controls and associated wiring to source of signal and supply.
- c. Remove abandoned piping and ductwork back to source of supply or other point as shown, and cap tight to accept normal system test pressures.
- d. Remove exposed abandoned or indicated for demolition controls, equipment, pipes and ducts, including abandoned items above ceiling finishes. Cut concealed pipes and ducts flush with walls and floors. Remove brackets, stems, hangers and other accessories. Fill and repair surfaces to match surrounding finish work.
- e. Repair damaged surfaces, insulation, ceiling tiles, and fireproofing. Plug, patch, repair holes, and surfaces. Repair assemblies to match existing fire, temperature, and/or smoke ratings. Refinish surface to match surrounding finish work.
- f. Seal room penetrations to maintain pressure relationships to adjacent spaces.
- g. Maintain access to existing mechanical and electrical installations that remain active. Modify installation or provide access panels as appropriate; coordinate with the Contracting Agency.
- h. Turn salvaged items over to the Contracting Agency as noted on the Drawings. Dispose of items that the Contracting Agency does not desire to retain at a legal disposal site.
- i. Recover refrigerant charge from existing units to be demolished in accordance with EPA section 608 of the Clean Air Act of 1990. Remove recovered refrigerant from the premises.

3.2 INSTALLATION

A. Interface with Other Work:

1. Electrical Work:

- a. Coordinate with Division 26.
- b. Suggested Coordination Schedule: The Contractor is responsible to provide heating, ventilating, and plumbing equipment motors and controls, including fire suppression controls. Unless otherwise indicated on the Drawings, it is recommended that motors and controls be furnished, set in place, and wired in accordance with the following schedule. "CC" applies to either a Control subcontractor working as a sub to the

General Contractor or to the Divisions 20, 21, 22, 23, 25 Mechanical subcontractor.  
Coordinate work between subcontractors.

MC - Divisions 20, 21, 22, 23, 25-Mechanical CC - Divisions 20, 21, 22, 23, 25-Controls EC - Divisions 26, 27 and 28-Electrical	Furnished By	Set in Place By	Power By	Control By
Equipment Motors	MC	MC	EC	CC
*Magnetic motor starters:				
Automatic controlled, w/ or w/o HOA switches	EC	EC	EC	CC
Automatic controlled, w/ or w/o HOA switches, and that are furnished as part of factory wired equipment	MC	MC	EC	MC
*Manual Motor Starters:				
Manually controlled	EC	EC	EC	EC
Manually controlled, and that are furnished as part of factory wired equipment	MC	MC	EC	MC
Combination disconnect and motor starter	EC	EC	EC	CC
Motor Control Centers	EC	EC	EC	CC
Variable Speed Drives	MC	EC	EC	CC
Push-button stations, pilot lights, contactors, multi-speed switches	EC	EC	EC	EC
Disconnect switches, thermal overload switches, manual operating switches	EC	EC	EC	--
Multi-speed switches furnished as part of factory wired equipment	MC	MC	EC	MC
Temperature control relays, transformers, electric thermostats, time clocks, etc., that are not part of factory furnished equipment	CC	CC	CC	CC
Remote bulb thermostats, motor valves, controls, which are an integral part of factory furnished mechanical equipment.	MC	MC	EC	MC
Fire sprinkler suppression controls	MC	MC	EC	MC
Duct smoke detectors, including relays for fan shutdown	MC	MC	EC	EC
Fire/Smoke Dampers	MC	MC	EC	EC
Control Systems	CC	CC	CC	CC
Damper & Valve Actuators (120 v)	CC	CC	EC	CC
Damper & Valve Actuators (24 v)	CC	CC	CC	CC
Boiler and water heater controls, boiler burner control panels, internally wired	MC	MC	EC	MC



\* Provide starters in accordance with the Electrical Division of these Specifications. Note that a thermal overload relay in each phase is required for each starter (packaged equipment included).

### 3.3 REPAIR/RESTORATION

- A. Touch-up, repair or replace product components broken during installation or startup with new replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.
- C. Clean and repair existing identification tags/labels, hangers, supports, insulation, materials, instrumentation, and equipment that remain or are to be reused or are affected by this work. Materials and equipment which require major repair may be replaced at the Contractor's option.
- D. Plug, patch and repair surfaces, adjacent construction, and finishes damaged during demolition and new work. Restore to original condition or better including fire, smoke or temperature ratings or listings. Retexture surfaces to match surrounding surfaces. Repaint affected surfaces, with extent of paint to include adjacent surfaces to next wall or other clean break to avoid mismatched finish. Replace cracked or damaged ceiling tiles. Repair fire proofing, assembly fire ratings, and construction resistant to the passage of smoke.

### 3.4 SITE QUALITY CONTROL

#### A. Site Tests and Inspections:

- 1. The Contracting Agency may inspect and approve sample installation of systems and equipment prior to general installation of units.
- 2. Schedule, obtain, and pay for fees and/or services required by the local Authorities Having Jurisdiction and by these specifications, to test the mechanical systems.
- 3. Notify the Contracting Agency a minimum of 24 hours in advance of tests. Certify in writing that specified tests have been made in accordance with the specifications.
- 4. Immediately correct deficiencies that are discovered during the tests and repeat tests until system is approved. Do not cover or conceal piping, equipment, or other portions of the mechanical installations until satisfactory tests are made and approved.
- 5. Under the direction of the Contractor and in the presence of the Contracting Agency, place the entire mechanical installation and/or any portion thereof in operation to demonstrate satisfactory operation.
- 6. Arrange for the Contracting Agency to witness tests. The Contracting Agency may waive witnessing any specific test at its discretion.

#### B. Non-Conforming Work:

- 1. Expediently remove and provide new for work not conforming to the Project Manual upon discovery; including warranty and discovery periods.
- 2. Warranty period shall start over for replaced equipment and installation from the date of accepted by the Contracting Agency.

C. Manufacturer Services:

1. Authorized manufacturer's representative shall be on-site for testing, start-up, functional check-out, and commissioning of equipment and systems.
2. Procurement, installation, start-up, and warranty services to be provided by manufacturer's authorized representative and service company.
3. Equipment, devices, hardware, and software to be approved for application, and of current production. Original manufacturer's parts, hardware, software, and support to be available for ten years after installation.

3.5 CLEANING

- A. Upon completion of installation and prior to initial operation, remove debris, and clean and wipe down equipment, piping, ductwork and floor to eliminate dust and dirt.

3.6 CLOSEOUT ACTIVITIES

- A. Demonstration: Provide demonstration, conducted by authorized factory start-up personnel, to the Contracting Agencies authorized personnel as listed in each individual specification section.
- B. Training: In addition to training specified in each individual specification section, provide 4 additional hours of operational instruction conducted by qualified personnel, covering any of the mechanical systems and installation requested by the Contracting Agency to its authorized maintenance personnel.

3.7 PROTECTION

- A. Provide finished products with protective covers during balance of construction.
- B. Provide open duct ends, grilles, and diffusers with protective covers during balance of construction.
- C. Provide open pipe ends with protective caps during balance of construction.

END OF SECTION 200000

## PART 1 - GENERAL

### 1.1 SUMMARY

#### A. Section Includes:

1. Hanger, support and anchoring requirements for plumbing and mechanical appliances, equipment, and related distribution systems.
2. Building wall, floor, and roof penetration methods for the routing of plumbing and mechanical distributions systems (e.g., sleeving and sealants).

#### B. Related Sections:

1. 019100 - Commissioning
2. 200000 - Mechanical General Requirements
3. 200548 - Mechanical Vibration and Seismic Control
4. 200553 - Mechanical Identification
5. 200700 - Mechanical Insulation
6. 221100 - Domestic Water Piping and Specialties
7. 221300 - Sanitary Waste and Vent Piping and Specialties
8. 224000 - Plumbing Fixtures
9. 226300 - Medical Gas Systems
10. 231123 - Fuel Gas Piping and Specialties
11. 232113 - Hydronic Piping and Specialties
12. 232123 - Hydronic Pumps
13. 233100 - Ducts and Accessories
14. 233400 - HVAC Fans
15. 233600 - Air Terminal Units
16. 233700 - Air Outlets and Inlets
17. 237416 - Packaged Rooftop Units
18. 238200 - Terminal Heating Units

### 1.2 RELATED WORK

- A. The building structure shall be designed to support the weight of plumbing and mechanical appliances, equipment, and distribution systems (non-structural components), as well as related seismic and wind forces in accordance with ASCE/SEI.
- B. See Structural drawings for appliance and equipment housekeeping pad material, construction, and attachment. Actual housekeeping pad locations, dimensions and through penetrations shall be coordinated with approved appliance and equipment base dimensions, weights, and anchoring requirements using the product submittal and shop drawing process.

## 1.3 REFERENCES

## A. Codes and Standards:

1. See Section 200000 - Mechanical General Requirements.
2. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
3. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
4. ASCE/SEI 7-16 Minimum Design Loads for Buildings and Other Structures - Chapter 13 (Anchorage Requirements) and Chapter 29 (Wind Load Requirements).

## B. Abbreviations, Acronyms and Definitions:

1. Refer to Section 200000 - Mechanical General Requirements for general mechanical related definitions.
2. Refer to Mechanical Drawings legend sheet for general mechanical related abbreviations.

## 1.4 DESCRIPTION

## A. This section applies to Division 20, 21, 22, 23, 25 equipment and systems:

1. Support fire suppression system piping and equipment in accordance with Section 211000 - Water Based Fire Suppression Systems.
2. Support plumbing piping, appliances, and equipment in accordance with this section and Uniform Plumbing Code (UPC) requirements as applicable, whichever is more restrictive. In case of conflicts, follow UPC criteria.
3. Support mechanical system piping, appliances, and equipment in accordance with this section and International Mechanical Code (IMC) requirements as applicable, whichever is more restrictive. In case of conflicts, follow IMC criteria.
4. Support ductwork in accordance with Section 233100 - Ducts and Accessories.
5. Provide additional seismic restraint as required for mechanical and plumbing appliances, equipment, and related distribution systems in accordance with 20 0548 - Vibration and Seismic Control.

## B. Design Requirements:

1. Equipment and piping system support:
  - a. Select and apply pipe hangers and supports per MSS SP58 using stock or production parts whenever possible.
  - b. Design support spacing such that free span of piping does not exceed Code or MSS SP69 criteria, whichever is most restrictive.
  - c. Calculate required supporting force at each hanger location to confirm hanger type and hanger rod diameter selection.
  - d. Provide hangers such that equipment connection points do not carry connected piping load.
  - e. When possible, adjust hanger spacing, hanger rod length/diameter to meet the seismic design exclusion criteria of ASCE/SEI 7 to minimize the need for additional seismic restraint.

2. Vibration and seismic restraint systems: If the exclusion criteria of ASCE/SEI 7 cannot be met, provide additional seismic support as required for mechanical and plumbing appliances, equipment, and related distribution systems in accordance with 20 0548 - Vibration and Seismic Control.
3. Building Design Criteria:
  - a. This project is not designated as an essential facility.
  - b. Wind design data: See Structural Design Criteria Schedule.
  - c. Seismic design data: See Structural Design Criteria Schedule.
  - d. Component Importance Factors,  $I_p$ :
    - 1). Fire suppression systems:  $I_p = 1.5$
    - 2). Fuel gas system:  $I_p = 1.5$
    - 3). Piping Importance Factor:  $I_p = 1.0$
    - 4). All other components:  $I_p = 1.0$

C. General Performance Requirements:

1. Plumbing and mechanical distribution systems as shown are semi-diagrammatic.
2. Provide additional hangers, expansion loops, pipe anchors and pipe guide assemblies as required based on actual (as-built) distribution system layout/routing.
3. Coordinate hanger and support anchor locations and methods with structural.
4. Provide hangers and supports that allow for the free expansion and contraction of system piping without transferring tensile and compressive stresses to adjacent supports or connected equipment.

D. Special Performance Requirements for Open Ceiling Spaces:

1. Coordinate the support of piping, ductwork, lighting, and electrical cabling in open ceiling spaces (utilizing the shop drawing review process) to provide a uniform and symmetrical appearance.
2. In general, utilize trapeze hanger style support systems with hangers equally spaced based on the limiting component being supported. Provide hanger rods vertical and straight. Trim hanger rod ends to provide a "finished" appearance.

- E. Equipment and Systems Subject to Wind Loading: Provide equipment anchorage and additional support in accordance with the manufactures recommended installation requirements, as well as ASCE/SEI 7 anchorage and wind load requirements (e.g., roof mounted equipment).

1.5 PRE-INSTALLATION MEETINGS

- A. See Section 200000 - Mechanical General Requirements.

1.6 SUBMITTALS

- A. See Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

B. Product Data:

1. Provide manufacturers catalog data, including load capacity, embedment depth.
2. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

C. Shop Drawings:

1. Submit dimensioned shop drawings for housekeeping pads and roof curbs (with dimensioned penetration locations).
2. Submit shop drawings for field fabricated support systems.
3. For plumbing and mechanical distributions system shop drawings.
  - a. Overlay locations and types of hangers and supports to be provided.
  - b. Include details for each hanger and support type with anchorage requirements.
  - c. Dimension expansion loops and alignment guide locations and offsets.
  - d. Coordinate additional seismic and vibration isolation requirements with Section 20 0548 - Vibration and Seismic Control.

1.7 CLOSEOUT SUBMITTALS

A. Record Documentation:

1. Indicate installed locations of hangers, supports and expansion control assemblies on record drawings on associated piping record drawings.
2. Provide Operating and Maintenance Data (installation and adjustment instructions) for non-commodity products.

1.8 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum 3 years documented experience.
2. Installers: Minimum 3 years' experience.
3. Provide piping and support systems designed and manufactured per MSS SP69.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. See Section 200000 - Mechanical General Requirements.

1.10 WARRANTY

- A. See Section 200000 - Mechanical General Requirements.

## PART 2 - PRODUCTS

## 2.1 PIPE HANGERS AND SUPPORTS

## A. General:

1. Piping and support systems materials: Malleable iron, steel, or copper.
2. Ferrous hangers and supports installed outdoors or in unheated spaces shall be hot dipped galvanized.
3. Select and apply pipe hangers and supports per MSS SP69. Use stock or production parts whenever possible.
4. Fabricate and install pipe hangers and supports per MSS SP69 recommended practices.
5. Hangers shall securely lock using a mechanical fastener. Hangers and supports using gravity type locking are not acceptable. For example, adjustable swivel ring Type 6 is not allowed.
6. Pre-engineered support systems such as Unistrut, Super-Strut, B-Line and K-Line may be used in accordance with manufacturers load limits.
7. Manufacturers: Grinnell, M-CO Michigan Hanger Company, Kin Line.

## B. Plumbing Piping:

1. Conform to the Uniform Plumbing Code requirements.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Adjustable swivel ring; split ring.
3. Hangers for DWV and Cold Pipe Sizes two inch and over: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe sizes two to four inch: Carbon steel, adjustable, clevis.
5. Multiple or Trapeze Hangers under six inches: Steel channels with welded spacers and hanger rods.
6. Wall Supports: Welded steel bracket and wrought steel clamp.
7. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.
8. Vertical Support: Steel riser clamp.
9. Provide copper plated hangers and supports for copper piping. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

## C. Hydronic Piping:

1. Conform to ASME B31.9 and the International Mechanical Code.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Adjustable swivel ring; split ring.
3. Hangers for Hot Pipe sizes two to four inch: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support: Welded steel bracket and wrought steel clamp.
6. Vertical Support: Steel riser clamp.
7. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.
8. Floor Support for Hot Pipe Sizes up to four inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.
9. Provide copper plated hangers and supports for copper piping. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

## D. Refrigerant Piping:

1. Conform to ASME B31.5.
2. Hangers for pipe sizes 1/2 to 1-1/2 inch: Adjustable swivel ring, split ring.
3. Hangers for pipe sizes two inches and over: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support: Welded steel bracket and wrought steel clamp.
6. Vertical Support: Steel riser clamp.
7. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and steel support.
8. Provide copper plated hangers and supports for copper piping. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
9. Pre-insulated pipe hanger inserts to permit continuous insulation at the pipe hangers: Armaflex, Model IPPH or equal.

## 2.2 DUCTWORK, FLUES, STACKS, AND BREECHINGS HANGERS AND SUPPORTS

- A. Provide hangers and supports for ductwork in accordance with Section 233100 - Ducts and Accessories.
- B. Provide hangers, supports, and/or guy wires as applicable for flues, stacks, and breechings in accordance with Section 235100 - Breechings, Chimneys and Stacks.

## 2.3 ACCESSORIES

- A. Hanger Rods: Mild steel, threaded both ends, threaded one end, or continuous threaded.
- B. Escutcheons: Nickel or chrome plate with screws or springs for holding plate in position.
- C. Pipe Protection Saddles: Shop fabricated or purchase specially manufactured saddles specifically designed for the intended use. Provide saddles where roller type support is used, or where the pipe hanger is installed outside the insulation for protection of insulating jacket.
- D. Outdoor applications: Metal components shall be galvanized.

## 2.4 INSERTS

- A. Provide inserts to match the load bearing capacity of hangers.
- B. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inch diameter.
- C. Concrete deck inserts: Galvanized rod, steel plate, similar to Kin-Line Figure 293.
- D. Screw insert for concrete: Malleable iron similar to Grinnell Figure 152.



## 2.5 PRE-ENGINEERED SUPPORT SYSTEMS

## A. Manufacturers:

1. Unistrut.
2. Super-Strut.
3. B-Line.
4. K-Line.
5. Erico.
6. Approved equal.

## B. Materials and Finish:

## 1. Heated Indoor Applications:

- a. Carbon steel with pre-galvanized zinc (PG) finish.
- b. Carbon steel with plain (PL), paintable galvanized, or phosphatized and primed when welding or painting will be required.

## 2. Outdoor and Unheated Applications:

- a. Carbon steel with hot dipped galvanized zinc (HG) finish. Coat field cuts with zinc rich paint provide by the support system manufacturer.
- b. Stainless steel (Type 304) where specifically specified for use in damp, corrosive, or marine environments.

## C. Special Finishes for Surface Metal Raceways: High performance epoxy coating (e.g., Unistrut Perma-Green III).

## D. Channel:

1. Standard Size: 1-5/8 inch x 1-5/8 inch. Gauge thickness as required for attached load.
2. Standard Hole Pattern: Slotted. Provide solid channel in exposed public areas.

## E. Fittings: Match channel material and finish.

## F. Nuts and Hardware:

1. Channel nuts: Hardened steel (ASTM-A675 and ASTM A36).
2. Bolts, screws, and nuts: Hardened steel (ASTM-A307, ASTM A563 and SAE J429).
3. Material and Finish:
  - a. Heated indoor applications: Electro-galvanized (EG).
  - b. Outdoor applications: Hot-dipped galvanized (HG). Stainless steel (Type 304) where specifically specified for use in damp, corrosive, or marine environments.

## G. Mechanical Accessories: Provide accessories from the support system manufacturer designed for the specific equipment to be supported to include but not limited to:

1. Pre-insulated pipe hanger inserts to permit continuous insulation at the pipe clamps: Unistrut model PUX, Armaflex model IPPH.
2. Splice and gusset plates.
3. Corner angles.
4. Specialized support brackets.
5. Beam clamps with restraints.
6. Column supports.
7. Strut pipe clamps.
8. Straps.
9. Brackets.

## 2.6 PIPING ROOF SUPPORTS (NON-PENETRATING)

- A. Manufacturers:
  1. Cooper Industries (Dura-Blok).
  2. Miro Industries, Inc.
  3. Pipe Pier.
  4. Mifab.
- B. Resilient, non-abrasive, UV resistant base. Galvanized steel channel and clamps. Zinc plated, adjustable hardware. Compatible with roof system.
- C. Roof supports shall be provided to maintain piping a minimum of 3-1/2 inches above the roof surface.

## 2.7 SEISMIC RESTRAINT SYSTEMS

- A. See Section 200548 - Vibration and Seismic Control.

## 2.8 SLEEVES, ACOUSTICAL SEALS AND FIRE-STOPPING

- A. Fabricate sleeves in non-load bearing walls from 20-gauge galvanized sheet steel conforming to ASTM A924 / A924M.
- B. Fabricate sleeves in load-bearing walls from standard-weight galvanized steel pipe conforming to ASTM A53 / A53M.
- C. Provide UL listed prefabricated fire rated sleeves and seals for pipes through fire rated and fire resistive floors and walls.

## 2.9 FRAMED OPENINGS

- A. Provide structural steel members for framed openings conforming to ASTM A36 / A36M.
- B. Closure Collars:

1. For round and rectangular ducts with a minimum dimension less than 16 inches, fabricate collars from 20 gauge galvanized steel.
2. For round and rectangular ducts with a minimum dimension of 16 inches or greater, fabricate collars from 18 gauge galvanized steel.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Visually inspect appliances, equipment and distribution systems requiring anchorage/attachment to structure for installation location tolerance, interference and other conditions affecting installation.
- B. Verify actual locations of cast-in-place anchors, structure reinforcements and other required attachments prior to installation.
- C. Document and correct deficiencies or submit proposed design modifications for approval prior to the installation.
- D. Note if Project contains cast in place radiant floor heating tubing. Coordinate slab penetration locations so as to not damage tubing.

#### 3.2 PREPARATION

- A. Prior to installation, prepare detailed shop drawings of the planned installation of hanger and support products specified by this section. Coordinate the location, type and size of hangers and supports, housekeeping pads (thickness/perimeter overhang dimensions) and roof curbs with Architectural and Structural elements utilizing the shop drawing review process.
- B. If exclusion criteria of ASCE/SEI 7 cannot be met, coordinate and provide additional seismic support as required for mechanical and plumbing appliances, equipment, and related distribution systems in accordance with 200548 - Vibration and Seismic Control.
- C. Submit shop drawings required by this section coordinated with the seismic design as required.
- D. Do not install hangers and supports without approved shop drawings.

#### 3.3 INSTALLATION

- A. Attachment:
  1. Hollow masonry: Toggle bolts.
  2. Solid masonry and concrete: Preset inserts or expansion bolts.
  3. Structural steel: Beam clamps which engage both sides of structural member or have retaining clips or other approved means for positive engagement.

4. Metal surfaces: Machine screws, bolts, or welding.
5. Wood construction: Wood or sheet metal screws.
6. Do not use powder-actuated fasteners for anchorage in tension applications. Obtain written permission from the Owner prior to using any type of powder powered studs.
7. Plastic screw inserts and caulked lead inserts are prohibited, except for mounting instructions and control diagrams.

B. Pipe Hangers and Supports:

1. Install hangers and supports in accordance with manufacturer’s instructions, applicable code requirements and approved shop drawings.
2. Pipe Support: Provide pipe support spacing as indicated in the table below, except where spacing is more restrictive by Code.

PIPE SIZE (Inches)	HANGER SPACING MAX (Feet )			
	Steel		Copper	PE, CPVC (1)
	Water Filled	Gas Filled		
1/2	7	9	5	
3/4	7	9	5	
1	7	9	6	
1-1/4	7	9	7	
1-1/2	9	12	8	
2	10	13	8	
2-1/2	11	14	9	
3	12	15	10	
4	14	17	12	
6	17	21	14	
8	19	24	16	

(Based on Table 4, MSS SP-69, except for PE piping)

(1) (Based on manufacturer's data)

3. Independently support piping at equipment, such that the equipment supports no weight.
4. Insulated piping: Coordinate with Section 200700 - Mechanical Insulation. Provide insulation saddles or 18 gauge steel insulation shields combined with sections of calcium silicate or cellular glass or provide pre-insulated pipe hanger inserts to permit continuous insulation at the pipe hangers or clamps.
  - a. Support cold piping outside the insulation and vapor barrier where continuous vapor barrier is specified.
  - b. Subject to approval, hot piping may be insulated around the supports.

5. Provide trapeze hangers when more than three pipes run parallel and at same elevation.
6. Provide roller supports for hot pipes. Provide saddles where roller type support is used, or where the pipe hanger is installed outside insulation for protection of insulating jacket.
7. Design rods and cross members to support three times the weight of pipes and contents plus 250 pounds.
8. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
9. Place hangers within 12 inches of each horizontal elbow.
10. Use hangers with 1-1/2 inch minimum vertical adjustment.
11. Support horizontal cast iron pipe adjacent to each hub, with five feet maximum spacing between hangers.
12. Support riser piping independent of connected horizontal piping.

C. Piping requiring Vibration Isolation:

1. Support main risers less than 20 feet in height only at mid-level, with riser guides at other levels.
2. Do not support vibration isolated piping along with non-isolated piping on a common trapeze.
3. Rigidly mount steel spring hanger boxes to the supporting structure. Do not locate in the middle of the hanger rod.
4. Rigid pipe anchors are not permitted in vibration isolated piping circuits. When pipe anchors are required.

D. Equipment Bases and Supports:

1. For cast-in-place concrete requirements refer to Division 3 - Concrete.
2. Unless noted otherwise, provide 3-1/2 inch high (2x4 form) reinforced concrete housekeeping pads with 8 inches minimum extended, chamfered edge beyond base frame in all directions for floor mounted appliances and equipment. Where exterior isolators are used, this distance is measured from the outermost holes in the isolator base plate to the edge of the housekeeping pad.
3. Provide 5-1/2 inch high (2x6 form) reinforced concrete housekeeping pads for larger and heavier equipment to include fuel oil day tanks, steam generators, boilers, buffer tanks, water heaters, air compressors, expansion tanks, water cooled chillers and heat pumps, water storage tanks, pressure tanks, and kitchen makeup air unit MAU-2. Pads shall extend 8 inches minimum beyond equipment as noted above.
4. The 8-inch extended edge beyond base frame dimension may be reduced to 6 inches minimum with approved anchorage calculations.
5. Construct field fabricated equipment bases and supports from steel members and/or pre-engineered support systems. Prime and paint bases and supports black in accordance with Division 9 - Finishes.
6. Pre-engineered support systems which are factory coated are not required to be painted.

E. Roof Curbs:

1. Coordinate field fabricated roof curb locations and dimensional and support requirements for roof mounted equipment with Architectural and Structural.
2. Pre-engineered roof curbs are specified with the equipment being mounted. See applicable specification sections.

## F. Equipment and Systems Subject to Wind Loads:

1. Provide equipment anchorage and additional support in accordance with the manufacturer's recommended installation requirements, as well as ASCE/SEI 7 anchorage and wind load requirements.
2. As applicable, provide wind restraint systems (e.g., guy wires, etc.) in compliance with the manufacturer's written instructions, and certified and approved application engineering installation details.
3. Install wind restraints so as not to stress or misalign equipment, piping, and ductwork.

## G. Penetrations:

1. Coordinate mechanical penetrations with architectural and structural construction details prior to installation. Set sleeves in position in concrete formwork. Provide reinforcement around sleeves as required.
2. Provide compatible materials, fasteners, adhesives, sealants, and other products required for proper installation.
3. Provide penetrations through roof, exterior walls, and floors (See floor penetration seals) to be weather and watertight.
4. Provide UL rated fire-stopping assemblies for rated roof, wall and floor penetrations in accordance with Division 07.
5. Seal penetrations through smoke partitions and barriers to resist the passage of smoke.
6. Sleeves:

- a. Provide sleeves for pipe and round ducts less than 16 inches diameter passing through floors, walls, ceilings, or roofs.
- b. Provide 1 inch clearance between the pipe or duct and sleeve opening. Oversize sleeves for cold piping to allow continuous insulation through sleeve. Coordinate with UL listed firestop through penetration details.

## 7. Framed Openings:

- a. Provide framed openings for round ducts 16 inch diameter and greater and rectangular ductwork passing through floors, walls, ceilings, or roofs.
- b. Provide 1 inch clearance between the duct and framed opening.
- c. Provide closure collars not less than 4 inches wide on each side of penetration.
- d. Escutcheons: Provide escutcheons for ductwork, piping, and conduit passing through walls, floors, and ceilings in finished areas, below counters and inside closets and casework subject to view when doors are open. Size escutcheons to cover sleeves. Secure escutcheons in position.

## 8. Wall Penetration Seals:

- a. Provide pre-engineered wall penetration water seal systems for exterior wall penetrations.
- b. Select appropriate wall penetration sealing systems based on pipe/conduit material and nominal pipe/conduit size in accordance with the manufacturer's selection charts.
- c. Install piping/conduit and sealing system prior to waterproofing the wall. Grout void between water seal and outside face of foundation wall to provide continuous bearing surface for waterproofing fabric.

9. Floor Penetration Seals:
  - a. Provide pre-engineered floor penetration water seal systems for floor penetrations in rooms where a pipe leak/failure could result in water damage to adjacent spaces (i.e. mechanical rooms located above the ground floor or basement) and other areas as noted.
  - b. Floor penetrations to include but not limited to: Building service piping, conduit, ductwork and building automation system wiring.
  - c. Extend floor penetration sleeves 2 inches above finished floor.
10. Roof Flashing: Provide roof penetration and roof curb flashing in accordance with Division 07 as an integral part of the roofing system.

### 3.4 INTERFACE WITH OTHER WORK

- A. Coordinate and sequence installation of hangers and supports with trades responsible for portions of this and other related sections of the Project Manual

### 3.5 REPAIR/RESTORATION

- A. Repair any product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

### 3.6 SITE QUALITY CONTROL

- A. Non-Conforming Work: Rework required as a result of failure to follow the manufacturer's written installation instructions or to properly coordinate with related Work shall be completed at no additional expense to the Owner.

### 3.7 CLEANING

- A. Waste Management: After construction is completed, clean and wipe down exposed surfaces.

END OF SECTION 200529

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PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Section Includes: Performance requirements for the design, product selection and installation of seismic and vibration control anchors, bracing and supports for nonstructural mechanical, electrical, and plumbing (MEP) system components.

B. Related Divisions and Sections:

1. Divisions 20, 21, 22, 23, 25 - Mechanical
2. Divisions 26, 27 and 28 - Electrical

1.2 RELATED WORK

- A. The building structure shall be designed to support the weight of the projects non-structural components, as well as related seismic and wind forces in accordance with ASCE/SEI 7.

1.3 REFERENCES

A. Codes and Standards:

1. Refer to Section 200000 - Mechanical General Requirements for general Code and Standard references.
2. ASCE/SEI 7-16 Minimum Design Loads and Associated Criteria for Buildings and Other Structures.

B. Abbreviations, Acronyms and Definitions:

1. See Section 200000 - Mechanical General Requirements and Section 260000 - Electrical General Requirements for general abbreviations, acronyms, and definitions.
2. See Mechanical and Electrical Drawings (Legend and Abbreviations).
3. Seismic Design Firm (SDF): A firm specializing in the design, manufacturing, testing and certification of vibration and seismic restraint systems (and their individual components) for attachment and support of building mechanical and electrical equipment and associated distribution systems. The SDF provides certification that it's manufactured vibration and seismic restraint systems are seismically qualified for service by analysis, testing and/or experience data in accordance with ASCE/SEI 7, Chapter 13.
4. Seismic Design Firm Representative: Structural engineer regularly employed by the SDF. Proficient in the design and proper application of seismically qualified (certified) vibration and seismic control attachments and support systems for building mechanical and electrical equipment and distribution systems.

5. Seismic Design Engineer (SDE): Alaska licensed professional structural engineer with advanced formal education and training in structural engineering relating to seismic design. Responsible for the design, field certification and as-built drawing documentation of the project's vibration and seismic control design.
6. Project Structural Engineer: The project's structural design engineer of record.

#### 1.4 SYSTEM DESCRIPTION AND CRITERIA

##### A. Design Requirements:

1. Provide vibration isolation and seismic control anchoring and support system products and application design and installation supervision services from a single pre-approved product manufacturer/Seismic Design Firm (SDF) and/or an Alaska licensed Structural Design Engineer serving as the SDE.
2. Note that the project's structural design engineer of record may serve as the SDE.
3. Provide the design to anchor, brace, and support the facility's non-structural components and associated distribution systems, including pre-engineered equipment, to the building's structure in accordance with ASCE/SEI 7 Chapter 13 (Seismic).

##### B. Building Design Data: See Section 200529 - Mechanical Hangers and Supports

##### C. Performance Requirements are the responsibility of the SDE and include:

1. Review the contract documents to determine the scope of the vibration and seismic control design for the project.
2. Work with the Contractor and provide recommendations regarding the physical routing of mechanical and electrical distribution systems to limit the need for additional seismic support. See ASCE/SEI 7, Section 13.6 Exceptions.
3. Define the mechanical and electrical components and distribution systems which will require vibration and seismic support to comply with ASCE/SEI 7.
4. Provide professional engineering seismic design force calculations, associated design drawings, details and selected products to be used to provide the necessary vibration isolation and/or seismic restraint at each required location.
5. Coordinate vibration and seismic design force conditions with Project Structural Engineer and incorporate adjustments necessary to avoid overstressing the building structure.
6. Submit vibration and seismic design for review by the Owner's Representative for approval.
7. Supply and deliver packaged vibration isolation and seismic restraint products with detailed installation instructions to the project site.
8. Provide onsite training to the Contractor to ensure the proper installation and performance of the project's vibration and seismic control systems.
9. Review MEP product submittals for products which include factory provided vibration isolation and/or seismic restraint component(s) for compliance with the seismic design. Provide written review comments.
10. Provide field certification that the project's vibration isolation and seismic attachments and supports installation is complete and conforms to the approved vibration and seismic control design.

## 1.5 SUBMITTALS

- A. See Section 200000 - General Mechanical Requirements and Section 260000 - General Electrical Requirements for general submittal requirements.
- B. Submit Quality Assurance qualifications for:
  - 1. Seismic Design Firm (SDF).
  - 2. Seismic Design Engineer (SDE).
  - 3. Vibration isolation and seismic restraint product manufacturer.
  - 4. Mechanical, electrical, and plumbing trade installers.
  - 5. Contractor's Statement of Responsibility.
- C. Submit stamped engineering design for the project's vibration isolation and seismic design by a qualified, Alaska licensed professional structural engineer to include:
  - 1. Support and attachment (or anchoring) detail drawings for each application.
  - 2. Product selection, size, and installation configuration for each application.
  - 3. Seismic design force data, assumptions, and calculations for each application.
  - 4. Coordination requirements for topping slabs for embedded mechanical or electrical systems (e.g., radiant tubing, conduit, sensors).
  - 5. Include evidence of coordination with Project Structural Engineer.
- D. Submit vibration and seismic control design as a single submittal package. For larger projects, the vibration and seismic control submittal may be broken down into multiple smaller submittal packages, with each package covering a specific area of the building (e.g., Area A – First Floor, Penthouse Mechanical Room, etc.).
- E. Product Data:
  - 1. Annotated product catalog cutsheets and/or data sheets for the selected vibration isolation and seismic restraint products to be provided.
  - 2. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and restraints by referencing numbered descriptive drawings.
- F. For Seismic Design Categories C thru F:
  - 1. Life Safety Components: Submit approved agencies' Analytical or Shaker Test "Certificate of Compliance" certificates.
  - 2. Components Needed for the Continued Operation of the Facility: Submit approved agencies' Analytical or Shaker Test "Certificate of Compliance" certifications.
  - 3. Components Containing Hazardous or Flammable Materials: Submit approved agencies' Analytical or Shaker Test "Certificate of Compliance" certificates. Testing shall prove that no internal component will rupture to ensure against loss of hazardous or flammable (explosive) material which could support combustion, ignition or cause contamination.
  - 4. Use of historical data is permitted if evidence confirms historical based component having the same construction and weight with accompanying center of gravity as the submitted unit and basis of historical claim conforms to loads derived in testing with accompanying accelerations based on ICC-ES AC-156, "Acceptance Criteria for Seismic Certification by Shake-table Testing of Nonstructural Components."

5. Components not listed and requiring only anchorage and load transfer compliance: The SDE shall submit stamped engineering calculations, drawings, and details to support the project specific equipment will accept anchorage through the component's load path to structure at its center of gravity, at the designated anchorage locations.

G. Substitutions:

1. The proposed substitution equipment manufacturer shall provide a letter certifying that the equipment's packaged or recommended vibration isolation and seismic restraint methods comply with the requirements of this specification. Letters from field offices or representatives are not acceptable.
2. The cost associated with converting to the specified vibration isolation and/or seismic restraints method shall be borne by the Contractor in the event of non-compliance.

H. Shop Drawings. Submit floor plan shop drawings which include and identify the locations of:

1. Approved major mechanical and electrical system components.
2. Vibration isolated components and systems.
3. Mechanical and electrical distribution systems.
4. Identify building seismic joint locations and calculated displacement at each floor level.
5. Identify exempt components and distribution systems in accordance with ASCE/SEI 7 Chapter 13.
6. Identify vibration isolation and seismic control attachment and support locations with reference to applicable detail drawing(s).

I. Quality Assurance/Control Submittals:

1. Contractor's Quality Assurance and Quality Control procedures for the administration and tracking of special inspections and testing.
2. Design Data and Test Reports.
3. Certificates and Manufacturer's Instructions.
4. SDF qualifications and E&O insurance certificate.
5. SDE professional license and seismic engineering qualifications.
6. Authority Having Jurisdiction submittal review comments and final approval notification.
7. Manufacturer's Field Reports.
8. SDF and/or SDE certification of the correctness of completed installation.

J. Installation, Operation and Maintenance (IO&M) Manual:

1. Provide a copy of the manufacturer's written installation, operation, and maintenance manual to include the following information:
  - a. Manufacturer's descriptive literature neatly annotated to clearly indicate information applicable to the equipment installed.
  - b. Certified seismic design calculations and installation details.

K. Close-out Submittals:

1. Project record drawings: Annotate a clean copy of the project Contract Drawings to clearly indicate the actual installation location of each vibration and seismic restraint device type and keyed to the appropriate installation detail.
2. Provide a certificate from the Manufacturer's Representative indicating that the vibration and seismic restraint systems of the facility are installed and operational as designed.

#### 1.6 QUALITY ASSURANCE

- A. Manufacturer qualifications: Company specializing in manufacturing the products specified in this section with a minimum of five years documented experience.
- B. Installers' qualifications: Minimum five years' experience in the installation of specialized vibration and seismic control systems.
- C. SDF qualifications: Minimum five (5) years' experience in the design, selection, and inspection of specialized seismic control systems for facilities with similar occupancies and seismic criteria and acceptable to the Authority Having Jurisdiction.
- D. SDE qualifications: Minimum five (5) years documented seismic engineering experience and acceptable to the Authority Having Jurisdiction.
- E. Errors and Omissions Insurance Certificate: Submit copy of SDF/SDE E&O insurance certificate(s). Product liability insurance certificates are not acceptable.
- F. Pre-Installation Meetings:
  1. Conduct a coordination meeting prior to the installation of vibration isolation and seismic restraint equipment.
  1. Discuss the equipment and systems affected by this Section and the method to be used to coordinate the installation and inspection of vibration isolation and seismic restraint equipment.
  2. Conduct additional meetings as required to coordinate the work.
  3. The meeting will be attended by:
    - a. The Contractor.
    - b. Contractor's Commissioning Representative (if applicable).
    - c. Trade foremen for the systems affected by the work.
    - d. The SDF representative.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. See Section 200000 - Mechanical General Requirements.

#### 1.8 WARRANTY

- A. See Section 200000 - Mechanical General Requirements.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

#### A. Seismic Design Firms (SDF):

1. ISAT/Kinetics Noise Control.
2. Mason Industries.
3. Vibration Mountings & Controls (VMC Group).
4. Pre-approved equal.

#### B. Vibration Isolation and Seismic Restraint Products:

1. International Seismic Application Technology (ISAT) (Seismic Restraint).
2. Kinetics Noise Control (Vibration Isolation).
3. Mason Industries.
- 4.
5. Vibration Mountings & Controls (VMC Group).
6. Hilti.
7. Unistrut, Tyco International.
8. Other: Pre-approved.

### 2.2 FINISHES

#### A. Product finishes for corrosion protection:

1. Exposed steel to be stainless steel, galvanized, or finished with dry powder coating.
2. Hardware: Zinc electroplated, galvanized, or stainless steel.
3. Hardware in contact with concrete and surfaces subject to liquids shall be stainless steel.
4. Springs and housings shall be powder coated.

#### B. In public areas, exposed support systems and elements shall be painted, excluding dynamic assemblies which shall have manufacturer's coating:

1. Clean and prepare pipe, fittings, hangers, restraints, supports, and miscellaneous items for areas to be painted.
2. Refer to the requirements specified in Division 09.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- #### A. Visually inspect appliances, equipment and distribution systems requiring vibration isolation and/or seismic restraint for installation location tolerance, interference and other conditions affecting installation.

- B. Verify actual locations of cast-in-place anchors, structure reinforcements and other required attachments prior to installation.
- C. Document and correct deficiencies or submit proposed design modifications for approval prior to the installation.
- D. Note if Project contains cast in place radiant floor heating tubing. Coordinate slab penetration locations so as to not damage tubing.

### 3.2 INSTALLATION

- A. When possible, and without compromising distribution system performance or maintenance/replacement accessibility, route distribution systems such as to limit the extent of seismic support required in accordance with ASCE/SEI 7 Chapter 13, Section 13.6 Exemptions.
- B. When the exemption requirements of ASCE/SEI 7 cannot be met, provide vibration isolation and seismic restraint in accordance with the applicable sections of Section 13.6. and the following:
  - 1. Install seismic control systems in compliance with the approved seismic design drawings and details and approved product manufacturer's written instruction instructions.
  - 2. Install seismic control so as not to stress or misalign equipment, piping, or ductwork.
  - 3. Provide flexible connections for piping, ductwork, and conduit connections to vibration isolated equipment.
  - 4. Do not install rigid connections directly between vibration isolated equipment and the building structure.
  - 5. Seismic restraint systems shall not interfere with installation or maintenance access to other building systems.
  - 6. Install seismic cable assemblies taut on non-vibration isolated systems.
  - 7. Install seismic cable assemblies with a slight amount of slack for vibration isolated systems to avoid sound shorts.
  - 8. Seismic single arm braces may be used in place of cables on rigidly attached systems and in place of cables on isolated systems when resilient bushings are used.
  - 9. Conduct Special and Periodic Inspections in accordance with FIELD QUALITY CONTROL article requirements.

### 3.3 INSTALLATION OF EQUIPMENT

- A. Install indoor floor mounted equipment on raised reinforced concrete housekeeping pads. Extend pads beyond equipment base rails/floor mounting plates equally in all directions to meet seismic anchor embedment requirements. See Section 150529 - Mechanical Hangers and Supports for detailed housekeeping pad requirements.
- B. Install exterior equipment on crowned reinforced concrete equipment pads. Extend pads beyond equipment base rails/floor mounting plates equally in all directions to meet seismic anchor embedment requirements.

- C. Install pump and other equipment bases into position, at normal vibration isolator operating height, using temporarily support blocks or shims prior to the installation of the equipment, isolators, and seismic restraints.
  - 1. After the installation, and under full load (e.g., equipment filled with operating fluid), adjust isolators to transfer load from the temporary blocks to the isolators.
  - 2. Next, remove temporary blocks, shims, and debris from beneath the equipment and verify no vibrational “short circuits” exist.
  - 3. Confirm equipment is free to move in all directions, within the limits of the seismic snubbers (maximum 0.25 inches).
  - 4. Minimum operating clearance between top of housekeeping pad and underside of isolator mounted equipment is 2 inches.
- D. Protect air handling equipment and centrifugal fans from excessive displacement resulting from air thrust in relation to equipment weight. Provide horizontal thrust restraints if horizontal motion exceeds 3/8 inch.
- E. Provide earthquake ceiling clips or other approved means of positive attachment of ceiling mounted diffusers and lighting fixtures (less than 75 pounds) to the ceilings T-bar support grid. Where ceilings are not braced, provide lay-in lighting fixtures with 4 independent corner diagonal wire ties to structure.

### 3.4 CONSTRUCTION

- A. Interface with other Work:
  - 1. Coordinate and sequence installation of vibration, seismic control and wind load bracing with trades responsible for portions of this and other related sections of the Project Manual.
  - 2. Rework required because of failure to follow the manufacturer’s written installation instructions or properly coordinate with related Work shall be completed at no additional expense to the Contracting Agency.
  - 3. Coordinate and schedule special inspections related to systems under this specification section.

### 3.5 REPAIR/RESTORATION

- A. Repair product components broken during installation or startup with replacement parts supplied by the product manufacturer.
- B. Substitute replacement parts from other manufacturers are not acceptable.

### 3.6 FIELD QUALITY CONTROL

- A. Special Inspections:



1. Perform Independent Special and Periodic Inspections with written reports of findings of the seismic restraint systems serving nonstructural MEP system components at the expense of the Owner.
2. Special Periodic Inspections: See IBC Section 1705.13.6 for minimum inspection requirements.
3. Submit special inspection written reports a maximum of 2 working days following site inspection.

B. Manufacturer's Field Services:

1. Upon completion of installation of vibration isolation and seismic restraint devices and systems, the SDF's representative shall inspect the completed project and certify in writing to the Contractor that systems are installed properly or provide detailed corrective action as required.
2. If corrections are required, additional inspections shall be completed by the SDF's representative until all the work is certified to be installed properly.
3. The Contractor shall submit a report to the Owner which includes the SDF's representative letter certifying correctness of the installation.

3.7 CLEANING

- A. Upon completion of installation remove construction debris from around vibration isolated and seismically restrained components to allow free motion in all directions within the limits of the seismic restraining devices.

3.8 EQUIPMENT STARTUP

- A. Prior to equipment startup, remove shipping restraints from vibration isolators and adjust in accordance with the applicable manufacturers written operating instructions.
- B. During start-up, with attached piping systems filled (as applicable), verify proper vibration isolator active spring heights and snubber offsets.
- C. Adjust vibration isolators and seismic restraints during equipment operation to allow normal movement and minimize the transmission of equipment sound and vibration through the building structure and attached distribution systems.

END OF SECTION 200548

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## PART 1 - GENERAL

### 1.1 SUMMARY

#### A. Section includes:

1. Equipment Nameplates.
2. Valve Tags.
3. Valve and Equipment Directories.
4. Pipe Identification.
5. Ceiling Markers.

#### B. Related Sections:

1. 200000 - Mechanical General Requirements
2. 221100 - Domestic Water Piping and Specialties
3. 221300 - Sanitary Waste and Vent Piping and Specialties
4. 226300 - Medical Gas Systems
5. 231123 - Fuel Gas Piping and Specialties
6. 232113 - Hydronic Piping and Specialties
7. 233100 - Ducts and Accessories
8. 233400 - HVAC Fans
9. 233600 - Air Terminal Units
10. 237416 - Packaged Rooftop Units
11. 238200 - Terminal Heating Units

### 1.2 REFERENCES

#### A. Codes and Standards:

1. See Section 200000 - Mechanical General Requirements.
2. ANSI/ASME A13.1-2015 (American Society of Mechanical Engineers) - Scheme for the Identification of Piping Systems.
3. ANSI Z535.1-2017 - Safety Colors.

#### A. Abbreviations, Acronyms and Definitions:

4. Refer to Division 01 for general abbreviations, acronyms, and definitions.
5. Refer to Section 200000 - Mechanical General Requirements for general mechanical related definitions.
6. Refer to Mechanical Drawings legend sheet for general mechanical related abbreviations.

### 1.3 SYSTEM DESCRIPTION

#### A. Design Requirements:

1. Provide equipment nameplates, valve tags and labels for the mechanical systems provided under this contract.
2. Provide labels for piping.

1.4 SUBMITTALS

- A. Refer to Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.
- B. Product Data:
  1. Master Schedule of Equipment:
    - a. Submit master schedule of equipment, components, and systems that will be tagged and labeled for the project.
    - b. Include the proposed method of labeling to be implemented (nameplate, tag, label/marker, etc.), legend (“Domestic Cold Water,” “PMP-1,” etc.) and letter/background colors.
    - c. Match legend to Contract Document legend, abbreviations, and schedule symbols. Use standard mechanical identification products when available.
  2. Equipment Directories: Submit separate proposed “Equipment Directories” (subset of the master schedule) for each mechanical room that includes the equipment located within the applicable space. Include system name, fluid or medium type, and normal operating properties and ranges.
  3. Valve Directories: Submit separate proposed “Valve Directories” (subset of the master schedule) for each mechanical room that includes the valves located within the applicable space. Include valve designations, a brief description and normal position (open (NO), closed (NC), balanced to X GPM). For Example:

Valve Designator	Description	Normal Position
H-101	BLR-1 Supply Isolation	NO
H-102	BLR-1 Return Isolation	NO
H-103	BLR-1 Flow Balance	150 GPM
P-100	Domestic Water Service Isolation	NO
P-201	Supply Strainer Flush Valve	NC
ETC.		

- C. Installation, Operation and Maintenance (IO&M) Manuals:
  1. Provide completed, typed “Master Schedule of Equipment.”
  2. Provide completed, typed “Equipment Directories.”
  3. Provide completed, typed “Valve Directories” with balance valve settings obtained from the final balance report.

## PART 2 - PRODUCTS

## 2.1 MANUFACTURERS

- A. Marking Services Incorporated (MSI).
- B. Seton Identification Products.
- C. Craftmark.
- D. Approved equal.

## 2.2 EQUIPMENT NAMEPLATES

- A. Plastic Engraved Equipment Nameplates:
  - 1. Minimum letter height: 3/4 inch.
  - 2. Tag size: Minimum 2 inches high, length to fit equipment tag lettering requirements. Provide uniform size for similar types of equipment.
  - 3. Plastic thickness: 1/16 inch minimum.
  - 4. Fastening method:
    - a. Mounting holes.
    - b. Adhesive backing may be provided for labeling equipment where drilling holes is not feasible, with the pre-approval of the Contracting Agency.
  - 5. Color coding: As designated by the Contracting Agency. If specific direction is not provided, select white letters on black background.
  - 6. Legend: As designated by the Contracting Agency. If specific direction not provided, match scheduled equipment symbols.

## 2.3 VALVE TAGS

- A. General:
  - 1. Small equipment, such as in-line pumps may be identified with tags in lieu of nameplates if inadequate room is available.
  - 2. Provide service indicator on top line of tag, using system abbreviations provided in Part 3 Pipe Identification Table.
  - 3. Provide valve number on bottom line of tag. Start valve numbering with "001" for each legend series/service indicator. Assign valve numbers in a logical sequence from the source (i.e. service water entry point, gas meter service isolation) or heat source (boiler or water heater supply) and continue numbering outward to the most remote terminal connection point.
- B. Plastic Engraved Tags:
  - 1. Round, 1-1/2 inches diameter, engraved plastic.

2. Text stamped and filled black:
  - a. 1/4 inch service indicator on top.
  - b. 1/2 inch valve number below.
3. Beaded chain tag fasteners.
4. Provide tag color coding to match pipe marker coding or as designated by the Contracting Agency.

C. Brass Stamped Tags:

1. Round, 1-1/2 inches diameter, brass with smooth edges.
2. Text stamped and filled black:
  - a. 1/4 inch service indicator on top.
  - b. 1/2 inch valve number below.
3. Beaded chain tag fasteners.

2.4 VALVE AND EQUIPMENT DIRECTORIES

A. Equipment and Valve Directory Frame:

1. 8-1/2" x 11" aluminum frame with plastic lens.
2. Provide multiple frames as required.

2.5 PIPE IDENTIFICATION, MARKING

A. Identify both service and flow direction.

B. Colors and Lettering: Conform to ANSI/ASME A13.1; see tables under Article 3.2E below.

C. Plastic Pipe Labels:

1. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering.
2. Larger sizes may have maximum sheet size with plastic nylon ties or straps.

D. Plastic Tape Pipe Labels: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.6 CEILING MARKERS

A. Description:

1. 7/8-inch diameter, color-coded.
2. Metal push tacks or 0.030" rigid vinyl, pressure sensitive stickers.

- B. Provide color coding to match existing facility standards. In the absence of existing facility standards, utilize the color code as follows:
  - 1. HVAC equipment: Yellow.
  - 2. Plumbing valves: Green.
  - 3. Non potable water and valves: Orange.
  - 4. Heating/cooling valves: Blue.
  - 5. Fire suppression valves and drains: Red.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to be painted or directly receive adhesive labels.
- B. Install identifying devices after completion of coverings and painting.

3.2 INSTALLATION

- A. Do not install identifying devices over factory installed equipment labels.
- B. Locate identifying devices in clear view for simple identification.
- C. Tag automatic controls, instruments, and relays. Key these to control system schematic drawings.
- D. Frame and install approved equipment and valve directories in each mechanical room, at a location designated by the Contracting Agency.
- E. Pipe Identification:
  - 1. Identify piping, concealed or exposed, using ANSI A13.1 compliant pipe labels. Identify both service and flow direction in accordance with the following table. Coordinate color scheme with existing facility standards. In the absence of existing facility standards, utilize the color scheme in the following table.

Abbreviation	Legend	Color (Letters/Background)
CW	Domestic Cold Water	White/Green
HW	Domestic Hot Water	White/Green
HWC	Domestic Hot Water Circulation	White/Green
HWS	Heating Water Supply	White/Green
HWR	Heating Water Return	White/Green
GHS	Glycol Heating Supply	White/Green
GHR	Glycol Heating Return	White/Green
RL	Refrigeration - Liquid	Black/Orange

Abbreviation	Legend	Color (Letters/Background)
RS	Refrigeration - Suction	Black/Orange
NG	Natural Gas	Black/Yellow
W	Sanitary Drain	White/Green
V	Sanitary Vent	White/Green
RL, ORL	Rain Leader, Overflow Rain Leader	White/Green
SD	Storm Drain	White/Green
FW	Fire Suppression Water	White/Red

- Pipe label letters shall be a minimum of 1/2" high and increase with pipe diameter as follows:

Pipe Outside Diameter	Letter Height
0.75" to 1.25"	0.5"
1.5" to 2"	0.75"
2.5" to 6"	1.25"
8" to 10"	2.5"
over 10"	3.5"

- Install labels in unobstructed view and aligned with horizontal or vertical axis of piping as appropriate. For piping located above the normal line of vision, place labels below the horizontal centerline of the pipe for clear unobstructed view from below.
- Install labels not to exceed 20 foot intervals along straight piping runs (including risers and drops), close to valves, adjacent to changes in direction and branches, on each side of pipe penetrations through walls or floors, and at each access panel.
- Medical gas piping shall be identified and labeled as required by NFPA 99, see Section 22 6300 - Medical Gas Systems.

END OF SECTION 200553



## PART 1 - GENERAL

### 1.1 SUMMARY

- A. Section Includes: Specific requirements, products and methods of execution which relate to the insulation of ducts, fittings, equipment, pipes, and other surfaces of the mechanical installation.
- B. Related Sections:
  - 1. 200000 - Mechanical General Requirements
  - 2. 221100 - Domestic Water Piping and Specialties
  - 3. 221300 - Sanitary Waste and Vent Piping and Specialties
  - 4. 224000 - Plumbing Fixtures
  - 5. 232113 - Hydronic Piping and Specialties
  - 6. 233100 - Ducts and Accessories
  - 7. 237416 - Packaged Rooftop Units

### 1.2 REFERENCES

- A. See Section 200000 - Mechanical General Requirements.
- B. ASHRAE 90.1 - 2010 Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. NFPA 90A - 2002 Standard for the Installation of Air Conditioning and Ventilating Systems.
- D. NFPA 90B - 2006 Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- E. MSS Standard Practice SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

### 1.3 DESCRIPTION

- A. Provide thermal insulation for ventilation system ductwork and building service piping.
- B. Provide insulation for exposed ADA plumbing fixture piping.

### 1.4 PRE-INSTALLATION MEETINGS

- A. See Section 200000 - Mechanical General Requirements.

### 1.5 SUBMITTALS

- A. See Section 200000 - Mechanical General Requirements for general submittal requirements for the items listed below, supplemented with the additional requirements listed.

- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Qualifications: Submit manufacturer and Applicator qualifications.

1.6 QUALITY ASSURANCE

- A. See Section 200000 - Mechanical General Requirements.

1.7 DELIVERY, STORAGE AND HANDLING

- A. See Section 200000 - Mechanical General Requirements.

1.8 WARRANTY

- A. See Section 200000 - Mechanical General Requirements.

PART 2 - PRODUCTS

2.1 FIRE RATING OF MATERIALS

- A. Provide insulation products used aboveground in building with burning characteristics in compliance with NFPA Standards 90A and 90B: Flame Spread 25, Fuel Contributed 50, Smoke Developed 50. Tested according to UL 723, ASTM E84, or NFPA 255.
- B. Insulation specified for use underground and aboveground away from the building might have other burning characteristics. Use such products only where specifically required.

2.2 FIBERGLASS INSULATION

- A. Piping (Domestic water, Vent-Thru Roof, and Hydronic): Provide insulation products as follows:
  - 1. Thermal conductivity K equals 0.24 at 100 degrees F mean temperature, ASTM C335.
  - 2. Factory applied vapor-barrier, flame retardant all service jacket and tape, with permeability rating equal to 0.02 perms, ASTM E 96.
  - 3. Temperature limits for fiberglass pipe insulation: 350 degrees F, unless otherwise indicated.
  - 4. Manufacturers: Johns Manville, Owens Corning, Knauf Fiber Glass, or approved equal.
- B. Ductwork: Provide insulation products as follows:
  - 1. Flexible insulation: Average thermal conductivity K equals 0.24 at 75 degrees F mean temperature at 1.5 pounds per cubic feet (PCF) density, ASTM C335.

2. Rigid insulation: Average thermal conductivity K equals 0.24 at 75 degrees F mean temperature at 3.0 PCF density, ASTM C518.
3. Factory-applied vapor barrier flame-retardant Foil-Scrim-Kraft (FSK) or all-service jacket and tape, with permeability rating equal to 0.02 perms, ASTM E 96.
4. Temperature limits for fiberglass duct insulation: 250 degrees F unless otherwise indicated.
5. Manufacturers: Johns Manville, Owens Corning, Certainteed, Knauf Fiber Glass, or approved equal.

### 2.3 FIRE RESISTIVE PIPE AND DUCT WRAP

- A. Lightweight, asbestos free high temperature inorganic ceramic fiber blanket totally encapsulated in foil/scrim having a service temperature up to 2,300 degrees F.
- B. Performance requirements:
  1. Two-hour rated fire resistive enclosure assembly, ASTM E119.
  2. Zero clearance to combustible, maximum surface temperature on unexposed side, UL 1978.
  3. Class I interior finish materials, ASTM E84.
  4. Through-penetration protection systems for grease and air ducts, ASTM E814 and UL 1479.
- C. Provide manufacturer's tapes, banding materials, pins/washers, through-penetration fire stop materials, duct access doors, and miscellaneous hardware necessary for complete installation according to manufacturer's instructions.
- D. Manufacturer: 3M.

### 2.4 FLEXIBLE FOAM PLASTIC

- A. Thermal Conductivity: 0.27.
- B. Water Vapor Transmission: 0.08.
- C. Flame-spread rating of 25 or less and a smoke-developed rating of 50 or less as tested by ASTM E 84.
- D. Manufacturer: Armaflex, Aerotube, Rubatex.

### 2.5 FIXTURE INSULATION ASSEMBLY

- A. Protective, molded, fire-resistant foam insulation, single piece insulation manufactured specifically for plumbing fixture supplies and drains.
- B. 4.5 PCF foam with insulation R factor 2, white fire retardant polyurethane integral skin, twist fasteners.

- C. Manufacturer: Skal+Gard, Model SG-100B, TCI Products, or approved equal.

## 2.6 CANVAS JACKETING

- A. Insulating Lagging Canvas: Eight ounces per square yard minimum, fire-retardant material complying with fire ratings specified above. Manufacturer: Chas Harmon "Osnaberg", Claremont Company Inc., "Claretex", or approved equal.
- B. Lagging Adhesive: Plastic synthetic resin emulsion adhesive; watertight, mildew resistant, fire retardant. Manufacturer: Childers Chil-Perm CP, Foster® Sealfas® coating 30-36, or approved equal.

## 2.7 METAL JACKETING

- A. 27 gauge (U.S. Standard) heavy corrugated aluminum.
- B. Preformed fitting covers.

## 2.8 COATINGS

- A. Coatings: UL labeled.
- B. On cold or dual service lines, use vapor barrier type coatings.

## 2.9 PREFORMED FITTING COVERS

- A. One piece pre-molded PVC jacketing and fitting covers specifically designed for the service intended.
- B. Install per manufacturer's instructions and secure with manufacturer's color matching PVC tape.
- C. Manufacturer: J-M "Zeston", TeeCee, Proto, Certainteed.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Do not apply insulation materials until surfaces to be covered are clean and dry and foreign material such as rust, dirt, etc. is removed. Keep insulation clean and dry during installation and during the application of any finish.
- B. Do not install the insulation on pipe fittings and pipe joints until the piping has been tested and approved.
- C. Do not install the insulation on ducts or fittings until the ductwork has been tested and approved.

- D. Do not apply under conditions of excessive humidity or at temperatures below 50 degrees F or above 100 degrees F.
- E. Provide insulation support blocks, shields, and transitions for hangers, supports, anchors, and guides. Coordinate insulation requirements through rated assemblies and Listing penetration's requirements.
- F. Adjust hangers, guides, anchors, and supports after insulation installation has been approved.

3.2 PIPE INSULATION

A. Cold Piping:

- 1. Includes rainwater piping, domestic cold water, plumbing, and other vents through roof, refrigeration, and other cold piping to zero degrees F.
  - a. Insulate aboveground rain leaders from the roof drain to the point pipe penetrates building skin or below grade. Cover underside of roof drain.
  - b. Insulate plumbing vents from three feet below the under deck of the roof to the termination above the roofline.
- 2. Insulate with sectional fiberglass (except for refrigerant piping) and provide a completely sealed vapor barrier. Provide insulation thickness per Insulation Thickness Table.
- 3. Insulate valves, unions, flanges, fittings, tanks, vessels, air separators, heat exchangers, and similar components, except where indicated otherwise.
- 4. Insulate refrigerant piping with flexible foam plastic insulation and glue seams with manufacturer's recommended cement.

B. Hot Piping:

- 1. Includes domestic hot water supply and recirculation, and hydronic heating.
- 2. Insulate with sectional fiberglass. Provide insulation thickness per Insulation Thickness Table.
- 3. Insulate valves, unions, flanges, fittings, tanks, vessels, air separators, heat exchangers, steam and process vents, and similar components, except where indicated otherwise.

C. In addition to specified jackets, provide heavy corrugated aluminum jacket on piping insulation anywhere piping is exposed to building exterior.

D. Insulation Thickness Table (units are in inches):

Fluid Design Operating Temperature Range	Less than 1	1 to <1-1/2	1-1/2 to <4	4 to <8	8 and up
Heating Systems (Water and Glycol Solutions) and Domestic (Hot Water and Hot Water Circulation):					
141 °F to 200 °F	1.5	1.5	2	2	2
105 °F to 140 °F	1.5	1.5	2	2	2

Fluid Design Operating Temperature Range	Less than 1	1 to <1-1/2	1-1/2 to <4	4 to <8	8 and up
<b>Cooling Systems (Well water, Chilled Water and Glycol Solutions, and Refrigerant):</b>					
40 °F to 60 °F	1.5	1.5	1.5	1.5	1.5
Below 40 °F	1.5	1.5	1.5	1.5	1.5
<b>Heat Recovery Systems (Water and Glycol Solutions):</b>					
35 degrees F to 90 degrees F	1	1	1.5	1.5	1.5
<b>Domestic Cold Water:</b>					
All	1	1	1.5	1.5	1.5
<b>Rain leaders, Plumbing vents through roof:</b>					
All	1	1	1.5	1.5	1.5

3.3 TECHNIQUE FOR APPLICATION TO PIPES

- A. Close longitudinal joints of pipe insulation firmly and butt insulation sections firmly together. Neatly and smoothly adhere laps and butt strips.
- B. Clean the contact area on jacket for adhesive lap strips and butt strips so it is free from fingerprints, oil, construction dust and other contaminants. Clean surfaces with tack rags, methanol, or other suitable agent before attempting to adhere the strip. Apply pressure to adhesive strip with suitable tool immediately after adhering. Remove insulation with inadequately sealed joints and install new sections. Outwardly clinching staples may be used to reinforce joints.
- C. Continuously seal vapor barriers. If staples are used at laps, seal the entire length of stapled lap with adhesive jacket tape applied as specified above for laps and butts. Sectionalize vapor barrier by sealing ends of insulation sections at not more than 25 feet intervals, to prevent moisture migrating lengthwise. Apply butt strips over joint as above.
- D. Provide double insulation thickness on piping in outside walls and within five feet of vehicle doors or other large openings.
- E. Except as indicated, locate pipe hangers and rollers outside insulation. Provide insulation saddles or sheet metal shields around insulation. On pipes two inches and larger, within the area of each insulation shield, use calcium silicate or cellular glass on the lower half of the insulation, equal in thickness to adjacent insulation.
- F. Where refrigerant piping is installed outdoors, provide flexible foam plastic insulation with sealed vapor barrier in addition to jacket specified.

3.4 TECHNIQUE FOR APPLICATION TO PIPE FITTINGS, EQUIPMENT, AND VALVES

- A. Insulate fittings, valves, and flanges to the same thickness as the pipe insulation.

- B. Any of the following methods of insulation are acceptable:
1. Blanket Wrap: Wrap the fitting with compressed glass fiber blanket. Wire the blanket securely in place and cover with a smooth layer of insulating/finishing cement. Cover with glass mesh tape, adhering it with an adhesive coating.
  2. Fabricated Segments: Cut mitered segments from pipe insulation that has the same wall thickness as adjacent pipe insulation to form a cover which will fit snugly around the fitting. Wire the segments firmly in place and seal the joints with insulating/finishing cement. Apply adhesive coating and wrap with glass mesh tape, then apply another layer of the same coating over the whole assembly.
  3. Cement: Apply insulating or insulating/finishing cement, molding it to the contour of the fitting. When area is large, apply an under layer of cement, wrap this with glass mesh tape, then apply an outer layer of cement. If the insulation is not concealed the exposed surface of insulating/finishing cement shall have a final glass mesh tape wrap embedded in adhesive.
- C. In each of the listed methods, to protect the insulation against contact damage, apply an adhesive coating when the cement is completely dry and hard, then wrap with glass mesh tape. Apply another coating of adhesive over the whole assembly.
- D. In each of the listed methods, pre-formed fitting covers may be substituted for the tape and adhesive covering specified. Cement and tape fitting covers on cold piping to provide a positive vapor barrier.
- E. Removable insulation blankets of comparable insulation value for valves and where equipment require frequent adjustments or maintenance shall be provided; identify and coordinate during submittal process.
- F. After insulation has been installed adjust hangers for proper fit, maintain pipe grade and support.

### 3.5 DUCT THERMAL INSULATION REQUIREMENTS

- A. Insulate ductwork as follows:
1. Insulate outside air intake ducts from air intake louver connection to equipment connections (including insulated isolation damper frame) with 2-inch rigid or semi-rigid board insulation.
  2. Insulate exhaust and relief ducts from point of discharge to and including back draft damper support frame with two inch rigid or semi-rigid board insulation.
  3. Supply air ductwork: When mechanical cooling is provided, insulate associated ventilation system supply ductwork from AHU connections to VAV terminal unit inlet connections with 1-1/2" inch thick fiberglass insulation.
  4. Return air ductwork: Insulate return air ductwork passing through unheated spaces, within in mechanical rooms and as indicated with 1-1/2" inch fiberglass insulation.
  5. Lined ductwork: Provide external duct insulation only when indicated in addition to duct lining.
- B. Insulation Type and Finish:

1. Rigid or semi-rigid board where canvas or metal jacket is specified. May also be used in place of blanket insulation where practical.
2. Blanket insulation where rigid board is not specified or indicated. Proper installation is critical. Loose joints and sagging insulation shall require re-insulation of entire branch or main duct before acceptance and during warranty period.
3. Fiberglass or canvas jacket over board insulation in mechanical and boiler rooms less than 10 feet above finish floor, where exposed in finished rooms and where indicated. Seal jacket with vapor barrier lagging adhesive.
4. Ductwork insulation to have a completely sealed vapor barrier, except segmental insulation on medium/high velocity trunk ducts and warm air ducts in concealed spaces, where approved.

### 3.6 DUCT SOUND INSULATION REQUIREMENTS

- A. Refer to Section 233100 - Ducts and Accessories.
- B. Install where shown.
- C. Install in accordance with manufacturers installation instructions. Completed installation shall be fastened tightly to ductwork and free of sags.

### 3.7 TECHNIQUE FOR APPLICATION TO DUCTWORK

#### A. Rigid and Semi-rigid Insulation:

1. Impaling Over Pins: Install insulation with edges tightly butted using adhesive and metal pins. Impale insulation on pins welded to the duct and secure with speed clips. Trim off pins close to speed clip. Space pins as required to hold insulation firmly against duct surface but not less than one pin per square foot.
2. Other Method of Securement: If the welded pin method is not feasible, secure the insulation to the duct with adhesive. Cover the entire surface of the metal with adhesive when applying to the underside of horizontal ducts. Application to top and sides may be in strips with a minimum of 50 percent coverage. Additionally, secure insulation with No. 16 galvanized wire on not more than 12 inches on center. Provide metal angle at corners to protect edges of insulation.
3. Vapor Barrier: Seal joints and speed clips with adhesive tape of similar construction to insulation jacket. Thoroughly clean contact surfaces for adhesive as specified under pipe insulation technique. Glass cloth tape set in adhesive may be used. Provide metal or plastic corner angles within eight feet of floor, walkway, or stairs.
4. Provide fiberglass or canvas jacket where specified. Completely cover with minimum 1/8" lagging adhesive. Cover canvas with two heavy coats of same adhesive and completely fill the weave. Inspect when dry for complete vapor barrier throughout and refinish as required.

#### B. Blanket Insulation:

1. Position insulation so that longitudinal seam will be underneath and not supporting weight of sheet. Remove a uniform strip of insulation from backing to provide a lap strip. Butt insulation and secure lap strip with outwardly clinching staples.



2. Use pins to secure blanket on large flat areas as specified for rigid insulation. Reinforce jacket at pin penetration where required.
3. Seal laps, staples and butt joints with adhesive tape of similar construction to insulation jacket. Seal speed clips if used. Thoroughly clean contact surfaces for adhesive as specified under pipe insulation technique.
4. When system is under pressure, inspect insulation for inflation caused by improperly sealed ducts. Repair duct seal and reinsulate as necessary.
5. The Contracting Agency may inspect completed insulation and test taped joints for adhesion. Seal laps and butt tapes that can be removed with reasonable force shall require that entire branch or trunk duct be reinsulated.

3.8 FIRE RESISTIVE DUCT AND PIPE WRAP

- A. Install in accordance with manufacturer's instructions.
- B. Provide fire rated duct wrap on exhaust air duct from medical gas storage room to building exterior wall penetration as indicated on drawings.

3.9 FIXTURE INSULATION ASSEMBLY

- A. Insulate cold and hot water supply and waste piping exposed beneath sink and lavatory fixtures designated on drawings or specified in Section 224000 - Plumbing Fixtures, as intended for use by disabled persons. Install in accordance with ANSI A117.1 - 2009.

END OF SECTION 200700

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PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Demolition and removal of selected mechanical systems, equipment, and selected components.
- B. See Division 1 for general demolition requirements and disposal of demolished materials.
  - 1. Coordinate the demolition and disposal of materials and equipment with Contracting Agency.
  - 2. Provide Contracting Agency with the first right of refusal for the salvage of demolished equipment and materials.
- C. Related Sections:
  - 1. 200000 - Mechanical General Requirements
  - 2. 200529 - Mechanical Hangers and Supports
  - 3. 211000 - Water Based Fire Suppression Systems
  - 4. 221100 - Domestic Water Piping and Specialties
  - 5. 221300 - Sanitary Waste and Vent Piping and Specialties
  - 6. 224000 - Plumbing Fixtures
  - 7. 226300 - Medical Gas Systems
  - 8. 231123 - Fuel Gas Piping and Specialties
  - 9. 232113 - Hydronic Piping and Specialties
  - 10. 232123 - Hydronic Pumps
  - 11. 233100 - Ducts and Accessories
  - 12. 233400 - HVAC Fans
  - 13. 233600 - Air Terminal Units
  - 14. 233700 - Air Outlets and Inlets
  - 15. 237416 - Packaged Rooftop Units
  - 16. 238200 - Terminal Heating Units
  - 17. 253000 - Building Automation System Field Devices
  - 18. 255000 - Building Automation System

1.2 REFERENCES

- A. See Section 200000 - Mechanical General Requirements.

1.3 DEFINITIONS

- A. Demolish: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Detach items from existing construction and deliver them to Owner ready for reuse.

- C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed, and salvaged, or removed and reinstalled.

#### 1.4 SUBMITTALS

- A. See Section 200000 - Mechanical General Requirements.
- B. Submit a demolition and construction plan for review by the Contracting Agency prior to beginning work. Describe procedures that will be used to protect and maintain cleanliness of the adjacent building areas/systems during construction.

#### 1.5 QUALITY ASSURANCE

- A. See Section 200000 - Mechanical General Requirements.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Standards: Comply with ANSI A10.6 - Safety and Health Program Requirements for Demolition Operations, and NFPA 241 - Standard For Safeguarding Construction, Alteration, And Demolition Operations.
- D. Pre-demolition Meetings: Conduct coordination meetings prior to demolition as required by Division 1.

#### 1.6 PROJECT CONDITIONS

- A. Adjacent portions of the building will remain occupied during selective demolition. Conduct demolition such that Owner's operations will not be disrupted.
- B. Drawings and specifications involving existing conditions are based on building record drawings and limited field observation. Provide field verification. Addition building record drawings are available from the Owner with a written request.
- C. Notify Contracting Agency of discrepancies between existing conditions and the Contract Documents before proceeding with demolition.
- D. Maintain existing utilities to the maximum extent possible. Coordinate outages, if necessary, in accordance with Division 1.
- E. Maintain fire-protection systems in service during mechanical demolition operations.
- F. Storage or sale of removed items or materials on-site is not permitted.