

SECTION 230010 – HVAC GENERAL

PART 1 - GENERAL

1.1 DESCRIPTION

- A. These heating, ventilating and air conditioning (HVAC) provisions specified herein apply to all Sections of Division 23.
- B. Refer to the General and Supplementary Conditions and Division 01 for special requirements and conditions which apply to all Sections of Division 23.
- C. This Section includes responsibilities and obligations in support of the performance verification specified in Section 230090, HVAC Performance Verification.

1.2 QUALITY ASSURANCE

- A. Conform to the following:
 - 1. North Carolina State Energy Conservation Code-2018.
 - 2. North Carolina State Mechanical Code-2018.
- B. Codes, standards and regulations specified herein refer to the edition date. Revisions and addenda to these codes, standards and regulations shall be part of these specifications. Provisions of referenced codes, standards, and regulations do not create duty or responsibility by the Engineer or the Owner, unless otherwise specified herein.
- C. Codes, standards and regulations referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes, standards and regulations, the drawings or specifications shall govern.
- D. HVAC/Electrical Design Coordination:
 - 1. The power ratings of motors and other HVAC equipment and the electrical characteristics of electrical systems serving them, as specified herein and indicated on the Drawings, have been established as minimums which will allow that equipment to satisfactorily function while producing the required capacities. These power ratings include a safety factor deemed appropriate to accommodate common differences between design parameters and field construction practices. Under no circumstances shall equipment with power ratings less than those indicated on the Drawings or specified herein be provided.
 - 2. Reasonable efforts have been made to coordinate the electrical requirements of the HVAC equipment with the electrical systems serving that equipment. Differences among manufacturers of HVAC equipment make it impossible to produce a single electrical design which will satisfy the varying electrical requirements of those manufacturers. Consequently, the Contractor shall coordinate the electrical requirements of the HVAC equipment actually furnished on this Project and provide the electrical systems required by that equipment. This coordination effort shall be completed prior to the installation of either the HVAC equipment or the electrical systems serving that equipment. Electrical system revisions required to coordinate with the HVAC equipment actually furnished shall be provided at no additional cost to the Owner.
- E. Low-Emitting Materials
 - 1. Adhesives, sealants, sealant primers, paints, and coatings used inside the building (defined as inside the weatherproofing envelope and applied on-site) shall be tested and determined compliant with California Department of Public Health (CDPH) Standard Method v1.2-2017, using the applicable exposure scenario.

2. Methylene chloride and perchloroethylene shall not be intentionally added in paints, coatings, adhesives, or sealants that are applied on-site.
3. All paints and coatings that are wet-applied on site and used inside the building must meet the applicable VOC content limits of one of the following:
 - a. California Air Resources Board (CARB) 2019, Suggested Control Measure (SCM) for Architectural Coatings
4. All adhesives and sealants that are wet-applied on site and used inside the building must meet the applicable VOC content requirements of SCAQMD Rule 1168, July 1, 2017.
5. All exterior applied adhesives, sealants, coatings, and waterproofing materials must meet VOC content limits of BOTH of the following:
 - a. California Air Resources Board (CARB) 2019 Suggested Control Measure (SCM) for Architectural Coatings
 - b. South Coast Air Quality Management District (SCAQMD), Rule 1168, effective July 1, 2017.
 - 1) Small containers of adhesives and sealants subject to state or federal consumer product VOC regulations are exempt.
6. Paint that is applied on site shall not contain lead or any intentionally added cadmium.

1.3 SPACE CONDITIONS

- A. Drawings are diagrammatic in nature and, unless explicitly dimensioned, indicate approximate locations of apparatus, equipment, ductwork and piping. Changes in the location, and offsets, of same which are not shown on the Drawings but are necessary in order to accommodate building conditions and coordination with the work of other trades, shall be made during the preparation of coordination drawings and prior to initial installation, without additional cost to the Owner.
- B. Provide access to equipment and apparatus requiring operation, service or maintenance throughout the life of the system.
- C. Piping, equipment, or ductwork shall not be installed in electrical equipment rooms, elevator equipment rooms, or elevator shafts unless specifically indicated on the Drawings. In addition, piping, ductwork, or mechanical equipment shall not be installed in the space equal to the width and depth of switchgear, switchboards, panelboards, and motor control centers from floor to structure above nor within the working space in front, rear and/or side (where rear and/or side access is required to work on equipment) of electrical equipment (switchgear, switchboards, panelboards, motor control centers, variable frequency drives, transformers, and starters). Dimensions of the working space shall be a minimum depth of 42" horizontally, the width of the equipment or 30", whichever is greater, and the height of the equipment or 78", whichever is greater. Minimum depth shall be increased to 60" for equipment rated over 600 V.

1.4 ASBESTOS MATERIALS

- A. Materials containing asbestos or any trace of asbestos related materials shall not be used on this Project.

1.5 DEFINITIONS

- A. Exposed piping, conduit, or ductwork is that which can be seen when the building is complete without opening or removing access doors or panels or accessible ceiling components.
- B. Other piping, conduit, and ductwork is considered to be concealed.

1.6 RELATED WORK DESCRIBED IN OTHER DIVISIONS

- A. Installation of access panels in wall and ceiling construction.
- B. Cutting, coring, waterproofing, and patching of walls, floors, ceilings, roofs and structure of existing buildings.
- C. Painting, except as specified herein.
- D. Electric power, interlock, and control wiring, except as specified herein.
- E. Installation of starters, contactors, thermal overload switches, and remote push buttons, except as specified herein.
- F. Fire alarm initiating devices, control modules, and monitoring modules.
- G. Curbs, flashing, and pitch pockets for equipment on roof, except as specified herein.
- H. Structural supports for the heat rejection equipment and roof-mounted fans.
- I. Door grilles.
- J. Louvers and screens.

1.7 SUBMITTALS

- A. Within 15 days after notice to proceed, submit a schedule indicating the proposed submission date of each submittal specified herein. Schedule shall anticipate the submittal review time, the possible need for resubmittals, and the time required for fabrication, shipping and integration into the construction sequence. Architect will advise of any conflicts in reviewing submittals that the proposed schedule presents.
- B. Submittals shall be prepared in a line-by-line format corresponding to these Specifications and shall indicate compliance with each requirement specified herein and indicated on the Drawings.
 - 1. In addition to any other transmittals or cover sheets used, fill out and attach to each individual submittal a copy of the Cover Sheet for Submittals to Newcomb & Boyd included at the end of this Section.
 - 2. Indicate manufacturer's installation instructions.
 - 3. Indicate deviations, if any, including any from the manufacturer's installation instructions.
 - 4. Reproductions or electronic versions of design drawings shall not be used in the preparation of shop drawings.
 - 5. Resubmittals that are required to address review comments shall include a cover transmittal with a written explanation of how each review comment has been addressed.
 - 6. Submittals not specifically required, or not complying with the format requirements, will be returned unreviewed.
 - 7. Shop drawings and submittals shall be provided in portable document format (PDF). PDF files containing multiple drawings or components shall include an index of the file contents and electronic bookmarks.
- C. Shop drawings shall include the following:
 - 1. Trade shop drawings (i.e., HVAC equipment room drawings, HVAC piping system drawings, HVAC sheet metal system drawings, and electrical main feeder raceway drawings) shall be submitted within 30 days after award of contract.
 - 2. Approved trade shop drawings shall be utilized as the basis for the coordination drawings. Coordination drawings shall be submitted within 30 days after approval of trade shop drawings.

3. Coordination drawings shall utilize either manual or electronic means of analyzing the work of each trade in spatial relationship with other trades. Locations of conflicts between trades, and the proposed resolution for each conflict, shall be noted on the coordination drawings submitted.
4. No work shall be fabricated and/or installed prior to receipt by the Contractor of approved trade shop drawings and approved coordination drawings without specific written authorization from the Architect. No change orders will be approved or design assistance provided for remedial field coordination activities for work fabricated and/or installed prior to receipt by the Contractor of approved trade shop drawings. and approved coordination drawings.

D. HVAC submittals shall include the following:

1. Performance Verification Supervisor qualifications.
2. Coordination drawings, with dimensions and elevations, of HVAC work, including ductwork, equipment, piping with fittings, valves, dampers, accessories and sleeves coordinated with the work of other trades, including plumbing, fire suppression, electrical, structural, and architectural, minimum 1/4" = 1'-0" scale.
3. Insulation.
4. Seismic and wind restraint devices, including calculations, restraint selection, installation details and written confirmation that a licensed engineer prepared the calculations.
5. HVAC underground preinsulated piping systems, including drawings with dimensions and bury depths, fittings, valves, accessories, thrust blocks, expansion loops, factory-prepared calculations of thrust and expansion, coordinated and shown with the work of other trades including plumbing, civil, fire suppression, electrical, structural and architectural, minimum 1" = 20'-0" scale.
6. Vibration isolation, including spring data, manufacturer's equipment operating weight, actual load distribution and actual deflection at each loading point for each piece of isolated equipment. Shop drawings for piping isolators shall be made on prints of the piping shop drawings. For floating riser support system, include structural loads, stresses, and isolator deflections at minimum and maximum operating temperatures for piping, elbows, accessories and equipment connections.
7. Air handling units with coil, fan, and filter data, and fan curves.
8. Automatic temperature controls with information as specified in Section 23 80 00, Automatic Temperature Controls. Each control device, software, sequence of operation, and control schematic and I/O summary submittal shall be cross-referenced to a specific requirement in these Specifications and Drawings.
9. Centrifugal water separators.
10. Chillers.
11. Coils.
12. Combination fire/smoke dampers, including static pressure drop for each damper.
13. Dampers.
14. Ductless split systems.
15. Ductwork and fittings, factory-fabricated.
16. Electric heating coils, including diagrams showing arrangement of circuits to prevent stratification of hot and cold air for coils controlled at 3 stages or more.
17. Energy recovery units.
18. Energy recovery wheels.
19. Expansion tanks.
20. Fan-coil units.
21. Fans and fan curves.
22. Filters and frames.
23. Finned tube radiation.
24. Fire dampers, including static pressure drop for each damper.
25. Flexible ductwork.
26. Flow measuring elements.
27. Grilles, registers and diffusers, including performance data.
28. HVAC equipment room drawings, with dimensions and elevations, showing equipment, coil and tube pull areas, sheet metal work and piping with locations of valves, thermometers, thermometer wells, gauges and needle valves, minimum 1/4" = 1'-0" scale.

29. Piping system drawings, showing equipment, piping, fittings, elevations, dimensions, valves, sleeves and accessories, coordinated with ductwork, building conditions, and other trades, minimum 1/4" = 1'-0" scale.
30. Precision air conditioning units.
31. Pumps and pump curves.
32. Rooftop air conditioning units.
33. Sheet metal system drawings indicating sizes, liner locations and static pressure class, showing air distribution equipment, including required clearances around control panels, coils, filters, return air openings, and other components, ductwork, fittings, dampers, ductwork access panels plenums, elevations, dimensions, offsets, and transitions coordinated with piping, building conditions, and other trades, minimum 1/4" = 1'-0" scale.
34. Smoke dampers, including static pressure drop for each damper.
35. Sound attenuators including certified laboratory data on dynamic insertion loss, airflow generated noise and airflow performance.
36. Split system air conditioning units.
37. Terminal units.
38. Unit heaters.
39. Valves, and strainers.
40. Variable frequency drives, including harmonic analysis study and report.
41. Water storage tanks.

1.8 EQUIPMENT AND INSTALLATION REQUIREMENTS

- A. Equipment and materials shall, unless otherwise specified herein, be new and shall be of the customary standard and quality furnished by the designated manufacturer for that catalogue number.
- B. Materials and equipment shall be UL listed, and shall bear the UL listing mark on products for which standards have been established and for which listing is regularly furnished by UL.
 1. In lieu of the UL listing, or where standards have not been established by UL and UL listing is not regularly furnished, materials and equipment shall be listed by a laboratory recognized under the OSHA Nationally Recognized Testing Laboratory Program or by a laboratory accredited by International Accreditation Service. Examples include:
 - a. Canadian Standard Association.
 - b. ETL Testing Laboratories, Inc.
 - c. MET Electrical Testing Company, Inc.
- C. Mechanical equipment that is not covered by NAECA-2015 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE/IES 90.1-2019.

PART 2 - PRODUCTS

2.1 HANGERS AND SUPPORTS

- A. Hangers:
 1. General: complete with rods and supports proportioned to the size of piping or equipment to be supported.
 2. For steel pipe: steel or malleable iron, unless specified otherwise herein.
 3. For copper piping 4" and smaller: copper-plated; Anvil CT-69, B-Line B3170 CT, or ERICO 101.
 4. For black steel piping 2" and smaller: Anvil 69, B-Line 200, or ERICO 115.
 5. For chilled water piping 3" and larger, and piping insulated to prevent sweating: galvanized; Anvil 260, B-Line B3100, or ERICO 401.

B. Hanger Rods:

1. One-piece steel type, threaded as required.
2. Sizes, unless specified otherwise herein, shall be as follows:

<u>Pipe Size</u>	<u>Rod Diameter</u>
2" and smaller	0.375"
2.5" and 3"	0.5"
4"	0.625"

3. Sizes for gang or multiple hangers: calculated for the combined weight of the piping and accessories.
4. Sizes for equipment hangers: calculated for the weight of the equipment supported.

C. Inserts:

1. Adjustable type: Anvil 282, B-Line B3014, or ERICO 355.
2. Continuous type: Anvil PS-5000, B-Line B321, or ERICO CON.

D. Expansion Anchors:

1. In concrete: wedge, self-drilling, or drilled flush type.
2. In masonry: sleeve type.
3. Manufacturer: Hilti, ITW Ramset/Red Head, or Rawl.

E. Clamps for piping in bar joist construction: Anvil 92 or 93, B-Line B3031 or B3033, or ERICO 300.

F. Insulation protectors: Anvil 167, B-Line B3151, or ERICO 125.

G. Channel strut systems: 14 gauge minimum galvanized steel, with factory-punched attachment holes. Straps shall be designed so that the attachment nut is captive on the shoulder of the strap when tightened. Attachment nuts shall be designed to provide a surface on the turned down edge while making positive contact with the side walls of the channel. Nuts, bolts, straps, and accessories shall be protected with same finish as channels.

1. Manufacturer: B-Line, Kindorf, Midland-Ross, or Unistrut.

H. Pipe Stand Supports:

1. For chilled water piping: adjustable pipe saddles, stanchion type with locknut nipple, reducer, flange and baseplate. Provide U-bolt yoke for pipe 12" and smaller.
 - a. Manufacturer: Anvil 264, B-Line B3093, or ERICO 723 for pipe over 12".
 - b. Manufacturer: Anvil 265, B-Line B3092, or ERICO 724 for pipe 12" and smaller.

2.2 VALVE TAGS

- A. Minimum 19 gauge polished brass, 1.5" minimum size. Tags shall be square. Stamped numbers and letters shall be not less than 0.75" high, and filled with black paint.

2.3 IDENTIFICATION MATERIALS

- A. Pipe identification shall be 5 mil thick, self-adhering vinyl plastic tape. Tape and legend shall be as follows:

<u>Diameter (Including Insulation)</u>	<u>Width</u>	<u>Size of Legend Letters</u>
0.75 - 1.25"	8"	0.5"
1.5 - 2"	8"	0.75"
2.5 - 6"	12"	1.25"
8 - 10"	24"	2.5"
Over 10"	32"	3.5"

1. Legends shall be in full or abbreviated form, in contrasting color to background color.

B. Nameplates and signs: laminated plastic, engraved with white letters. Background color shall be:

<u>System</u>	<u>Color</u>
Equipment served by emergency power	Red
Other equipment	Black

C. Duct identification shall be strap-on type vinyl markers, minimum size 32" x 6" with minimum 3.5" lettering.

2.4 SLEEVES

A. Sleeves shall be standard weight steel pipe except sleeves for concealed piping through floors not in structural members, and through interior drywall construction may be formed from 26 gauge galvanized sheet metal lapped and pop riveted.

2.5 PENETRATION SEALS

A. Firestops:

1. Refer to Section Joint Firestopping 078443

B. Expansion Seals:

1. Waterproof, modular, mechanical expansion type consisting of synthetic rubber grommets or interlocking links shaped to continuously fill the annular space between the penetrating item and the opening. Sizing of links and sleeve shall be determined by the manufacturer.
2. Manufacturer: Calpico Pipe Linx, Metraflex MetraSeal, or Thunderline Link Seal.

2.6 MOTORS

A. General:

1. Motors shall be dripproof, unless otherwise specified herein or indicated on the Drawings, and in compliance with NEMA MG 1-2016 (R2018). Refer to Electrical Drawings for exact characteristics of motors. Dripproof and totally enclosed fan-cooled motors shall be rated on a 50°C and 55°C temperature rise basis, respectively, unless otherwise specified herein.
2. Dripproof and totally enclosed: 1800 rpm, induction type with a 1.15 service factor, unless otherwise specified herein.
3. Motors indicated on the Drawings as being controlled by variable frequency drives shall be:
 - a. Designed in accordance with Part 31 of NEMA MG 1-2016 (R2018) for use with variable frequency drives.
 - b. Provide with factory-installed shaft grounding rings, which shall consist of a circumferential ring of conductive microfibers that discharge shaft voltages to ground.

- 1) Manufacturer: AEGIS SGR, **Inpro-Seal, or ABB.**
4. Motors not furnished with equipment shall be by: Baldor, Century, Delco, GE, Marathon, Reliance, or Siemens.

2.7 STARTERS

A. General:

1. Manual reset, Class 20, thermal type overload protection for each phase, in accordance with NEMA ICS 2-2000 (R2005).
2. NEMA 3R enclosures for exterior application.
3. Equipment furnished with factory-installed starters shall also be equipped with individual motor disconnect and thermal magnetic circuit breakers or fuses as specified herein with lugs sized to receive a feeder as indicated on the Electrical Drawings.
4. 120 V secondary control power transformer with fused primary and secondary circuit in the enclosure.
5. Starters and contactors not furnished with equipment shall be provided by: ABB, Allen-Bradley, Crouse-Hinds, Cutler-Hammer, GE, Square D, Furnas, or Joslyn Clark, or Siemens-ITE.

B. For 3-phase motors, unless otherwise specified herein:

1. Combination magnetic type and fused disconnect switch with:
 - a. Fuses having type and UL class rating as specified in Division 26, providing Type 2 protection.
 - b. External operating handle capable of being locked in the off or open position.
 - c. Hand-off-automatic switch on the face for each fan and pump, except those manually controlled.

C. For 1-phase, unless otherwise specified herein:

1. Manual starting switch with thermal overload protection and pilot light.
2. Hand-off-automatic switch, except for manually controlled equipment.

2.8 VARIABLE FREQUENCY DRIVES

A. Variable frequency AC motor controllers shall be designed for use with new motors as specified in Paragraph 2.6, Motors.

B. Controllers:

1. NEMA 3R enclosure, wall- or floor-mounted, UL 508C-2016 listed, with integral power disconnect with door interlock, completely factory-wired, ready for field connection of incoming and outgoing power, and control signal, in compliance with NEMA ICS 1-2000 (R2005, R2008, R2015), NEMA ICS 6-1993 (R2001, R2006, R2011, R2016), and NEMA ICS 7.1-2014. Drives shall be rated a minimum of 100,000 A RMS symmetrical AIC.
2. Controllers shall be of the pulse width modulation type, and shall have the following features and functions contained in the cabinets unless otherwise specified herein:
 - a. Current limiting fuses or semi-conductor protection on the incoming line side.
 - b. Speed regulation within 3% accuracy.
 - c. Serial communications capability for transmitting operating data and receive commands through a single connection to the building control system. Provide hardware and software for BACnet, LonWorks, or Modbus communication, as coordinated with building control system supplier.
 - d. Interface connections for remote controls shall be wired to terminal strips as follows:

- 1) Dry contacts for remote enable/disable.
 - 2) Process transducers for 4-20 mA speed adjustment signal.
 - 3) Terminals for connection of normally closed remote safety devices.
 - 4) Dry contact for external alarm, to open on internal drive fault, power supply fault, process transducer signal fault, or operation of remote safety devices.
- e. Harmonic Distortion Control:
- 1) The variable frequency drive manufacturer shall perform a harmonic analysis study in accordance with IEEE 399-1997. The study shall establish the requirements for harmonic distortion control. Harmonic analysis study report shall be submitted concurrently with the variable frequency drive submittals and shall include variable frequency drives factory-installed on equipment, such as chillers.
 - 2) Variable frequency drive design shall be such that the maximum contribution from all variable frequency drives does not exceed the following:
 - a) IEEE 519-2014 voltage and current distortion limits at the point of common coupling.
3. Where specified herein, controllers shall be provided with damped low pass DV/DT drive output filters. Filters shall have K-rated line reactor, gapped iron core, inductor, copper windings and 40°C ambient temperature rating with a 155°C maximum operating temperature. Filters shall allow mounting of variable frequency drives up to 3000' from motor loads by filtering voltage spikes.
4. Controllers shall have the following internal protective functions for the protection of the controller modules and motors:
- a. DV/DT (voltage transient) and DI/DT (short circuit) protection.
 - b. Inverse time overcurrent protection.
 - c. Full time current limit to limit maximum speed for prevention of overload.
 - d. Phase sequence (if phase sensitive), phase loss, overvoltage, undervoltage, electronic thermal overload, abnormal temperature, DC overvoltage, and internal fault protection.
 - e. Motor winding ground fault.
 - f. Motor and variable frequency drive overtemperature protection.
 - g. Input power line surge protective device.
5. Integral EMI/RFI filter. Controllers shall be designed to avoid RF interference with other electronic equipment internal or external to the building.
6. Diagnostic module shall identify faults as they occur, storing them in nonvolatile memory for recall, including:
- a. Overcurrent.
 - b. Overvoltage.
 - c. Undervoltage.
 - d. Ground fault.
 - e. Electronic motor overload, UL listed for this function.
7. Operator panels shall include digital display and keyboard for entry of set-up parameters, recall of faults from diagnostic module, and display of current operating values including:
- a. Output frequency.
 - b. Motor speed.
 - c. Motor current.
 - d. Output voltage.
 - e. Analog input values.
 - f. Digital input status.
 - g. Elapsed time meter.
 - h. Power on indication.

8. Provide nameplate engraved with system identification and hand-off-automatic switch. The hand position shall start the drive and shall have a manual means of speed adjustment. In the automatic position, the drive shall be started and adjusted remotely.
9. Controller design shall permit operation at full load with ambient conditions between 0°C and 40°C, with capacity to handle 110% overload torque for 1 minute. Printed circuit boards shall be tested under full rated load at 10°C above rated ambient temperature for at least 20 hours, and failures corrected prior to shipment.
10. When enabled by remote controls, controller shall start at zero speed and ramp to the current speed setting. Speed range shall be adjustable between 0 Hz and 66 Hz, with separately adjustable maximum and minimum speeds, and adjustable rate of acceleration and deceleration. Provide at least 2 lockout speed ranges with adjustable minimum and maximum speed settings to prevent operation at driven equipment resonant vibration frequencies.
11. Controllers shall restart automatically upon restoration of stable electric service after power supply faults, with adjustable time delay before restart. Operating parameters shall be stored in nonvolatile memory. Controllers shall continue to operate at the minimum speed setpoint on loss of remote control signal, and activate the remote alarm contact.
12. Variable frequency drives shall be designed for starting into a spinning motor. The variable frequency drive shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the variable frequency drive shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.
13. Drive displacement power factor shall be between 0.95 and 1.0 lagging over the entire operating speed range.
14. Drive efficiency shall be greater than 96% at 100% speed full load.

C. Start-up service: as specified in Section 230090, HVAC Performance Verification.

D. Service: manufacturer shall maintain a parts and service facility within 8 hours of this Project, which shall have inventory to cover not less than 80% parts service within 24 hours, and 95% within 48 hours. Further, the facility shall have a factory-trained service representative to furnish installation, test, and start-up supervision necessary for final approval and acceptance, as well as to perform maintenance and repairs on components.

E. Warranty: in addition to other warranties specified herein, equipment shall be guaranteed against defective parts and workmanship under terms of the manufacturer's standard warranty, but in no event shall it be for a period of less than 2 years from date of initial start-up of the system and shall include labor and travel time.

F. Manufacturer: ABB, AC Tech, Allen-Bradley, Baldor, Danfoss, Eaton, Emerson, Fuji, GE, Hitachi, Johnson Controls/York, Siemens, Square D, Toshiba, Trane, US Drives, or Yaskawa.

2.9 VIBRATION ISOLATION

A. Apparatus shall be by one manufacturer, except where herein specified otherwise.

B. Where isolators are exposed to weather, springs shall be powder- or neoprene-coated and other parts hot-dipped galvanized or zinc-plated.

C. Isolators:

1. Type FS - Free-standing, laterally stable, unhooused spring type with leveling bolts for bolting to the equipment. Spring diameter shall be not less than 0.8 of the compressed height of the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Springs shall be complete with neoprene or fiberglass noise isolation pads, minimum 0.25" thick, bonded to the baseplate.

- a. Manufacturer: Kinetics Noise Control FDS, Mason SLF, Vibration Eliminator OST, VMC Group AW/AWH, or Vibro-Acoustics FS.
2. Type LS - Type FS isolators with addition of vertically restraining limit stops, and welded steel housings. Minimum clearance around the restraining bolts and between the housing and the spring shall be 0.5". Limit stops shall be out of contact with the housing during normal operation.
 - a. Manufacturer: Kinetics Noise Control FLS, Mason SLR, Vibration Eliminator KW, VMC Group M, or Vibro-Acoustics CSR.
3. Type DN - Double-deflection neoprene type, with neoprene-coated metal surfaces, and top and bottom surfaces ribbed. Isolators shall have bolt holes in the base.
 - a. Manufacturer: Kinetics Noise Control RD, Mason ND, Vibration Eliminator T44 or D44, VMC Group RD or RVD, or Vibro-Acoustics RD.
4. Type SH - Combination type hanger with steel spring and double-deflection neoprene or natural rubber element in series. The neoprene or natural rubber element shall have a minimum static deflection of 0.35". Spring diameter shall be not less than 0.8 of the compressed height of the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Hangers shall be designed for a minimum of 15° angular misalignment from vertical before rod contacts housing.
 - a. Manufacturer: Kinetics Noise Control SRH, Mason 30N, Vibration Eliminator SNRC, VMC Group HRSA, or Vibro-Acoustics SHR.
5. Type PSH - Type SH isolators precompressed to the rated deflection. Hangers shall have a release mechanism to free the spring after installation is complete.
 - a. Manufacturer: Kinetics Noise Control SFH, Mason PC 30N, Vibration Eliminator PCSR, VMC Group HRSA-PR, or Vibro-Acoustics PSHR.
6. Type NH - Double-deflection neoprene or natural rubber hanger type, with neoprene or natural rubber grommet between hanger rod and housing. Neoprene or natural rubber element shall have neoprene- or natural rubber-coated metal surfaces.
 - a. Manufacturer: Kinetics Noise Control RH, Mason HD, Vibration Eliminator C, VMC Group HR, or Vibro-Acoustics NH.
7. Type NS - Sandwich pad type, with minimum 0.25" thick ribbed or waffled neoprene pad bonded to each side of 16 gauge plate. Isolator pads shall be selected for less than 80% maximum rated load.
 - a. Manufacturer: Kinetics Noise Control RSP, Mason WSW, Vibration Eliminator P, VMC Group Multi-Layer Shear-Flex, or Vibro-Acoustics 400 NP.
8. Type NP - Neoprene pad type, minimum 0.25" thick ribbed or waffled on both sides. Isolator pads shall be selected for less than 80% maximum rated load.
 - a. Manufacturer: Kinetics Noise Control NP, Mason W, Vibration Eliminator N, VMC Group Shear-Flex, or Vibro-Acoustics N.
9. Type NR - Isolator anchor type consisting of a telescopic arrangement of two sizes of steel tubing separated by a minimum 0.5" thick heavy duty neoprene and duck or neoprene isolation material. Vertical restraints shall be provided by similar materials arranged to prevent vertical travel in either direction. Allowable loads on the isolation material shall not exceed 500 psi and the design shall be balanced for equal resistance in any direction.
 - a. Manufacturer: Mason ADA, VMC Group AG, or Farrat.
10. Type PI - Piping isolator type, 30 durometer ribbed neoprene ring, inside diameter sized for piping outside diameter, and mounting bracket.
 - a. Manufacturer: Specialty Products Company, Stock Drive Products or Owens Corning.

11. Type SR - Rail type, consisting of a set of structural steel beam, aluminum channel or angle rails to which Type FS DN isolators are rigidly attached. Bolt holes shall be provided for bolting equipment to the rails. Rail deflection shall be limited to less than 1/360 of unsupported span. Wind and uplift restraints shall be provided as required for exterior installations.
 - a. Manufacturer: Kinetics Noise Control SFB, Mason M, or WF, VMC Group SR, DRB, or Vibro-Acoustics IFB.
 12. Type SC - Curb type, with integral isolators, designed to fit over the roof curb and under the isolated equipment. The extruded aluminum top and bottom members shall contain cadmium-plated springs having a 1" minimum deflection with 50% additional travel to solid. Spring diameter shall be not less than 0.8 of the compressed height of the spring. Springs shall be provided with positive spring retainers with flexible ties to maintain base integrity during shipping and rigging. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 0.25" so as not to interfere with the spring action except in high winds. The weather seal shall consist of continuous closed cell sponge materials both above and below the base and a waterproof, frictionless, flexible neoprene connection joining the outside perimeter of the extruded aluminum members. Upper and lower extruded aluminum members shall have heliarc welded, mitered corners.
 - a. Manufacturer: Kinetics Noise Control KSR, Mason RSC, Vibration Eliminator AR, VMC Group RTIR, or Vibro-Acoustics RTR.
 13. Type SCH - Curb type, with integral isolators, designed for the roof structure and equipment to be isolated. Lower members shall be rectangular steel tubes with provisions for accommodating roof slope and maintaining equipment level. Upper frame shall provide continuous support for the equipment and shall resiliently withstand wind and seismic forces. Directional snubber bushings shall be minimum 0.25" thick neoprene. Steel springs isolating the upper frame shall be stable unhooded type with a minimum static deflection of 2" 3" with 50% additional travel to solid. Springs shall be adjustable and removable, and shall be mounted on 0.25" thick neoprene pads. Hardware shall be cadmium-plated or galvanized, and springs shall have a corrosion resistant finish. Weather seal shall consist of a continuous closed cell sponge material on top of the curb and a waterproof flexible aluminum seal joined at the corners by EPDM bellows. Lower portion of curb shall be insulated, and curb shall have provisions for flashing and counter flashing.
 - a. Manufacturer: Kinetics Noise Control KSCR or ESR, Mason SRSC, Vibration Eliminator VERC, VMC Group P, or Vibro-Acoustics VCR.
 - b. Manufacturer: Mason MT.
- D. Flexible elastomeric pipe connectors: twin-sphere type, made of multiple plies of nylon cord fabric and neoprene, hydraulically molded. Connectors through 1.5" shall have threaded ends, and connectors 2" and larger shall have flanges with recessed groove to receive the connector's raised neoprene face. Connectors 4" and larger operating above 100 psig shall have isolated limit stops to prevent overextension and over compression. Limit stops shall be either control cables with neoprene isolated end fittings and anti-compression stops, or spring-loaded control units. Connectors shall be line size and shall be designed for the pressures and temperatures encountered in the system, minimum 150 psig and 220°F.
1. Manufacturer: Kinetics Noise Control KinFlex, Mason Safeflex, VMC Group 2600 or 2655, or Vibro-Acoustics EJE2 or EJN2.
- E. Flexible metal hose connectors: stainless steel corrugated type with stainless steel woven braid outer sheath.
1. Manufacturer: Kinetics Noise Control BFMC, Mason BSS, VMC Group SS, Vibration Eliminator Stainless Steel Flexible Connectors, or Vibro-Acoustics FCSS.
- F. Thrust restraints: a set (2 or more) of spring thrust resisting assemblies consisting of coil springs, spring retainers, isolation washers, angle mounting brackets, and elastomeric tubing for isolating thrust rods.
1. Manufacturer: Kinetics Noise Control HSR, Mason WB, Vibration Eliminator HTR-1, VMC Group TRK, or Vibro-Acoustics AHCS.

- G. Caulking: resilient, paintable, nonsag and nonhardening latex sealant complying with ASTM C834-2017.
 - 1. Manufacturer: Hilti Smoke & Acoustic Sealant CP506, Owens Corning Quietzone Acoustical Sealant, 3M FireDam 150+, STI SpecSeal Smoke 'N' Sound Sealant, or U.S. Gypsum Firecode Smoke-Sound Sealant.

2.10 SEISMIC AND WIND RESTRAINTS

- A. Seismic force design shall be determined in accordance with the following seismic design criteria:
 - 1. Office Tower
 - 2. Seismic Design Category: C
 - 3. Risk Category: II.
 - 4. Component Importance Factor, I_p : 1.0.
 - 5. E.O.C. Building
 - 6. Seismic Design Category: D.
 - 7. Risk Category: IV.
 - 8. Component Importance Factor, I_p : 1.5.
- B. Provide restraint devices as required for vibration isolated and non-vibration isolated mechanical components. Provide calculations to determine restraint loadings for specific components to be installed resulting from seismic forces on components. Seismic restraint calculations shall be signed by a licensed engineer in the employ of the seismic restraint device manufacturer.
- C. For roof-mounted equipment and components both the seismic acceleration and wind loads shall be calculated, and the highest load shall be utilized for the design of the seismic restraints and vibration isolators.
- D. Exceptions for HVAC components listed within the applicable project building code may be utilized. However, use of exceptions shall be noted with submitted seismic restraint calculations.
- E. Seismic restraints and vibration isolators provided with integral seismic restraint capacity shall have Anchorage Preapproval "R" Number from OSHPD in the State of California listing minimum certified horizontal and vertical load ratings.
- F. Floor-Mounted Restraints:
 - 1. All-directional external seismic restraints for floor-mounted components shall consist of interlocking steel assemblies restrained when engaged under seismic motion by elastomeric material with a minimum thickness of 0.25". The minimum air gap between interlocking assemblies shall be 0.125".
 - 2. Restraints for neoprene vibration isolators shall consist of Type DN isolators with the addition of welded steel housings to resist seismic forces.
 - 3. Restraints for free-standing floor springs shall consist of Type FS isolators with the addition of welded steel housings to resist seismic forces. Restraints shall allow a maximum movement of 0.25" in all directions.
 - 4. Manufacturer: Kinetics Noise Control, Mason Industries, VMC Group, Vibration Eliminator, or Vibro-Acoustics.
- G. Suspended Restraints:
 - 1. Restraints for vibration isolated suspended equipment and components shall consist of galvanized or stainless steel aircraft cables with end connection fittings designed to swivel in order to ensure proper cable alignment and avoid bending of cable.
 - 2. Restraints for non-vibration isolated suspended equipment and components shall consist of steel angle or unistrut with anchor bolts and end connection fittings designed to swivel to the final installation angle.

3. Manufacturer: B-Line, International Seismic Application Technology, Kinetics Noise Control, Mason Industries, Tolco, VMC Group, Vibration Eliminator, or Vibro-Acoustics.

2.11 CONCRETE

- A. Normal weight concrete (145 pcf) using Type I Portland Cement, 1" maximum size coarse aggregate to provide a minimum 28 day compressive strength of 3000 psi.

2.12 GROUT

- A. Nonshrink type, conforming to ASTM C1107/C1107M-2017 when tested at fluid consistency. Grout shall exhibit zero bleeding at every age when mixed to fluid consistency. Minimum 28 day compressive strength, when mixed to fluid consistency, shall be 7000 psi.
- B. Manufacturer: Cormix, Master Builders, or Quikrete.

2.13 ACCESS PANELS - BUILDING

- A. Refer to Section 083113, Access Door Panels.

2.14 ESCUTCHEONS

- A. Split hinged type, constructed of chromium-plated steel or cast brass, sized to fit over insulation and to cover sleeve.

2.15 UNDERGROUND WARNING TAPE

- A. Tape shall be acid- and alkali-resistant polyethylene film tape, 6" wide with minimum thickness of 0.004", specifically designed for marking and locating of underground utilities.
- B. Tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3' deep. The metallic core of the tape shall be encased in a protective jacket or provided with other means of corrosion protection.
- C. Tape color shall be as specified below and shall bear a continuous printed inscription describing the specific utility:

	<u>Utility</u>	<u>Color</u>
	Chilled water	Blue

- D. Manufacturer: Brady, Boddingtons, Carlton Industries, Seton, or Thor Enterprises.

2.16 PAINTING

- A. Paint for high temperature piping and equipment shall be high temperature resistant, designed for the temperatures at which the system will operate.

PART 3 - EXECUTION

3.1 PROTECTION OF EQUIPMENT AND MATERIALS DURING CONSTRUCTION

- A. Provide protective covers, skids, plugs or caps to protect equipment and materials from damage or deterioration during construction.
- B. Store equipment and material under cover, and off the ground or floors exposed to rain.
- C. For outdoor storage, protective covers of 10 mil thick black sheet plastic shall be fitted over equipment and materials. Covers shall be reinforced to withstand wind and precipitation. Set equipment and material on skids or platforms of height to avoid damage or deterioration from spattering and ground water.
- D. Protect coils against damage by installing temporary closure panels over exposed coil faces. Panels shall be minimum 24 gauge sheet metal or 0.375" plywood.
- E. Close open ends of fans, terminal units, air handling units, and ductwork with temporary closures of sheet plastic taped in place.
- F. Plug ends of pipes when work is stopped to prevent debris from entering the pipes.
- G. Provide dust and debris protection for ductwork, coils, fans, equipment, motors, and bearings operated during construction up to date of substantial completion.
- H. Cover open ends of exhaust and return ducts with temporary filter media while fan systems are operating.

3.2 EQUIPMENT AND INSTALLATION REQUIREMENTS

- A. Air systems shall operate without aerodynamic noise generated from the faulty installation of ductwork or any component of the air distribution system.
- B. Equipment shall be installed and connected as specified herein or indicated on the Drawings in accordance with the manufacturers' instructions and recommendations for this Project. Furnish and install auxiliary piping, water seals, valves, and electrical connections recommended by the manufacturer for operation.
- C. Motor quantities, sizes and equipment wattage ratings specified herein or indicated on the Drawings are the minimum requirements, unless noted otherwise. Motor quantities, sizes and equipment wattage ratings less than those specified herein or indicated on the Drawings are not acceptable. Larger motor sizes and equipment wattage ratings may only be provided if necessary to meet the prescriptive requirements specified herein or indicated on the Drawings. Where multiple motors or motor sizes or equipment wattage ratings larger than specified herein or indicated on the Drawings are furnished, provide and coordinate the corresponding increased number or capacity of feeders and other electrical equipment serving them, at no additional cost to the Owner.
- D. Fans, drive sheaves, motors, and pumps shall be statically and dynamically balanced and shall have steady state radial vibration levels which do not exceed the following:

<u>Equipment</u>	<u>Peak-to-Peak Displacement (mils)</u>
Fans, drive sheaves, and motors	
under 600 rpm	4
600 to 1000 rpm	3
1000 to 2000 rpm	2
over 2000 rpm	1
Pumps and motors	

<u>Equipment</u>	<u>Peak-to-Peak Displacement (mils)</u>
over 1800 rpm	1
under 1800 rpm	2

- E. Field-installed equipment controls or sensor wiring shall be installed in conduit. Low voltage control and sensor wiring shall be installed in conduits separate from line voltage control wiring and power wiring.
- F. Where connection sizes at equipment vary from the pipe size indicated on the Drawings, provide appropriate reducers/increasers directly adjacent to the pipe-equipment unions. Unless otherwise specified herein or indicated on the Drawings, the size of the valves and accessories dedicated to the equipment shall not be less than the pipe size to which they are connected.

3.3 HANGERS AND SUPPORTS

- A. Where several pipes run parallel and in the same plane:
 - 1. 2.5" and smaller: may be supported on gang or multiple hangers. Separate copper tubing from ferrous supports with copper-plated steel or 4 psf sheet lead.
 - 2. 3" and larger: support independently, parallel, and equally spaced.
- B. Supports for steel pipe and for copper tubing shall not be more than 10' apart. Supports for copper tubing 1.25" and smaller shall be not more than 5' apart. Pipes shall be supported within 1' of each elbow and tee, and for piping 2.5" and larger at each valve and strainer or each close-coupled group of valves, traps, and strainers.
- C. Install a 4 psf lead saddle at each hanger on uninsulated copper piping 4" and larger.
- D. Hangers and supports for insulated piping shall bear on outside of insulation. Hangers shall be sized for uncompressed insulation thickness.
- E. Provide insulation protectors.
- F. Support vertical chilled water, piping on every floor, unless otherwise specified herein or indicated on the Drawings.
- G. Support piping independently of equipment.
- H. Adjust hangers and supports so that loading is uniform.
- I. Hanger rods shall be suspended from the structure. Do not suspend from other piping, equipment, or ductwork.
- J. Inserts:
 - 1. Use for piping 2.5" and larger in new concrete construction.
 - 2. Where the weight to be supported by an insert exceeds 50% of its rated load, install 2 No. 3 reinforcing rods, 3' long through each yoke of insert.
- K. Expansion Anchors:
 - 1. Use for piping in existing concrete and masonry construction.
 - 2. Use for piping 2" and smaller in new concrete construction.
- L. Where indicated on the Drawings, support piping on pipe stand supports. At the base of each support, weld a slip-on flange to the vertical stanchion. Place stanchion and flange on top of a baseplate, welding the

flange to the baseplate. Anchor baseplates to vibration isolators or foundations. Provide schedule 40 pipe to increase stanchion height as required by field conditions.

3.4 SLEEVES

- A. Provide where pipes pass through walls, floors and roofs, except in the following circumstances:
 - 1. Concealed wall openings of the required diameter in non fire- or smoke-rated construction, unless specified herein to have voids packed with fiberglass and caulking.
 - 2. Concealed floor openings formed by the use of plastic forming devices providing a circular opening of the required diameter.
 - 3. Core drilled concealed openings. Openings in roofs shall not be core drilled. Obtain written permission prior to core drilling.
 - 4. Openings in concrete floor slabs on grade.
- B. Sleeves shall be placed into position prior to wall, floor, or roof construction. Sleeves shall be tight-fitting and cut smooth.
- C. Floor sleeves shall be cast in place, shall be watertight, and shall extend from the bottom of the slab to 2" above the finished floor.
- D. Wall sleeves shall extend 1" on each side of walls.
- E. Make sleeves through outside walls above and below grade watertight.
- F. Size sleeves for insulated pipes penetrating nonrated construction to allow full thickness insulation.
- G. Sleeves in nonrated construction shall be sized to provide clearance all around pipe, including insulation, to accommodate thermal movement. Clearance shall be minimum 0.75".
- H. Furnish 4 psf lead flashing for sleeves through flat built-up roofs extending at least 8" from the sleeve in all directions.

3.5 PENETRATION SEALS:

- A. General:
 - 1. Install in accordance with the manufacturer's published instructions to achieve ratings and classifications specified herein. A copy of these instructions shall be maintained and available on site.
- B. Firestops:
 - 1. Close and firestop penetrations through fire- and smoke-rated construction. Materials used to seal these penetrations shall continue the construction's fire and smoke resistance ratings uninterrupted and shall maintain an effective barrier against the spread of flame, smoke, water and hot gases. Install after installation of ductwork, piping, and conduits.
- C. Exterior Wall Seals:
 - 1. Piping without insulation: use expansion seals between pipes and sleeves. Where walls exceed the width of expansion seals, use two seals, one being flush with the inside sleeve face and the second with the outside sleeve face. Fill the annular void space between the two seals.
 - 2. Piping with insulation: pack center annular space between the insulation and the sleeve with fiberglass, then caulk 1" deep from each face to the fiberglass with nonhardening sealant. Smooth sealant with face of sleeve.

3.6 IDENTIFICATION OF PIPING

- A. Identify piping specified under this Division in accordance with ASME A13.1-2015.
- B. Legends shall be on the lower quarters of the pipe except where such location would be obscured. Arrow tape shall be wrapped completely around the pipe at each end of the legend with arrows pointing in the direction of flow.
- C. Locate pipe identification as follows:
 - 1. In equipment rooms:
 - a. Within 18" of each valve or valve assembly.
 - b. Within 36" of each 90° elbow, connection to equipment or vessel, point where pipe enters shafts and pierces outside walls.
 - c. On not over 20' intervals along exposed piping.
 - 2. Above suspended ceilings:
 - a. Within 18" of each valve or valve assembly.
 - b. At tees within 36" of both main and branch.
 - c. Within 36" of each 90° elbow.
 - d. Identify at not less than 1 point each piping run visible in each room with identification on not over 20' intervals.
 - 3. Piping concealed in chases or shafts:
 - a. Each pipe visible through an access door or panel.
 - 4. Piping exposed in rooms other than mechanical equipment areas:
 - a. Omit identification of piping 0.5" and smaller exposed at connections to equipment.
 - b. With the above exception, identify at not less than 1 point each piping run visible in each room with identification on not over 20' intervals.
- D. Schedule of Piping Identification:

<u>Piping System and Contents</u>	<u>Tape Color</u>	<u>Legend</u>	<u>Abbreviated Legend</u>
Chilled Water	Green	Chilled Water	CHS & CHR

- E. Piping with temperature maintenance cable shall be labeled Electronically Traced on the outside of the insulation jacket.

3.7 VALVE TAGS AND SCHEDULES

- A. Provide numbered brass tags on valves except at unit heaters, fan-coil units, terminal unit coils, finned tube radiation, and convectors. Attach tags to valve stems with brass S-hooks or brass chain.
- B. Tags on new valves shall continue the numbering sequence of existing valves.
- C. Provide for each system a typewritten schedule of valves giving number, location (room number), and function of each with a small scale diagram outlining general piping layout and location of each numbered valves.

3.8 IDENTIFICATION OF EQUIPMENT

- A. Identify equipment, Identification shall consist of upper case letters.
- B. Each starter, variable frequency drive, contactor, push button station, control switch, disconnect, and thermal overload switch shall be appropriately identified by nameplates with 0.25" high letters.
 - 1. Identification shall include the equipment designation and device function, e.g., CT-1 Water Level Control Disable.
- C. Each piece of equipment and access door shall be stenciled with its equipment number in a prominent location with minimum 2" high letters.
- D. Access panels and doors in ductwork and plenums shall be stenciled with minimum 1" high letters to indicate the type of devices accessible therein and the system or fan identification number associated with that ductwork or plenum.
- E. Access panels in grease ductwork shall be labeled "Access Panel – Do Not Obstruct".
- F. Identify each filter using a stick-on tag with the filter size and description, the American Air Filter part number, and the quantity of filter units required. Tags shall be installed near or on the filter access door.

3.9 IDENTIFICATION OF DUCTWORK

- A. Markers shall be secured to ductwork with draw bands.
- B. Legends shall be on the underside of the duct except where such location would be obscured. Legends shall include name of air handling unit or fan system and arrows pointing in the direction of flow.
- C. Concealed ductwork shall be labeled with identification materials specified herein. Exposed ductwork shall be stenciled with minimum 3.5" uppercase letters.
- D. Supply ductwork downstream of terminal units shall not be labeled.
- E. Locate duct identification as follows:
 - 1. Mechanical Equipment Rooms:
 - a. Within 36" of each elbow, connection to equipment, and point where duct enters a shaft.
 - b. On not over 20' intervals along exposed ductwork.
 - 2. Above Suspended Ceilings:
 - a. Within 18" of each terminal unit.
 - b. At branch connections within 36" of both main and branch.
 - c. Within 36" of each elbow and point where duct enters a shaft.
 - d. On not over 40' intervals.
 - 3. Ductwork Concealed in Chases or Shafts:
 - a. Each duct visible through an access door or panel.
- F. Schedule of Ductwork Identification:

<u>Duct System and Contents</u>	<u>Background Color</u>	<u>Legend</u>	<u>Legend Color</u>
Outside Air	Green	Outside Air	White
Supply Air	Blue	Supply Air	White

<u>Duct System and Contents</u>	<u>Background Color</u>	<u>Legend</u>	<u>Legend Color</u>
Return Air	Red	Return Air	White
Relief Air	Red	Relief Air	White
Toilet or Janitor Closet Exhaust	Yellow	Toilet Exhaust	White

3.10 MOTORS

- A. Provide motors for equipment covered in Division 23 unless otherwise specified herein. Select motors for operation not exceeding a 1.0 service factor and within the nameplate amperage and nominal power rating.

3.11 STARTERS

- A. Provide starters, push buttons, thermal overload switches, and contactors for equipment covered in Division 23 unless otherwise specified herein. Installation of starters, push buttons, and thermal overload switches, not factory installed, is specified under Division 26.
- B. Provide 120 V secondary control power transformers for control circuits where equipment is served at 208 V or higher.

3.12 FUSES

- A. Provide fuses in equipment furnished under this Division of the specifications.
- B. Provide 3 spare fuses of each size, UL class, and voltage rating furnished under this Division of the specifications and turn over to the Owner. Obtain a receipt for same.

3.13 VARIABLE FREQUENCY DRIVES

- A. Installation is specified under Division 26.
- B. Start-up shall be performed under the supervision of a technical service employee of the manufacturer. Set minimum speed at 20%, and calibrate the control input to match the operating conditions and the automatic temperature control system. Submit written certification, upon completion, that components have been installed correctly in accordance with the manufacturer's recommendations, are operating correctly, and that operation and set-up has been coordinated with the automatic temperature control systems.
- C. Test each fan from minimum to maximum speed to determine the resonant frequencies. Once the resonant speeds have been determined, adjust the frequency lock-out feature to eliminate fan operation at those speeds.
- D. Install DV/DT drive output filters where load lead length is 50' and greater.

3.14 VIBRATION ISOLATION

- A. General:
 - 1. Select and locate vibration isolation equipment for uniform loading and deflection, according to weight distribution of equipment.
 - 2. Vibration isolators shall be installed and connected as specified herein or indicated on the Drawings in accordance with the manufacturer's written instructions and certified submittal data.

3. Installation of vibration isolation equipment shall be supervised by an authorized, factory-trained manufacturer's representative.
4. There shall be no direct contact of isolated piping, ductwork, or equipment with shaft walls, floor slabs, structural elements, conduits, or any other nonisolated item.
5. Prior to startup, clean out foreign matter between bases, isolators, equipment, and mounting surfaces. Verify that there are no rigid connections between equipment and building structure.
6. Where recommended by the manufacturer, isolator baseplates shall be bolted to the structure or foundation. Bolting shall incorporate neoprene bushings and washers.
7. Installed Type FS isolators shall not incorporate a leveling bolt of greater length than that supplied with the isolators.
8. Isolator hangers shall be installed with housings a minimum of 2" below but as close to the structure as possible.
9. Absence of Type SR isolators scheduled on Drawings shall not preclude their use. Coordinate with the manufacturer if installation conditions warrant their use once specific equipment selection is finalized.
10. Vibration isolators shall not cause any change in position of equipment, piping, or ductwork resulting in stresses or misalignment.
11. Conflicts with other trades that will result in direct contact with isolated equipment, piping, or ductwork, shall be brought to the attention of the Architect prior to installation.
12. Discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection shall be brought to the attention of the Architect prior to installation.
13. After installation, manufacturer shall verify that vibration isolation systems are installed and operating properly, and shall submit a certificate so stating. Verify that isolators are adjusted, with springs perpendicular to bases or housing, adjustment bolts are tightened up on equipment mountings, and hangers are not cocked, and Type DN baseplates are bolted to foundations. In addition, manufacturer shall certify that Type **SC SCH** isolator curbs are assembled and installed properly.

B. Equipment Isolation:

1. Isolated equipment mounting systems shall permit equipment motion in all directions.
2. Mount fans, as indicated on the Drawings, on structural steel vibration bases common to both fan and motor.
3. Mount pumps and equipment, as indicated on the Drawings, on concrete-filled inertia bases. Inertia bases shall be arranged with spring isolator locations such that a horizontal plane passing through the top of the isolators will pass through or above the center of gravity of the equipment and base. There shall be a minimum operating clearance of 2" between each inertia base and its foundation.
4. Provide height saving brackets where recommended by the manufacturer for equipment stability, or operating height requirements.
5. Provide spring-loaded thrust restraints for fans and air handling units where movement under any operating condition will exceed 0.375".
6. Compressors for rooftop air conditioning units, penthouse air conditioning units, natatorium dehumidification units, and self-contained air conditioning units shall be isolated from the support structure with Type NP isolators.
7. If Type SC isolator curbs are not shipped to the site as one factory-fabricated unit, manufacturer shall provide an authorized representative to supervise field joining of sections (maximum of 2 joints per curb allowed).
8. Assemble, install and attach Type SCH isolator curbs in accordance with manufacturer's instructions. Manufacturer shall provide an authorized representative to supervise assembly and installation.
9. Engine-generator set silencers and associated piping shall be supported with Type SH isolators with a minimum 1.5" static deflection.
10. Steam pressure reducing valve assemblies shall be supported with Type SH isolators with a minimum 2" static deflection.
11. Type AS isolators shall be connected to the building control air supply system. served by a separate compressed air supply as specified herein.

12. Threads cut into compressed air galvanized pipe shall be painted with cold galvanizing compound.
13. Threads on compressed air fittings and bolts shall be fully engaged. Threads shall be made up using joint compound or Teflon tape.
14. Mount air compressor on Type NS isolators.

C. Piping Isolation:

1. Chilled Water Piping:

a. Horizontal:

- 1) Pipe stand supports shall be supported on Type LS isolators for the first 2 supports adjacent to the equipment and on Type FS isolators for the remaining isolated pipe length. Isolators shall have a minimum 1" static deflection.
- 2) Piping shall be suspended with Type PSH isolators for the first 3 hangers adjacent to the equipment. The remaining isolator hangers shall be Type SH. The first 3 hangers shall have the same minimum static deflection as the equipment isolators, with a maximum of 2". The remaining isolators shall have a minimum 1" static deflection.

b. Vertical:

- 1) Piping shall be isolated from the supporting members or structure with Type FS isolators with a minimum 1" static deflection.

D. Flexible Pipe Connections:

1. Provide at piping connections to equipment if the associated piping cannot be isolated as specified herein due to space limitations.
2. Install flexible metal hose with at least one 360° loop when the straight hose length between connections would be less than 5 times the hose diameter for air compressors and vacuum pumps.

E. Caulking: install in accordance with ASTM C919-2019.

3.15 EQUIPMENT AND EQUIPMENT ROOMS

A. Remove dust, dirt, rust, stains, and temporary covers.

B. Foreign matter shall be blown, vacuumed, flushed, or cleaned out of and from new equipment, piping, ductwork, pumps, fans, motors, bearings, devices, switches, controls, and panels.

C. Clean and polish identification plates.

D. In equipment rooms, clean equipment, ductwork, insulation, piping, conduit, and room surfaces from dust and dirt and maintain in a clean condition from date of substantial completion the Architect's final certificate until final completion of work and corrective work.

E. Remove excess material from the Project site.

3.16 SEISMIC AND WIND RESTRAINTS

A. Restraints shall be installed after the equipment is mounted, piped, connected, and operating to ensure that no contact occurs during normal equipment operation.

B. Installation of seismic restraints shall not cause any change of position of equipment or components resulting in stress and misalignment.

- C. No rigid connections between equipment or components and the building structure shall be made that degrade the vibration isolated system specified herein.
- D. Equipment that is internally vibration isolated and restrained shall have its entire unit assembly seismically attached to the structure.
- E. Do not brace a system to two different structures, such as a wall and a ceiling.
- F. After installation, manufacturer shall verify that seismic and wind restraints are installed and operating properly, and shall submit a certificate so stating.

3.17 FOUNDATIONS

- A. Provide concrete foundations for the following floor-mounted equipment:

<u>Equipment</u>	<u>Foundation</u>
Pumps	4" high pad
Chillers	4" high pad
Chilled water buffer tanks	4" high pad
Air handling units	4" high pad

- 1. Foundation height shall accommodate seismic anchors, and condensate P-traps, but shall be not less than the minimum specified above.

- B. Foundations shall be continuous and shall have beveled edges and smooth float finish. Foundations shall be reinforced with No. 3 bars a maximum of 12" on center each way, and held in place with dowel rods at each corner anchored in the slab. Dowel rods shall not penetrate through the slab.
- C. Roughen and clean exposed slabs before pouring foundations. Apply bonding agent to surfaces in contact.
- D. Foundations shall extend a minimum of 6" beyond the equipment footprint or 1.5 times the seismic anchor embedment depth from the point of anchoring (whichever is larger) in all directions, including appurtenances, vibration isolators, base elbow supports, and motors.
- E. Equipment attached directly to foundations or inertia bases; bases provided with grout holes; and bases consisting of a structural frame shall have voids filled with grout after attachment to foundation.
- F. Fill voids between baseplates and foundations, and level equipment, with grout.

3.18 ACCESS PANELS - BUILDING

- A. Where HVAC work is concealed by walls or ceilings, or is inaccessible, provide an access panel to provide access for service and maintenance.
- B. HVAC work located above ceilings is considered accessible if the ceiling is the accessible type and is arranged for access to the equipment.
- C. Fire-rated access panels shall be provided in fire barriers with ratings to match the construction fire rating.

- D. Access doors providing access to ductwork access doors shall allow for service and maintenance of the intended equipment.
- E. Installation of access panels is specified under another Division.

3.19 ESCUTCHEONS

- A. Provide escutcheons where exposed piping passes through walls, floors and ceilings in finished areas.

3.20 UNDERGROUND WARNING TAPE

- A. During backfill, install tape continuously along length of piping, 12" to 18" above the piping for:
 - 1. Chilled water.

3.21 PAINTING

- A. Except where otherwise specified herein, painting shall be done under another Division. Surfaces shall be left clean and free from oil.
- B. Equipment factory finishes damaged or deteriorated during construction shall be repaired to match original finish.
- C. Where galvanizing is broken during fabrication or installation, recoat exposed areas with zinc-rich paint.
- D. Exterior ferrous equipment, piping and supports shall be painted with 2 coats of rust preventive paint, color selected by the Architect.
- E. Exposed interior uninsulated black steel piping, and exposed nongalvanized ferrous accessories, hangers, rods, inserts, and mechanical supports shall be prepared and painted with 1 coat of rust preventive paint prior to other painting or identification, or 2 coats of rust preventive paint if no other painting is specified.
- F. Ductwork, conduits, insulation, pipe and structure visible through architectural return air openings, grilles, registers and diffusers shall be painted flat black.

3.22 EXCAVATION AND BACKFILLING

- A. Install underground piping outside the building with 36" minimum cover, unless specified otherwise herein.
- B. Determine exact location of existing underground utilities before excavation.
- C. Excavations shall be no longer or deeper than necessary. Backfill material shall be free from rocks and debris.
- D. Compact backfill as the excavation is filled.
- E. Excavation, shoring, bracing, backfilling, and compaction shall conform to Division 31, Earthwork.

3.23 COORDINATION

- A. Provide offsets, transitions, and fittings to coordinate the work of each trade with that of other trades, including plumbing, fire protection, electrical, structural, and architectural.

3.24 OPERATION AND MAINTENANCE MANUALS

- A. These operation and maintenance manual requirements supplement operation and maintenance manual documentation requirements of other Sections of these specifications.
- B. Operation and maintenance documentation, in a bookmarked PDF document and in hardback 3-ring loose-leaf binders except full size drawings, shall cover the HVAC and automatic temperature control systems. Documentation shall include an operations and maintenance documentation directory, emergency information, operating manual, maintenance manual, test reports, and construction documents.
- C. The operation and maintenance documentation package shall be submitted as one comprehensive package to the Architect 3 months before systems start-up, and shall be updated, revised and completed at completion of construction.
- D. Compile and coordinate the documentation for equipment and systems installed. Documentation shall be typewritten and shall contain, at a minimum, the following information.
 - 1. Introduction:
 - a. Project name, contractors' and subcontractors' names, addresses, and telephone and facsimile numbers. Indicate the portion of the work for which each subcontractor was responsible.
 - b. Index.
 - 2. Operation and Maintenance Documentation Directory:
 - a. Explanation of the identification system used, including lists of systems, equipment, and component identifiers and names.
 - 3. Emergency Information:
 - a. Information for technical and nontechnical personnel about actions recommended during emergency situations to protect life and property and to minimize disruption to the building occupants. Emergencies shall, at a minimum, include:
 - 1) Fire.
 - 2) Water outage.
 - 3) Power failure.
 - 4) Heating failure.
 - 5) Cooling failure.
 - 4. Operation Manual:
 - a. General Information:
 - 1) Building function.
 - 2) Building description.
 - 3) Operating standards and logs.
 - b. Technical Information:
 - 1) System description.
 - 2) Operating routines and procedures.
 - 3) Seasonal start-up and shutdown.
 - 4) Special procedures.
 - 5) Basic troubleshooting.
 - 5. Maintenance Manual:
 - a. Descriptions (specifications) of the equipment and components.
 - b. Description of function, as applicable: the function of the equipment, procedures before start-up, functional parameters (input, output) at the design load and at part loads, and performance verification procedures.

- c. Recommended maintenance and lubrication procedures and their recommended frequency for this Project.
 - d. Recommended list of spare parts, part numbers, and the place(s) from which they can be obtained.
 - e. Original purchase order number; date of purchase; name, address, and the telephone number of the vendor; and warranty information.
 - f. Name and address of at least one service agency capable of providing maintenance.
 - g. Installation information.
 - h. Other information needed for the preparation of documents supporting the management of operation and maintenance programs.
6. Test Reports and Certifications:
- a. Copies of tests and certifications performed during manufacture and construction, including but not limited to the following:
 - 1) Certification of installation of vibration isolation.
 - 2) Certification of seismic and wind restraints.
 - 3) Receipt for spare fuses.
 - 4) Receipt for instruction of operating personnel.
 - 5) Certification of installation of HVAC underground preinsulated piping systems.
 - 6) Certification of hydronic system cleaning.
 - 7) Certification of chiller installation and safety and control check-out.
 - 8) Certification of chiller factory performance test.
 - 9) Receipt for extra mechanical seals for pumps.
 - 10) Certification of alignment of pumps.
 - 11) Certification test report for energy recovery units.
 - 12) Certification of operation and accuracy for airflow measurement systems.
 - 13) Certification of BCS calibration and testing.
 - 14) Receipt for BCS training.
 - 15) Receipt acknowledging no BCS failures during test period.
 - 16) Certification of ductwork testing results.
 - 17) Seasonal adjustment reports.
7. Construction Documents:
- a. Record drawings.
 - b. Approved submittals, including revised shop drawings indicating as-installed conditions.
 - c. Equipment identification charts and schedules.
 - d. Warranty certificates.
 - e. Inspection certificates.
 - f. Test, adjust and balance report.
 - g. Performance verification report.
- E. Submit a receipt signed by the Owner acknowledging receipt of the operation and maintenance documentation package.
- 3.25 RECORD DRAWINGS
- A. Refer to Section Record Drawings 017839
- 3.26 DIAGRAMS
- A. Frame and mount the following information:

<u>Information</u>	<u>Location</u>
HVAC diagrams, start-stop procedures, and valve schedules.	Appropriate mechanical rooms.
Automatic temperature control diagrams and sequences.	Adjacent to each control panel.
Appropriate control and interface drawings, including a simplified guide to local programming through the digital display unit, a directory of I/O points connected to that panel, and variables which may be displayed.	Posted on the inside cover of each BCS panel.

B. Diagrams shall be type written or computer generated.

C. Diagrams shall be as-built, and shall include interfaces and interlocks with other equipment.

D. Diagram framing system: 0.125" thick acrylic with satin finish aluminum frames.

3.27 MAINTENANCE

- A. Equipment operated prior to the date of the Architect's final certificate shall be maintained in accordance with manufacturer's recommendations. In addition, provide complete water treatment for hydronic systems operated prior to date of the Architect's final certificate. substantial completion.
- B. Prepare and submit a lubrication chart listing for each piece of equipment:
1. Points requiring lubrication.
 2. Recommendations for a single manufacturer's lubricants with brand name and designation.
 3. Frequency of lubrication required.
- C. Lubricate each item of apparatus requiring lubrication prior to start-up in accordance with the manufacturer's recommendations.

3.28 INSTRUCTION OF OPERATING PERSONNEL

- A. Provide the designated Owner's personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment specified in Division 23. Conduct 2 formal instruction sessions for operating personnel. The first session shall be conducted at the time of start-up and check-out, and the second session shall be approximately 2 months later. Sessions shall be a minimum of 2 days for basic HVAC systems, and as specified herein for specialty systems and equipment. Sessions shall be conducted at the site.
- B. Prepare and submit a syllabus describing an overview of the proposed training program, describing how the training program will be conducted, when and where meetings are to be held, names and company affiliations of lecturers, description of contents and outline for each lecture, and recommended reference material and outside reading. Obtain direction from the Owner on which operating personnel shall be instructed in each system. Proposed training schedules, materials, and lesson plans shall be submitted to the Owner for review of the content and adequacy of the training of the Owner's personnel.

C. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the installing contractor, or manufacturer's representative. More than one party may be required to execute the training. The training program shall include the following, as appropriate for the system or equipment:

1. Training shall normally start with classroom sessions followed by hands-on training for each piece of equipment, which shall illustrate the various modes of operation, including start-up, shutdown, fire/smoke alarm modes, and power failure.
2. During any demonstration, should the system fail to perform in accordance with the requirements of the operation and maintenance manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
3. The controls contractor shall attend training sessions for each type of equipment or system controlled by the control system, to discuss the interaction of the control system as it relates to the equipment or system, in addition to the training required for the control system.
4. Training shall include:
 - a. Use of the printed installation, operation and maintenance instruction material included in the operation and maintenance manuals.
 - b. A review of the written operation and maintenance instructions emphasizing safe and proper operating requirements, preventative and routine maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover, and any emergency procedures.
 - c. Discussion of relevant health and safety issues and concerns.
 - d. Discussion of warranties and guarantees.
 - e. Common troubleshooting problems and solutions.
 - f. Explanatory information included in the operation and maintenance manuals and the location of plans and manuals in the facility.
 - g. Discussion of any peculiarities of equipment installation or operation.
 - h. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as appropriate.
 - i. Specific operating and maintenance procedures for:
 - 1) Chillers.
 - j. Factory-trained technicians shall give instruction on the following specialty systems and equipment:

<u>System/Equipment</u>	<u>Minimum Session Duration, hours</u>
Variable frequency drives	4
Chillers	4

- k. BCS training: as specified in Section 238000, Automatic Temperature Controls.
5. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
6. Explain and demonstrate the operation, function and overrides of local packaged controls not controlled by the central control system.
7. Training shall occur after testing is complete, unless approved otherwise by the Owner.
8. Provide DVD format video recordings of training sessions and a complete record copy of training materials, handouts, and other printed materials used in each training session.
9. Obtain a receipt acknowledging completion of each item of instruction.

END OF SECTION 230010

COVER SHEET FOR
SUBMITTALS TO NEWCOMB & BOYD

Project: _____ Date: _____

Item: _____ Submittal Number: _____

Manufacturer: _____ Model: _____

Specification Paragraph and/or Drawing Number: _____

Capacity: _____

Electrical Characteristics (including identification of all separate connections or services required): _____

Accessories: _____

Options: _____

Deviations (if any; if none, state so): _____

General Contractor Approval: _____
