SECTION 22.05.53
MECHANICAL IDENTIFICATION

PART 1 – GENERAL

1.01 SECTION INCLUDES
   A. Nameplates.
   B. Tags.
   C. Stencils.
   D. Pipe Markers.

1.02 REFERENCES
   A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers.

1.03 SUBMITTALS
   A. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
   B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
   C. Product Data: Provide manufacturers catalog literature for each product required.
   D. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
   E. Project Record Documents: Record actual locations of tagged valves.

PART 2 – PRODUCTS

2.01 NAMEPLATES
   A. Description: Laminated three-layer plastic with engraved letters.
      2. Letter Height: 1/4 inch (6 mm).
      3. Background Color: Green.

2.02 TAGS
   A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch (40 mm) square.
   B. Metal Tags: Aluminum with stamped letters; tag size minimum 1-1/2 inch (40 mm) square with smooth edges.
   C. Chart: Typewritten letter size list in anodized aluminum frame.

2.03 PIPE MARKERS
   B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
   C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm) thick, manufactured for direct burial service.

2.04 CEILING TACKS
A. Description: Steel with 3/4 inch (20 mm) diameter color coded head.
B. Color code as follows:
   1. Yellow - HVAC equipment
   2. Red - Fire dampers/smoke dampers
   3. Green - Plumbing valves
   4. Blue - Heating/cooling valves

PART 3 – EXECUTION

3.01 PREPARATION
A. Degrease and clean surfaces to receive adhesive for identification materials.
B. Prepare surfaces for stencil painting.

3.02 INSTALLATION
A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
B. Install tags with corrosion resistant chain.
C. Install plastic pipe markers in accordance with manufacturer’s instructions.
D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer’s instructions.
E. Install underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.
F. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
G. Identify control panels and major control components outside panels with plastic nameplates.
H. Identify thermostats relating to terminal boxes or valves with nameplates.
I. Identify valves in main and branch piping with tags, show numbers on as-built drawings.
J. Tag automatic controls, instruments, and relays. Key to control schematic.
K. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch (20 mm) diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet (6 m) on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
L. Identify ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
M. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION
PART 1 – GENERAL

1.01 SECTION INCLUDES
A. Piping insulation.
B. Jackets and accessories.

1.02 REFERENCES

1.03 SUBMITTALS
A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.04 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of experience.
B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 5 years of experience and approved by manufacturer.

1.05 DELIVERY, STORAGE, AND PROTECTION
A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.06 ENVIRONMENTAL REQUIREMENTS
A. Maintain ambient conditions required by manufacturers of each product.
B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 – PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION
A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84.


2.02 GLASS FIBER
A. Insulation: ASTM C 547; rigid molded, noncombustible.
   1. 'K' ('Ksi') value: ASTM C 177, 0.24 at 75 degrees F (0.035 at 24 degrees C).
   3. Maximum moisture absorption: 0.2 percent by volume.
B. Insulation: ASTM C 547; semi-rigid, noncombustible, end grain adhered to jacket.
   1. 'K' ('Ksi') value: ASTM C 177, 0.24 at 75 degrees F (0.035 at 24 degrees C).
   3. Maximum moisture absorption: 0.2 percent by volume.
C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E 96 of 0.02 perm-inches (0.029 ng/Pa s m).
D. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.
E. Vapor Barrier Lap Adhesive:
   1. Compatible with insulation.
F. Insulating Cement/Mastic:
   1. ASTM C 195; hydraulic setting on mineral wool.
G. Indoor Vapor Barrier Finish:
   1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
   2. Vinyl emulsion type acrylic, compatible with insulation, white color.
H. Outdoor Vapor Barrier Mastic:
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
I. Insulating Cement:
   1. ASTM C 449/C 449M.

2.03 EXPANDED POLYSTYRENE
A. Insulation: ASTM C 578; rigid closed cell.
   1. 'K' ('Ksi') value: 0.23 at 75 degrees F (0.033 at 24 degrees C).
   3. Maximum water vapor permeance: 5.0 perms (287 ng/Pa s sq m)

2.04 JACKETS
A. PVC Plastic.
   1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
      a. Minimum Service Temperature: 0 degrees F (-18 degrees C).
      b. Maximum Service Temperature: 150 degrees F (66 degrees C).
      c. Moisture Vapor Permeability: 0.002 perm inch (0.00029 ng/Pa s sq m), maximum, when tested in accordance with ASTM E 96.
      d. Thickness: 15 mil (0.38 mm).
      e. Connections: Brush on welding adhesive.
   2. Covering Adhesive Mastic:
      a. Compatible with insulation.
   1. Thickness: 0.016 inch (0.40 mm) sheet.
   2. Finish: Smooth.
   3. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
   4. Fittings: 0.016 inch (0.4 mm) thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.015 inch (0.38 mm) thick aluminum.

PART 3 – EXECUTION

3.01 EXAMINATION
A. Verify that piping has been tested before applying insulation materials.
B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION
A. Install in accordance with manufacturer’s instructions.
B. Install in accordance with NAIMA National Insulation Standards.
C. Exposed Piping: Locate insulation and cover seams in least visible locations.
D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
E. Glass fiber insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
F. For hot piping conveying fluids 140 degrees F (60 degrees C) or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
G. For hot piping conveying fluids over 140 degrees F (60 degrees C), insulate flanges and unions at equipment.
H. Glass fiber insulated pipes conveying fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
I. Inserts and Shields:
   1. Application: Piping 1-1/2 inches (40 mm) diameter or larger.
   2. Shields: Steel between pipe hangers or pipe hanger rolls and inserts.
   3. Insert location: Between support shield and piping and under the finish jacket.
   4. Insert configuration: Minimum 6 inches (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
   5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to drawings.
K. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet (3 meters) above finished floor): Finish with PVC jacket and fitting covers.
L. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.
3.03 SCHEDULES

A. Plumbing Systems:
   1. Domestic Water Supply:
      a. Expanded Polystyrene Insulation:
         1) Pipe Size Range: All sizes.
         2) Thickness: 3/4 inch.

B. Cooling and Heating Systems:
   1. Cold Condensate Drains and drains accepting condensate: All sizes, Glass Fiber 1 1/2 ".
   2. Refrigerant Suction: In accordance with Manufacturer's instructions.
   3. Refrigerant Hot Gas: In accordance with Manufacturer's instructions.

C. Other Systems:
   1. Equipment and refrigerant piping where recommended by manufacturer and consistent with service medium.

END OF SECTION
SECTION 22.10.05
PLUMBING PIPING

PART 1 – GENERAL

1.01 SECTION INCLUDES
A. Pipe, pipe fittings, valves, and connections for piping systems.
   1. Sanitary sewer including condensate.
   2. Domestic water.
   3. Storm water, Interior to building.

1.02 REFERENCES
A. ASME B16.3 - Malleable Iron Threaded Fittings; The American Society of Mechanical Engineers.
B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; (ANSI B16.18).
C. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers.
D. ASME B31.1 - Power Piping; The American Society of Mechanical Engineers; (ANSI/ASME B31.1).
E. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; (ANSI/ASME B31.9).
O. ASTM D 2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
R. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society.
S. MSS SP-67 - Butterfly Valves; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
T. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
U. MSS SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
V. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
W. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

1.03 SUBMITTALS
A. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
B. Project Record Documents: Record actual locations of valves.

1.04 QUALITY ASSURANCE
A. Perform Work in accordance with local standards.
B. Valves: Manufacturer's name and pressure rating marked on valve body.

1.05 REGULATORY REQUIREMENTS
A. Perform Work in accordance with plumbing code.
B. Conform to local requirements for installation of backflow prevention devices.
C. Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.

1.06 DELIVERY, STORAGE, AND PROTECTION
A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Provide temporary protective coating on steel valves.
C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 ENVIRONMENTAL REQUIREMENTS
A. Do not install underground piping when bedding is wet or frozen.

1.08 EXTRA MATERIALS
A. Provide two repacking kits for each size valve.

PART 2 – PRODUCTS

2.01 SANITARY SEWER AND CONDENSATE PIPING, BURIED WITHIN 5 FEET (1500 mm) OF BUILDING
A. PVC Pipe: ASTM D 2665 or ASTM D 3034.
   1. Fittings: PVC.

2.02 SANITARY SEWER AND CONDENSATE PIPING, ABOVE GRADE
A. Cast Iron Pipe: CISPI 301, hubless svc. wt.
   1. Fittings: Cast Iron.
2.03 WATER PIPING, BURIED WITHIN 5 FEET (1500 mm) OF BUILDING
A. Copper Pipe: ASTM B 42, hard drawn.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.

2.04 WATER PIPING, ABOVE GRADE
A. Copper Tube: ASTM B 88 (ASTM B 88M), Type L (B), Drawn (H).
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.

2.05 FLANGES, UNIONS, AND COUPLINGS
A. Unions for Pipe Sizes 3 Inches (80 mm) and Under:
   1. Ferrous pipe: Class 150 malleable iron threaded unions.
   2. Copper tube and pipe: Class 150 bronze unions with soldered joints.
B. Flanges for Pipe Size Over 1 Inch (25 mm):
   1. Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
   2. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
C. Grooved and Shouldered Pipe End Couplings:
   1. Housing: Malleable iron clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; steel bolts, nuts, and washers; galvanized for galvanized pipe.
   2. Sealing gasket: "C" shape composition sealing gasket.
D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.06 PIPE HANGERS AND SUPPORTS
A. Plumbing Piping - Drain, Waste, and Vent:
   2. Hangers for Pipe Sizes 1/2 Inch (15 mm) to 1-1/2 Inches (40 mm): Carbon steel, adjustable swivel, split ring.
   3. Hangers for Pipe Sizes 2 Inches (50 mm) and Over: Carbon steel, adjustable, clevis.
   4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   5. Wall Support for Pipe Sizes to 3 Inches (80 mm): Cast iron hook.
   6. Wall Support for Pipe Sizes 4 Inches (100 mm) and Over: Welded steel bracket and wrought steel clamp.
   8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
B. Plumbing Piping - Water:
   2. Hangers for Pipe Sizes 1/2 Inch (15 mm) to 1-1/2 Inches (40 mm): Carbon steel, adjustable swivel, split ring.
   3. Hangers for Cold Pipe Sizes 2 Inches (50 mm) and Over: Carbon steel, adjustable, clevis.
   4. Hangers for Hot Pipe Sizes 2 Inches (50 mm) to 4 Inches (100 mm): Carbon steel, adjustable, clevis.
   5. Hangers for Hot Pipe Sizes 6 Inches (150 mm) and Over: Adjustable steel yoke, cast iron pipe roll, double hanger.
   6. Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches (150 mm) and Over: Steel channels with welded supports or spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes to 3 Inches (80 mm): Cast iron hook.
9. Wall Support for Pipe Sizes 4 Inches (100 mm) and Over: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 Inches (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron pipe roll.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes to 4 Inches (100 mm): Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 Inches (150 mm) and Over: Adjustable cast iron pipe roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.07 GATE VALVES
A. Up To and Including 3 Inches (80 mm):
   1. MSS SP-80, Class 125, bronze body, bronze trim, rising stem, handwheel, inside screw, solid wedge disc, threaded ends.
B. 2 Inches (50 mm) and Larger:
   1. MSS SP-70, Class 125, iron body, bronze trim, outside screw and yoke, handwheel, solid wedge disc, flanged ends. Provide chain-wheel operators for valves 6 inches (150 mm) and larger mounted over 8 feet (2400 mm) above floor.

2.08 BALL VALVES
A. Construction, 4 Inches (100 mm) and Smaller: MSS SP-110, Class 150, 400 psi (2760 kPa) CWP, bronze, two piece body, chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle, threaded ends with union.

2.09 BUTTERFLY VALVES
A. Construction 1-1/2 Inches (40 mm) and Larger: MSS SP-67, 150 psi CWP, cast or ductile iron body, aluminum bronze disc, resilient replaceable EPDM seat, grooved ends, extended neck, infinite position lever handle with memory stop.

2.10 SPRING LOADED CHECK VALVES
A. Class 125, iron body, bronze trim, stainless steel springs, bronze disc, Buna N seals, wafer style ends.

PART 3 – EXECUTION

3.01 EXAMINATION
A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION
A. Ream pipe and tube ends. Remove burrs.
B. Remove scale and dirt, on inside and outside, before assembly.
C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
E. Group piping whenever practical at common elevations.
F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
H. Provide access where valves and fittings are not exposed.
I. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.
J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
K. Provide support for utility meters in accordance with requirements of utility companies.
L. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09.90.00.
M. Install bell and spigot pipe with bell end upstream.
N. Install valves with stems upright or horizontal, not inverted.
O. Install water piping to ASME B31.9.
P. PVC Pipe: Make solvent-welded joints in accordance with ASTM D 2855.
Q. Sleeve pipes passing through partitions, walls and floors.
R. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches (100 mm).
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
S. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Support horizontal piping as scheduled.
   3. Install hangers to provide minimum 1/2 inch (15 mm) space between finished covering and adjacent work.
   4. Place hangers within 12 inches (300 mm) of each horizontal elbow.
   5. Use hangers with 1-1/2 inch (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   8. Provide copper plated hangers and supports for copper piping.
   9. Prime coat exposed steel hangers and supports. Refer to Section 099000. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
10. Provide hangers adjacent to motor driven equipment with vibration isolation.
3.04 APPLICATION
A. Use grooved mechanical couplings and fasteners only in accessible locations.
B. Install unions downstream of valves and at equipment or apparatus connections.
C. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
D. Install gate, ball, or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
E. Install butterfly valves for throttling, bypass, or manual flow control services.
F. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.

3.05 ERECTION TOLERANCES
A. Drainage Piping: Establish invert elevations within 1/2 inch (10 mm) vertically of location indicated and slope to drain at minimum of 1/8 inch per foot (1:100) slope.
B. Water Piping: Slope at minimum of 1/32 inch per foot (1:400) and arrange to drain at low points.

3.06 SCHEDULES
A. Pipe Hanger Spacing:
   1. Metal Piping:
      a. Pipe size: 1/2 inches (15 mm) to 1-1/4 inches (32 mm):
         1) Maximum hanger spacing: 6.5 ft (2 m).
         2) Hanger rod diameter: 3/8 inches (9 mm).
      b. Pipe size: 1-1/2 inches (40 mm) to 2 inches (50 mm):
         1) Maximum hanger spacing: 10 ft (3 m).
         2) Hanger rod diameter: 3/8 inch (9 mm).
      c. Pipe size: 2-1/2 inches (65 mm) to 3 inches (75 mm):
         1) Maximum hanger spacing: 10 ft (3 m).
         2) Hanger rod diameter: 1/2 inch (13 mm).
      d. Pipe size: 4 inches (100 mm) to 6 inches (150 mm):
         1) Maximum hanger spacing: 10 ft (3 m).
         2) Hanger rod diameter: 5/8 inch (15 mm).
   2. Plastic Piping:
      a. All Sizes:
         1) Maximum hanger spacing: 4 ft.
         2) Hanger rod diameter: 3/8 inch (9 mm).

END OF SECTION
SECTION 23.00.01
MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.01 REFER TO DIVISION 1 FOR FULL PROJECT SCOPE OF WORK

1.02 MECHANICAL SCOPE OF WORK
A. Heating, ventilating, air conditioning systems, plumbing, and other piping systems modifications as specified; complete and in operating order.
B. Maintenance of heating and air conditioning equipment used for temporary heating, cooling, and for testing.
C. Installation of all mechanical control components which require mechanical connections only, both mechanical and electrical connections, penetrations of air plenums and ducts, or installations into piping systems.
D. All low voltage and line voltage control wiring, conduit, and devices for systems furnished under this division.
E. Counterflashing of penetrations of roof or exterior walls by pipes, ducts, or other Work under this Division.
F. Cutting and patching required due to omissions in the installation of Work under this Division, or due to failure to properly coordinate Work with other Divisions.
G. Painting and labeling of pipe, ductwork, equipment, and devices furnished under this Division.
H. Furnish access panels required for equipment furnished and installed under this Division.

1.03 RELATED ELECTRICAL WORK
A. Wiring and conduit for electrical power shall be furnished and installed under Division 26.

1.04 OTHER RELATED WORK UNDER OTHER DIVISIONS
A. Flashing of ducts and pipes into roofs and outside walls.
B. Holes, chases, and recesses required for mechanical work.
C. Miscellaneous steel including equipment supports.

1.05 CONFLICTS
A. Designer shall be notified in writing at least ten (10) days prior to the Bid Date of any conflicts or items requiring clarification. Resolution shall be only by written notice from the Designer. Oral clarifications shall be confirmed in writing.

1.06 REQUIREMENTS OF REGULATORY AGENCIES
A. The requirements listed below are given as a supplement to those in Division 1 and do not relieve the Contractor of complying with any and all applicable regulatory requirements set forth in this Specification.
B. Obtain and pay for the required permits, inspection fees, tapping fees, connection charges, and utility company service charges.
C. The mechanical work installation shall comply with State and local Health Departments and Building Codes, applicable Life Safety Code, State and local ordinances, and with NFPA Standard 90A and 90B.
D. Equipment shall be U.L. listed. All installations shall comply with U.L. standards, where applicable.
E. Equipment and Work shall comply with existing noise and safety standards.
F. Certificates of compliance from authorities having jurisdiction shall be transmitted to the Engineer and the Owner. Complete all work, pay all fees, and arrange for tests to obtain certificates of compliance.

1.07 SUBMITTALS
A. Submit to the Designer for review certified shop drawings on material furnished under this division as listed below. Submittal data shall be checked and stamped approved by the Contractor prior to his transmitting to the Designer. Refer to Division 1 for additional requirements.
B. Submittals shall be bound in three-ring binders and indexed with a table of contents for each indexed section. Table of contents shall list item, manufacturer, and model number. Large drawings shall be attached to binder or inserted in pockets of binder.
C. Submittal books shall be complete with all information required for this project prior to submittal. Submittals will be reviewed two (2) times only. The first review will include all items submitted. The second review will verify that comments noted on the first review have been resolved. Additional reviews required due to failure of Contractor to comply with Contract documents shall be at the Contractor's expense.
D. Submittals shall contain rating data, accessories and features, the same as listed in specifications and capacities, shall be stated in the terms specified. Deviations from specifications and drawings shall be noted on the submittal. If none are noted, it shall be assumed the material meets the specified requirements fully.
E. Where preprinted manufacturer's data describes more than one (1) product, mark submittals to indicate the specific product to be provided for this Project. Delete or mark out significant portions of pre-printed data which is not applicable. Where operating curves, graphs, etc. are required, mark the operating point or range for the Project.
F. Requests for substitution of products not specifically named shall be submitted in writing a minimum of fourteen (14) calendar days prior to the bid date. Requests shall include section number, items, name of manufacturer to be substituted, and catalog data. Requests shall be reviewed only to approve or reject submission of detailed submittals as noted in other paragraphs of this Section.
G. Acceptable manufacturers are noted in each section. Do not substitute materials, equipment, or methods unless such substitution has been approved in writing. Where the phrase "approved equal" appears, do not assume that materials, equipment, or methods will be approved until specific written approval has been given. The burden of proof for requested substitutions rests with the Contractor.
H. Approved substitution requiring variations in quantity or arrangement of materials, or equipment from that specified, or indicated on drawings shall be furnished and installed by the Contractor at no additional cost to the Owner.
I. Work shall not proceed until submittals for equipment and shop drawings have been approved. Work installed using unapproved substitutions shall be replaced at no additional cost to the Owner.

1.08 GUARANTEE, MAINTENANCE, AND OPERATING INSTRUCTIONS
A. Guarantee

Refer to Division 1 for additional requirements for guarantees.
1. Equipment shall be turned over to Owner clean and in complete working order with full one (1) year warranty by the manufacturer. Use of equipment for temporary heating or cooling
shall not be included as part of the warranty period.

B. Maintenance
   1. Work furnished and installed under this Division shall be maintained including inspection, lubrication, etc., in accordance with manufacturer's recommendations until acceptance of system by Owner.

C. Operating Instructions:
   1. Refer to Division 1 for O & M Requirements.

1.09 RECORD DRAWINGS

A. At completion of Work, prepare mechanical record drawings to accurate scale. Drawings shall indicate piping connections, other service connections, and interfaces with other Work including structural supports.

B. Indicate portions of mechanical Work shown on record drawings which deviate from Work as indicated in the contract drawings and note the reasons for such deviations.
SECTION 23.05.01
BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.01 WORK DESCRIPTION

A. Provide all labor, equipment, materials, etc. required to complete installation as specified herein and/or shown or scheduled on the drawings.

PART 2 - PRODUCTS

2.01 ELECTRICAL EQUIPMENT

A. Motor controllers, protective devices, etc. for control and protection of equipment shall be furnished with the equipment; but installed and electrically connected to power source under "Electrical Division".
B. NEMA Standards shall be taken as a minimum requirement for electrical equipment.
C. Equipment shall operate properly under a 10% plus or minus frequency variation.
D. Unless noted otherwise, motors shall be squirrel-cage induction type with ball bearings. Motors 1/2HP and smaller shall be 120 volts, single phase with permanently lubricated bearings; 3/4 HP and larger shall be 3 phase, general purpose, Design "B" or "C", drip proof type. Verify characteristics of available current at the building before equipment is ordered.
E. Motors shall be in accordance with IEE, UL and NEMA Standards, non-radio interfering type, rated for continuous, full-load duty and capable of withstanding momentary overloads of 50%. Select motors so actual loads does not exceed nameplate rating, and does not use motor "service factor". "Open" motors shall be rated 40 degrees C.; “totally enclosed” type shall be 50-degrees C. rated. Motors over 5 HP shall be "high efficiency" type and so labeled.
F. Provide both overload and under-voltage protection in all phases.
G. Except where interlock or automatic control is required, single speed motors, and smaller than 1/2 HP have manual switch with pilot light and thermal overload protection. H. For manual operation of 3/4 HP and larger motors, furnish magnetic starter with:
   1. Maintained contact PB and pilot light or momentary contact pushbutton station and pilot when directed.
   2. Trip free, thermal overload relays.
   3. Capable of accepting electrical interlocks.
I. Where interlock or automatic operation is specified, regardless of HP, provide magnetic starter complete with RUN/OFF/AUTO switch so connected that in “RUN” or “AUTO” all safety controls shall stop the motor.
J. All magnetic starters shall have control circuits individually fused from line side of starter, or load side of breaker. All starters on service 200 volts and above shall have 120 volt, built-in control circuit transformer fused on line and load side.
K. Provide dual element fused disconnect for all hermetic motors above 3/4 HP.
L. Heating Equipment: Phase and voltage as noted or unless noted otherwise.
M. Contactors shall be UL listed for 100,000 cycles of operation.
N. Normal operation pilot lights shall be green; emergency condition signal lights shall be red.

2.02 EQUIPMENT ACCESSORIES

A. AS NOTED UNDER SPECIFIC EQUIPMENT SCHEDULES AND SPECIFICATIONS.
2.03	ACCESS PANELS
A. Provide access panels, or doors, at concealed dampers, valves, shock absorbers, vents, trap primers, inspection points, etc. and where noted. Panels shall be galvanized steel, 16 gauge frame, 14 gauge door with mounting accessories, spring hinges, screwdriver operated lock, and prime coat paint. Milcor "A" for acoustic tile, "M" for exposed masonry, "K" for plaster finishes, stainless steel for ceramic, or glazed structural tile. Where ceiling is "lift out" construction, ceiling access panels are not required. Panels shall be 18" x 18" or larger, as required for service intended.
B. Access doors giving access to "live" electrical gear shall have switch to cut off power when opened.
C. Access panels in fire rated construction shall have a UL label, Class B rating.

2.04	CONCRETE: Where required for thrust blocks, pipe system encasement, equipment bases, etc. for Division 21, 22, and 23, provide 3,000 PSI concrete.

PART 3 - EXECUTION
3.01	ELECTRICAL WORK
A. All electrical work shall be provided under "Electrical Division 26", except: (1) motor controls (2) interlock circuits, (3) control circuits, (4) temperature-humidity controls. For these excepted items, this division shall provide conduit, wiring, connections, etc. as required for a complete control installation according to the appropriate sections of Specifications.
B. The work under this Division shall be of the same type and quality as specified under "Electrical Division".

3.02	EXCAVATION, SHORING AND BACKFILL
A. Provide any excavation required for this Division below that needed for general construction. Unless specifically noted, no extra shall be paid if rock or excavation difficulties are encountered.
B. Provide separate trench for each utility.
C. Provide: (1) bracing, shoring, etc. to protect sides of excavation, (2) staging, suitable ladders, barricades, etc. Comply with local regulations, or absence thereof with Division of the Manual of Accident Prevention provided for in Construction of the AGC.
D. Remove all timber before backfilling. Backfill simultaneously on both sides of tanks, piping, etc. Backfill material shall be approved clay or chert, free of debris, rock larger than 1%" or other harmful material.
E. All backfilling shall be compacted to 90% under sidewalks, or grass areas, and to 95% when under paved areas, structures, building slabs, steps, etc. These percentages refer to "Percent of Maximum Density" per ASTM #D-1557. If more stringent, compact backfill to a dry density equal to that required by G.C.
F. Restore existing pavement, curbs, sidewalks, sodding, etc. removed or damaged in connection with work.

3.03	CUTTING AND PATCHING
A. Provide all cutting, patching, etc. incidental to this work.
B. Do not cut into any structural element without written approval of Structural Engineer.
C. Patching shall be: (1) of quality equal to, and of appearance matching existing construction, and (2) shall restore all services and construction which remains in use to its condition prior to this contract, unless otherwise noted.
3.04 PIPING THRU RATED WALLS AND FLOORS
A. Insulation on pipe passing thru fire rated walls must stop at pipe sleeve unless 3M fire barrier fire stopping is used. Space between pipe and sleeve shall be protected with 3M Fire Barrier Penetration Sealing System or approved substitute. Installation shall be in accordance with the manufacturers recommendations for the hourly fire rating of the partition. The system shall be U.L. listed. Maintain vapor barrier on insulated chilled water and refrigerant suction piping.
B. PVC pipe passing through rated walls or floors shall have 3M UL Modified Fire Stop System, Pro-Set System or Hilti.
C. Refer to details on drawing for pipe and duct penetration thru rated walls and floors.

3.05 FLASHING
A. Where pipes, ducts, etc. pass through roof, flash per manufacturers recommendations.
B. Locate pipes, ducts, etc. through roof to clear parapets, etc. by at least 18”.
C. Provide flashing or caulking as required at each opening through outside walls or roof. Flashing through roof of same materials and methods as under "Moisture Protection Division"; through walls shall be aluminum unless noted otherwise.

3.06 PROTECTION
A. Work shall be protected at all times. Pipe openings shall be closed with caps or plugs until permanent connections are made. Fixtures and equipment shall be covered if necessary, to protect against dirt, water, chemical or mechanical damage or defacement.
B. All piping indicated to be installed above ceilings in walls or crawl spaces, shall be placed on the heated space side of the building insulation to prevent freezing. Piping indicated to be installed in areas outside heated envelope to be protected by the application of electric heat tape under pipe insulation. The Contractor shall be responsible in contacting the Architect/Engineer before installing and subjecting any piping to freezing conditions.

3.07 TEMPORARY WORK:
A. Water and electricity consumed during construction shall be paid for by General Contractor.

END OF SECTION
SECTION 23.05.48
VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 – GENERAL

1.01 SECTION INCLUDES
A. Inertia bases.
B. Vibration isolators.
C. Seismic restraints.

1.02 SUBMITTALS
A. Product Data: Provide schedule of vibration isolator type with location and load on each.
B. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.
C. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.

PART 2 – PRODUCTS

2.01 INERTIA BASES
A. Structural Bases:
   1. Construction: Welded structural steel with gusseted brackets, to support equipment and motor, with motor slide rails.
   2. Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.

2.02 VIBRATION ISOLATORS
A. Restrained Open Spring Isolators:
   1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
   2. Spring Mounts: Provide with leveling devices, minimum 0.25 inch (6 mm) thick neoprene sound pads, and zinc chromate plated hardware.
   3. Sound Pads: Size for minimum deflection of 0.05 inch (1.2 mm); meet requirements for neoprene pad isolators.
   4. Restraint: Provide heavy mounting frame and limit stops.
   5. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

B. Spring Hanger:
   1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
   2. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
   4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.
C. Neoprene Pad Isolators:
   1. Rubber or neoprene waffle pads.
      a. Hardness: 30 durometer.
      b. Thickness: Minimum 1/2 inch (13 mm).
      c. Maximum Loading: 50 psi (345 kPa).
      d. Rib Height: Maximum 0.7 times width.
   3. Configuration: 1/2 inch (13 mm) thick waffle pads bonded each side of 1/4 inch (6 mm) thick steel plate.

D. Roof Mounting Curb: 14 inches (350 mm) high with rigid steel lower section containing adjustable spring pockets with restrained spring isolators, steel upper section to support rooftop equipment, and continuous elastomeric membrane extending from upper section for counterflashing over roofing.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Bases:
   1. Set steel bases for one inch (25 mm) clearance between housekeeping pad and base.
   2. Adjust equipment level.

C. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

D. Support piping connections to equipment mounted on isolators using isolators or resilient hangers:
   1. Up to 4 Inches (100 mm) Pipe Size: First three points of support.
   2. 5 to 8 Inches (125 to 200 mm) Pipe Size: First four points of support.
   3. Select three hangers closest to vibration source for minimum 1.0 inch (25 mm) static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch (25 mm) static deflection or 1/2 static deflection of isolated equipment.

3.02 FIELD QUALITY CONTROL

A. Inspect isolated equipment after installation and submit report. Include static deflections.

END OF SECTION
SECTION 23.05.93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 – GENERAL

1.01 SECTION INCLUDES
A. Testing, adjustment, and balancing of air systems.
B. Measurement of final operating condition of HVAC systems.
C. Sound measurement of equipment operating conditions.
D. Vibration measurement of equipment operating conditions.
E. Commissioning activities.

1.02 REFERENCES
A. AABC MN-1 - AABC National Standards for Total System Balance; Associated Air Balance Council.
D. SMACNA (TAB) - HVAC Systems Testing, Adjusting, and Balancing; Sheet Metal and Air Conditioning Contractors' National Association.

1.03 SUBMITTALS
A. Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
B. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
   1. Submit to the Engineer within two weeks after completion of testing, adjusting, and balancing.
   2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
   3. Provide reports in 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
   4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
   5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
   6. Units of Measure: Report data in I-P (inch-pound) units only.
   7. Include the following on the title page of each report:
      a. Name of Testing, Adjusting, and Balancing Agency.
      b. Address of Testing, Adjusting, and Balancing Agency.
      c. Telephone number of Testing, Adjusting, and Balancing Agency.
      d. Project name.
      e. Project location.
      f. Project Architect.
      g. Project Engineer.
      h. Project Contractor.
i. Project altitude.

j. Report date.

C. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

1.04 QUALITY ASSURANCE (moved to PART 3)

1.05 PRE-BALANCING MEETING (moved to PART 3)

1.06 SEQUENCING AND SCHEDULING (moved to PART 3)

1.07 WARRANTY (moved to PART 3)

PART 2 – PRODUCTS - NOT USED

PART 3 – EXECUTION

3.01 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:
1. AABC MN-1, AABC National Standards for Total System Balance.
5. Maintain at least one copy of the standard to be used at project site at all times.

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.

D. TAB Agency Qualifications:
1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
2. Having minimum of 5 years documented experience.
3. Certified by one of the following:

E. TAB Supervisor Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.

B. Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.

C. Beginning of work means acceptance of existing conditions.

### 3.03 PREPARATION

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
   1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.

C. Provide additional balancing devices as required.

### 3.04 INSTALLATION TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

### 3.05 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:
   1. Running log of events and issues.
   2. Discrepancies, deficient or uncompleted work by others.
   4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. Mark on the drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

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 Owner.

H. Check and adjust systems approximately six months after final acceptance and submit report.

### 3.06 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Where modulating dampers are provided, take measurements and balance at extreme conditions.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches (12.5 Pa) positive static pressure.

### 3.07 SCOPE

A. Test, adjust, and balance the following:
   1. All existing systems impacted as well as new systems
   2. Heating/Cooling Units
   3. Air Handling Units
   4. Fans
   5. Air Filters
   6. Air Terminal Units
   7. Air Inlets and Outlets
   8. Recirculation of Potable Hot Water Systems

### 3.09 MINIMUM DATA TO BE REPORTED

A. Electric Motors:
   1. Manufacturer
   2. Model/Frame
   3. HP/BHP
   4. Phase, voltage, amperage; nameplate, actual, no load
   5. RPM
   6. Service factor
   7. Starter size, rating, heater elements
   8. Sheave Make/Size/Bore

B. V-Belt Drives:
   1. Identification/location
   2. Required driven RPM
   3. Driven sheave, diameter and RPM
   4. Belt, size and quantity
   5. Motor sheave diameter and RPM
   6. Center to center distance, maximum, minimum, and actual
C. Air Moving Equipment:
   1. Location
   2. Manufacturer
   3. Model number
   4. Serial number
   5. Arrangement/Class/Discharge
   6. Air flow, specified and actual
   7. Return air flow, specified and actual
   8. Outside air flow, specified and actual
   9. Total static pressure (total external), specified and actual
   10. Inlet pressure
   11. Discharge pressure
   12. Sheave Make/Size/Bore
   13. Number of Belts/Make/Size
   14. Fan RPM
   15. Total HW and CHW flow, specified and actual

D. Return Air/Outside Air:
   1. Identification/location
   2. Design air flow
   3. Actual air flow
   4. Design return air flow
   5. Actual return air flow
   6. Design outside air flow
   7. Actual outside air flow
   8. Return air temperature
   9. Outside air temperature

E. Exhaust Fans:
   1. Location
   2. Manufacturer
   3. Model number
   4. Serial number
   5. Air flow, specified and actual
   6. Total static pressure (total external), specified and actual
   7. Inlet pressure
   8. Discharge pressure
   9. Sheave Make/Size/Bore
   10. Number of Belts/Make/Size
   11. Fan RPM

F. Duct Traverses:
   1. System zone/branch
   2. Duct size
   3. Area
   4. Design velocity
   5. Design air flow
   6. Test velocity
   7. Test air flow
   8. Duct static pressure
   9. Air temperature
   10. Air correction factor
G. Duct Leak Tests:
1. Description of ductwork under test
2. Duct design operating pressure
3. Duct design test static pressure
4. Duct capacity, air flow
5. Maximum allowable leakage duct capacity times leak factor
6. Test apparatus
   a. Blower
   b. Orifice, tube size
   c. Orifice size
   d. Calibrated
7. Test static pressure
8. Test orifice differential pressure
9. Leakage
H. Terminal Unit Data:
1. Manufacturer
2. Type, constant, variable, single, dual duct
3. Identification/number
4. Location
5. Model number
6. Size
7. Minimum static pressure
8. Minimum design air flow
9. Maximum design air flow
10. Maximum actual air flow
11. Inlet static pressure
I. Air Distribution Tests:
1. Air terminal number
2. Room number/location
3. Terminal type
4. Terminal size
5. Area factor
6. Design velocity
7. Design air flow
8. Test (final) velocity
9. Test (final) air flow
10. Percent of design air flow
J. Potable Water:
1. Location of circuit setter
2. Design Flow
3. Actual Flow

END OF SECTION
PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Duct insulation.

1.02 REFERENCES


1.03 SUBMITTALS

A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
B. Manufacturer's Instructions: Indicate installation procedures which ensure acceptable workmanship and installation standards will be achieved.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of experience.
B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum 5 years of experience.

1.05 DELIVERY, STORAGE, AND PROTECTION

A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 – PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION

A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84.

2.02 GLASS FIBER, FLEXIBLE

A. Insulation: ASTM C 553; flexible, noncombustible blanket.
   1. ‘K’ (‘Ksi’) value: 0.36 at 75 degrees F (0.052 at 24 degrees C), when tested in accordance with ASTM C 518.
   3. Maximum Water Vapor Sorption: 5.0 percent by weight.

B. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Permeability: 0.02 perm inch (0.029 ng/Pa s sq m), when tested in accordance with ASTM E 96.
   3. Secure with pressure sensitive tape.

C. Vapor Barrier Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

D. Outdoor Vapor Barrier Mastic:
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

E. Tie Wire: Annealed steel, 16 gage (1.5 mm).

2.03 GLASS FIBER, RIGID

A. Insulation: ASTM C 612; rigid, noncombustible blanket.
   1. ‘K’ (‘Ksi’) value: 0.24 at 75 degrees F (0.036 at 24 degrees C), when tested in accordance with ASTM C 518.
   3. Maximum Water Vapor Sorption: 5.0 percent.
   4. Maximum Density: 8.0 lb/cu ft (128 kg/cu m).

B. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Permeability: 0.02 perm inch (0.029 ng/Pa s sq m), when tested in accordance with ASTM E 96.
   3. Secure with pressure sensitive tape.

C. Vapor Barrier Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

D. Indoor Vapor Barrier Finish:

1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight, glass fabric.
2. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.04 JACKETS


1. Thickness: 0.016 inch (0.40 mm) sheet.
2. Finish: Smooth.
3. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
4. Fittings: 0.016 inch (0.4 mm) thick die shaped fitting covers with factory attached protective liner.
5. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.015 inch (0.38 mm) thick aluminum.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Verify that ducts have been tested before applying insulation materials.
B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install in accordance with NAIMA National Insulation Standards.
C. Insulated ducts conveying air below ambient temperature:

1. Provide insulation with vapor barrier jackets.
2. Finish with tape and vapor barrier jacket.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
D. Insulated ducts conveying air above ambient temperature:

1. Provide with or without standard vapor barrier jacket.
2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
E. Ducts Exposed in Mechanical Equipment Rooms: Finish with aluminum jacket.
F. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with calked aluminum jacket with seams located on bottom side of horizontal duct section.
G. External Duct Insulation Application:
1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
2. Secure insulation without vapor barrier with staples, tape, or wires.
3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

### 3.03 SCHEDULES

A. Supply and Fresh Air Ducts: Glass Fiber 2” Thick.
B. Return and Relief Ducts in Mechanical Rooms: Glass Fiber, 1-1/2” Thick.
C. Ducts Exposed to Outdoors: Glass Fiber 2-1/2” Thick.

**END OF SECTION**
SECTION 23 08 00
MECHANICAL & CONTROL SYSTEMS COMMISSIONING

PART 1 – GENERAL

1.01 The Functional Performance Testing of the Mechanical Systems is essential to the operation and performance of the equipment and the completion of the project. Complete all inspections and tests prior to substantial completion of the Work.

PART 2 – PRODUCTS

2.01 TEST INSTRUMENTATION:

A. The following are suggested testing instruments that could be used but similar types of instruments are acceptable. If the Designer determines that additional instruments are required, provide at no additional charge.

B. Recommended Instruments for Testing Purposes

1. Shortridge Instruments: Air Data – Multimeter ADM – 860, 870 or 880
2. EXTECH Instruments: Digital Psychrometer + InfraRed Thermometer RH401
3. ThermoWorks: MTC Mini Handheld Thermocouple

PART 3 – EXECUTION

3.01 The Functional Performance Testing Procedures, approved by the Designer, will be used to document the inspection and testing of the equipment and systems. Provide all necessary manpower and have the appropriate subcontractor and/or manufacturer’s representative present during the testing and demonstrate, to the Designers satisfaction, the full operation of all mechanical and control equipment and systems. Coordinate the schedule of the testing so that the Designer and Owner can be present.

A. Prior to starting the final testing of the systems, ensure that all equipment and systems were initially started-up and initialized as prescribed by the manufacturers instruction or by the manufacturer’s representative and that the contractor has perform a complete operational test of all mechanical equipment and systems to ensure proper operation.

B. Review the Designer's inspection reports and correct all deficiencies.

C. Review the Test and Balance Report and correct all deficiencies.

D. Demonstrate the accuracy of 20% of the air and 20% of the water readings; and, if more than 10% are incorrect by +/- 10% continue to check 50% of the reports readings. If more than 10% of the additional readings are incorrect, have Test & Balance subcontractor recheck all readings.
E. Test and Balance readings that are verified will be recorded on the Terminal Box Point Calibration Check Sheet (see Division 23 group 08 specifications). The Designer may utilize the Test and Balance instruments furnished by the Test and Balance Contractor or provide their own instruments. All instruments utilized must have been calibrated within the past 12 months.

F. Demonstrate that all specified control equipment, software and system graphics are loaded into the operating system.

G. Check all control system control panels for cleanliness, neatness and that they are installed as specified.

H. Check the accuracy of all points and recorded readings on the Sensor Point Calibration Check Sheet (see Division 23 group 08 specifications).

I. In the event that the equipment, systems and/or sequences have been modified prior to the inspection and testing, document the modifications and correct the Performance Testing Procedures Form so that the system verification can continue.

J. Demonstrate the proper operation of the mechanical equipment and systems using the Performance Testing Identification Form and Performance Testing Procedures Forms approved by the Designer (see Division 01 group 91 specifications). During the testing, record on the forms the system response and point values to the operation. Record deficiencies, corrected and retested.

K. Upon completion of the performance testing procedures, the Installer, General Contractor and Designers representatives, who observed the testing, will sign the Functional Performance Test Certification form (see Division 01 group 91 specifications) and attach deficiency list.

1. Mechanical Systems
2. Control System
3. Domestic Hot Water System

L. Provide testing instruments, at no charge or the Designer may elect to provide their own instruments.

END OF SECTION
## Sensor Point Calibration Check Sheet

**Owner's Project Number:** 166/

**System/Unit Identifier:**

<table>
<thead>
<tr>
<th>Sensor Description</th>
<th>Location Satisfactory (Y/N)</th>
<th>BAS Reading</th>
<th>Field Measurement Value</th>
<th>Action Required</th>
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**Location:**

**NOTES:**

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*June 2011 OFD s230813*

Page 1 of 1

Sensor Point Calibration Check Sheet

23 08 13 - 1
SECTION 23.31.00  
HVAC DUCTS AND CASINGS

PART 1 – GENERAL

1.01 SECTION INCLUDES
   A. Metal ductwork.
   B. Ductwork Cleaning.

1.02 REFERENCES
   F. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; Sheet Metal and Air Conditioning Contractors' National Association.
   G. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association.

1.03 PERFORMANCE REQUIREMENTS
   A. No variation of duct configuration or sizes permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.04 SUBMITTALS
   A. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.
   B. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.05 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of experience.
   B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum 5 years of experience.

1.06 REGULATORY REQUIREMENTS
   A. Construct ductwork to NFPA 90A, NFPA 90B, and NFPA 96 standards.

1.07 ENVIRONMENTAL REQUIREMENTS
   A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
   B. Maintain temperatures within acceptable range during and after installation of duct sealants.
PART 2 – PRODUCTS

2.01 MATERIALS

A. Steel Ducts: ASTM A 1008/A 1008M, Designation CS, cold-rolled commercial steel.
C. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
   1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
   2. VOC Content: Not more than 250 g/L, excluding water.
   3. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E 84.
   4. For Use with Flexible Ducts: UL labeled.
D. Hanger Rod: ASTM A 36/A 36M; steel; threaded both ends, threaded one end, or continuously threaded.

2.02 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
B. Construct T’s, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.
C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
D. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Joints shall be minimum 4 inch (100 mm) cemented slip joint, brazed or electric welded. Prime coat welded joints.
E. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.
F. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.03 MANUFACTURED METAL DUCTWORK AND FITTINGS

A. Manufacture in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s instructions.
B. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
C. Install and seal metal and flexible ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
D. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

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

F. Use crimp joints with or without bead for joining round duct sizes 8 inch (200 mm) and smaller with crimp in direction of air flow.

G. Use double nuts and lock washers on threaded rod supports.

H. Connect terminal units to supply ducts with one foot (300 mm) maximum length of flexible duct. Do not use flexible duct to change direction.

I. Connect diffusers or light troffer boots to low pressure ducts with 5 feet (1.5 m) maximum length of flexible duct held in place with strap or clamp.

J. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

K. Set plenum doors 6 to 12 inches (150 to 300 mm) above floor. Arrange door swings so that fan static pressure holds door in closed position.

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

M. At exterior wall louvers, seal duct to louver frame.

END OF SECTION
SECTION 23.33.00
AIR DUCT ACCESSORIES

PART 1 – GENERAL

1.01 SECTION INCLUDES
   A. Air turning devices/extractors.
   B. Backdraft dampers.
   C. Combination fire and smoke dampers.
   D. Duct access doors.
   E. Duct test holes.
   F. Fire dampers.
   G. Flexible duct connections.
   H. Smoke dampers.
   I. Volume control dampers.

1.02 REFERENCES
   C. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association.
   D. UL 33 - Heat Responsive Links for Fire-Protection Service; Underwriters Laboratories Inc.
   E. UL 555 - Standard for Fire Dampers; Underwriters Laboratories Inc.
   F. UL 555S - Standard for Leakage Rated Dampers for Use in Smoke Control Systems; Underwriters Laboratories Inc.

1.03 SUBMITTALS
   A. Product Data: Provide for shop fabricated assemblies including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements.

1.04 PROJECT RECORD DOCUMENTS
   A. Record actual locations of access doors, test holes, and all dampers.

1.05 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of experience.
   B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Protect dampers from damage to operating linkages and blades.

1.07 EXTRA MATERIALS
   A. Provide two of each size and type of fusible link.

PART 2 – PRODUCTS
2.01 AIR TURNING DEVICES/EXTRACTORS
A. Multi-blade device with blades aligned in short dimension; steel or aluminum construction; with individually adjustable blades, mounting straps.

2.02 BACKDRAFT DAMPERS
A. Gravity Backdraft Dampers, Size 18 x 18 inches (450 x 450 mm) or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer’s standard construction.

2.03 COMBINATION FIRE AND SMOKE DAMPERS
A. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
B. Provide factory sleeve and collar for each damper.
C. Multiple Blade Dampers: Fabricate with 16 gage (1.5 mm) galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 x 1/2 inch (3.2 x 12.7 mm) plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch (12.7 mm) actuator shaft.
D. Operators: UL listed and labeled spring return electric type suitable for 120 volts, single phase, 60 Hz. Locate damper operator on exterior of duct and link to damper operating shaft.
E. Normally Open Smoke Responsive Fire Dampers: Curtain type, closing upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure, stainless steel springs with locking devices.
F. Electro Thermal Link: Fusible link melting at 165 degrees F (74 degrees C); 120 volts, single phase, 60 Hz; UL listed and labeled.

2.04 DUCT ACCESS DOORS
A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
B. Access doors with sheet metal screw fasteners are not acceptable.

2.05 DUCT TEST HOLES
A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

2.06 FIRE DAMPERS
A. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
B. Ceiling Dampers: Galvanized steel, 22 gage (0.76 mm) frame and 16 gage (1.5 mm) flap, two layers 0.125 inch (3.2 mm) ceramic fiber on top side with locking clip.
C. Horizontal Dampers: Galvanized steel, 22 gage (0.76 mm) frame, stainless steel closure spring, and lightweight, heat retardant non-asbestos fabric blanket.
D. Fusible Links: UL 33, separate at 160 degrees F (71 degrees C) with adjustable link straps for combination fire/balancing dampers.

2.07 FLEXIBLE DUCT CONNECTIONS
A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
B. Flexible Duct Connections: Fabric crimped into metal edging strip.
1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd (1.0 kg/sq m).
   b. Metal: 3 inches (75 mm) wide, 24 gage (0.6 mm) thick galvanized steel.
C. Leaded Vinyl Sheet: Minimum 0.55 inch (14 mm) thick, 0.87 lbs per sq ft (4.2 kg/sq m), 10 dB attenuation in 10 to 10,000 Hz range.

2.08 SMOKE DAMPERS
A. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.
B. Dampers: UL Class 1 curtain type fire damper, normally open automatically operated by electric actuator.
C. Electro Thermal Link: Fusible link melting at 165 degrees F (74 degrees C); 120 volts, single phase, 60 Hz; UL listed and labeled.

2.09 VOLUME CONTROL DAMPERS
A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
B. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch (150 x 760 mm).
C. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch (200 x 1825 mm). Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
D. End Bearings: Except in round ducts 12 inches (300 mm) and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.
E. Quadrants:
   1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
   2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
   3. Where rod lengths exceed 30 inches (750 mm) provide regulator at both ends.

PART 3 – EXECUTION

3.01 PREPARATION
A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION
A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 233100 for duct construction and pressure class.
B. Provide back draft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96. Provide minimum 8 x 8 inch (200 x 200 mm) size for hand access, 18 x 18 inch (450 x 450 mm) size for shoulder access, and as indicated. Provide 4 x 4 inch (100 x 100 mm) for balancing dampers only. Review locations prior to fabrication.
D. Provide duct test holes where indicated and required for testing and balancing purposes.
E. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
F. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.
G. Demonstrate re-setting of fire dampers to Owner's representative.
H. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.

I. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.

J. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

K. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION
SECTION 23.76.55
SMALL SPLIT-SYSTEM HEATING AND COOLING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Air-source heat pumps and cooling units.
B. Air cooled condensing units.
C. Indoor air handler (fan & coil) units for non-ducted and ducted connections.

1.02 REFERENCES
B. ARI 520 - Positive Displacement Condensing Units; Air-Conditioning and Refrigeration Institute.

1.03 SUBMITTALS
A. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
B. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.
C. Design Data: Indicate refrigerant pipe sizing.
D. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
E. Project Record Documents: Record actual locations of components and connections.
F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

PART 2 PRODUCTS

2.01 SYSTEM DESIGN
A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
   1. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.
B. Performance Requirements: See Drawings for additional requirements.
   1. Efficiency: Energy Efficiency Rating (EER)/Coefficient of Performance (COP) not less than requirements of ASHRAE Std 90.1 as indicated on drawings; seasonal efficiency to ASHRAE Std 103.
C. Electrical Characteristics:
1. Disconnect Switch: Provided under Division 26.

2.02 INDOOR UNITS FOR DUCTED SYSTEMS

A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heating and cooling element(s), controls, and accessories; wired for single power connection with control transformer.
   1. Cabinet: Steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.

B. Supply Fan: Centrifugal type rubber mounted with direct or belt drive with adjustable variable pitch motor pulley.

C. Air Filters: 1 inch (25 mm) thick urethane, washable type arranged for easy replacement.

D. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
   1. Construction and Ratings: In accordance with ARI 210/240 and UL listed.

2.03 INDOOR UNITS FOR DUCTLESS SYSTEMS

A. Ceiling Cassette Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer. Four-way 2’x2’ ceiling-cassette indoor unit with built-in drain pump mechanism for condensate removal. Low Ambient cooling capability to 0 degrees F and reverse cycle heating capability as specified. Wide air-flow pattern with ventilation air intake knockout. Air filter included with unit. Indoor unit powered from outdoor unit with control transformer. Automatic fan speed control; auto restart following a power outage. Auto wave airflow in heating mode—unit independently cycles through horizontal and vertical positions for more even heat distribution.

B. Indoor Wall Mounted Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer. Wall mounted indoor unit with built-in drain pump mechanism for condensate removal. Low Ambient cooling capability to 0 degrees F and reverse cycle heating capability where specified in heat pump configuration. Air filter included with unit. Indoor unit powered from outdoor unit with control transformer. Auto restart following a power outage.

C. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
   1. Construction and Ratings: In accordance with ARI 210/240 and UL listed.

2.04 OUTDOOR UNITS

A. Outdoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, with compressor and condenser.
   1. Cabinet: Steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
   2. Construction and Ratings: In accordance with ARI 210/240 with testing in accordance with ASHRAE Std 23 and UL listed.

B. Compressor: ARI 520; hermetic, two speed 1800 and 3600 rpm, resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling and rapid speed changes.

C. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gage ports, thermometer well (in liquid line).
   1. Provide thermostatic expansion and reversing valves for heat pump operation.
D. Operating Controls:
   1. Control by room thermostat to maintain room temperature setting. Thermostat shall allow occupied
      and unoccupied settings from BAS and have an occupied mode override. Provide outdoor coil
defrost control. Unit shall be capable of operating with automatic changeover in cooling or reverse
cycle heating, and auxiliary heating modes.

E. Unit shall be capable of operating to 0 degrees F.

2.05 AUXILIARY HEAT/ELECTRIC FURNACE COMPONENTS
   A. Electric Heater: Helix wound bare nichrome wire heating elements arranged in incremental stages of 5
      kW each, with porcelain insulators.
   B. Operating Controls:
      1. Heater stages energized in sequence with pre-determined delay between heating stages.
      2. High limit temperature control to de-energize heating elements, with automatic reset.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Install in accordance with NFPA 90A and NFPA 90B.

END OF SECTION