

Mechanical General Information

A. General

- 1. Conform to all general and special conditions of contract as specified by architect, tenant and owner.
2. Specifications are applicable to all contractors and subcontractors for mechanical and electrical systems
3. Contractor shall comply with owner's standards, facility specifications, rules and regulations. All owner's criteria shall be complied with and included in this bid. Check other plans and specifications and coordinate with other trades and architect's requirements.
4. Visit site, check facilities and conditions, and verify all utility company requirements and connection points in field prior to starting work. Take all items into consideration in bid.
5. Systems are to be complete and workable in all respects, placed in operation and properly adjusted.
6. Each contractor shall provide for his own clean-up, removal and legal disposal of all rubbish daily.
7. The contractor shall be solely responsible for construction means, methods, and sequences of construction and the safety of workers, comply with all OSHA regulations.
8. No piping, ductwork, controls, etc. shall be installed or routed above electrical panels and equipment or through elevator rooms or shafts.
9. The mechanical and electrical contractors shall coordinate the electrical characteristics of all mechanical equipment prior to ordering of equipment. No additional payment will be made for lack of contractor coordination of electrical characteristics.
10. All mechanical and electrical system components shall be routed tight to underside of structure and through joists or trusses where possible. Coordinate installation to preserve headroom, equipment access, and architectural clearances for finishes, including ceiling heights. Coordinate with all other trades and do not conflict with the architectural requirements for the finished construction. Provide offsets where required to coordinate with other trades.
11. Refer to architectural reflected ceiling plans for locations of all grilles and diffusers.
12. Operation and maintenance manuals: three (3) bound sets of the operation and maintenance manuals shall be provided to the construction representative at turnover, and are required for final acceptance.
13. As built drawings: the HVAC subcontractor shall progressively record all HVAC drawing changes which shall be available at all times for review by the construction representative. An AutoCAD copy of the final as-built drawings shall be provided to the construction representative at turnover. This AutoCAD as-built is required for final acceptance of the project.

- B. Codes, standards and regulations
1. Conform to all applicable codes, government regulations, utility company requirements, and national electrical code.
2. Obtain permits and pay all fees. Arrange for all required inspections and approvals.

- C. Related work specified elsewhere
1. Openings and chases, when shown on architectural drawings.

- D. Drawings
1. The systems as shown on the contract drawings are diagrammatic.
2. The intent is for complete and workable systems. The drawings and these notes are to be used together as a basis of showing and/or describing the system requirements for the facility.
3. Verify all dimensions and clearances by field measurement and check for interferences prior to starting work.

- E. Base equipment and materials and substitutions
1. All equipment and materials shall be new, free of defects and U.L. listed.
2. Submit shop drawings for all equipment, fixtures, etc., including all accessories to be furnished. Base bid manufacturers and models are included in specifications or listed in schedule on drawing. Any other manufacturer or model is a substitution.
3. Substitutions are subject to the approval of the owner and shall be listed on the form of proposal for the owner's consideration prior to contract award. If substitution is submitted, it is the contractor's responsibility to evaluate it and certify that the substitution is equivalent in all respects to the base specifications.
4. If substitutions are approved, notify all other contractors, subcontractors or trades affected by substitution and fully coordinate. Any costs resulting from substitution, whether by contractor or others, shall be responsibility of and paid for by substituting contractor.
5. All equipment shall be installed in full accordance with the manufacturer's installation instructions. It is this contractor's responsibility to check and conform to these requirements prior to starting work.

- F. Check, test, start, adjust, balance and instructions
1. After installation, check all equipment, and perform start up in accordance with the manufacturer's instructions.
2. All piping shall be tested and free of leaks.
3. Balance all systems, calibrate controls, check for proper operating sequence under all conditions, and make all necessary adjustments.
4. All wiring shall be fully tested and made free of grounds and short circuits.
5. Instruct owner in operation of systems and submit operating and maintenance manual on all equipment and systems.
6. Provide engraved labels and identification tags for all piping systems, valves and equipment.
7. Provide typed panel directions and engraved labels for all panels and equipment.

- G. Cutting, patching and drilling
1. All cutting and chasing of the building construction required for this work shall be by this contractor unless shown on architectural drawings and confirmed as to size and location prior to new construction. Cutting shall be in a neat and workmanlike manner.
2. Neatly saw cut all rectangular openings, set sleeve through opening, and finish patch or provide trim flange around opening.
3. Core drill and sleeve all round openings.
4. Cut and patch existing building walls as required for duct installation. Provide steel lintel above opening wider than 10". See structural drawings for sizes. Provide escutcheons or 2" wide sheet metal flanges around all exposed penetrations.
5. Do not cut any structural components without architect's approval.
6. Patch and finish to match adjacent areas that have been cut, damaged or modified to install equipment for this project.
7. Cutting of roof, installation of curbs, and patching of roof shall be by a certified roofing contractor, approved by building owner, and paid for by this contractor.
8. Fire stop all penetrations of fire rated construction in a code approved manner, using UL listed fire rated materials.
9. All contractors shall confirm with owner, prior to bid, times available for noise producing work such as cutting and core drilling of floors, walls, etc., as well as times for work which require access into adjoining areas. Include any premium time required in bid.
10. Exact location of roof top mechanical units shall be approved by owner's structural engineer. Mechanical contractor shall furnish and install all supplemental support steel for units and roof duct penetrators after approval of structural engineer.

- H. Warranty
1. Fully warrant all materials, equipment and workmanship for one (1) year from date of acceptance.
2. Extend all manufacturer's warranties to owner, including five (5) year compressor and ten (10) year heat exchanger extended warranty on HVAC equipment.
3. Repair or replace without charge to the owner all items found defective during the warranty period.

SECTION 23 0563 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

- PART 1 GENERAL
1.01 SECTION INCLUDES
A. Nameplates.
B. Tags.
C. Stencils.

PART 2 PRODUCTS

- 2.01 IDENTIFICATION APPLICATIONS
A. Rooftop Units: Nameplates.
B. Automatic Controls: Tags. Key to control schematic.
C. Small-sized Equipment: Tags.
D. Thermostats: Nameplates.

2.02 NAMEPLATES

- A. Letter Color: White.
B. Letter Height: 1/4 inch (6 mm).
C. Background Color: Black.

2.03 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) diameter.
B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch (40 mm) diameter with smooth edges.

2.04 STENCILS

- A. Stencils: With clean cut symbols and letters of following size:
1. Equipment: 2-1/2 inch (65 mm) high letters.

PART 3 EXECUTION

- 3.01 PREPARATION
A. Degrease and clean surfaces to receive adhesive for identification materials.

- 3.02 INSTALLATION
A. Install nameplates with corrosion-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

END OF SECTION

SECTION 23 0593 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.

1.02 SUBMITTALS

- A. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
1. Include at least the following in the plan:
a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
b. Copy of field check-out sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
c. Final test report forms to be used.
d. Procedures for formal deficiency reports, including scope, frequency and distribution.

B. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

- 1. Revise TAB plan to reflect actual procedures and submit as part of final report.
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. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
5. Units of Measure: Report data in IP (inch-pound) units only.
6. 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 settings.
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 (NBS/ST), AABC National Standards for Total System Balance.
2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
3. SMACNA (TAB).
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 three years documented experience.
3. Certified by one of the following:
a. AABC, Associated Air Balance Council: www.aabc.com/file; upon completion submit AABC National Performance Guaranty.
b. NEBB, National Environmental Balancing Bureau: www.nebb.org/rls.
c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/rls.
E. TAB Supervisor and Technician 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. 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 that will or could prevent proper system balance.
C. Beginning of work means acceptance of existing conditions.

3.03 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 10 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 10 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

3.04 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
1. Running log of events and issues.
2. Discrepancies, deficient or uncompleted work orders.
3. Contract interpretation requests.
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 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.

3.05 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site fill heights.
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 lobe system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
G. 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 of exhaust filters.
H. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
I. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
J. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
K. 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 near the building entries.

3.06 SCOPE

- A. Test, adjust, and balance the following:
1. Packaged Roof Top Heating/Cooling Units.
2. Fans.
3. Air Inlets and Outlets.
B. 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 of exhaust filters.
H. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
I. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
J. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
K. 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 near the building entries.

3.07 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. Air Cooled Condensers:
1. Identification/number.
2. Location.
3. Manufacturer.
4. Model number.
5. Serial number.
6. Entering DB air temperature, design and actual.
7. Leaving DB air temperature, design and actual.
8. Number of compressors.
C. Cooling Coils:
1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Entering air DB temperature, design and actual.
7. Entering air WB temperature, design and actual.
8. Leaving air DB temperature, design and actual.
9. Leaving air WB temperature, design and actual.
10. Air pressure drop, design and actual.

D. Heating Coils:
1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Entering air temperature, design and actual.
7. Leaving air temperature, design and actual.
8. Air pressure drop, design and actual.

- F. Air Moving Equipment:
5. Location.
6. Manufacturer.
7. Model number.
8. Serial number.
9. Air flow, specified and actual.
10. Return air flow, specified and actual.
11. Outside air flow, specified and actual.
12. Total static pressure (total external), specified and actual.
13. Inlet pressure.
14. Discharge pressure.
15. Sheave Make/Size/Bore.
16. Number of Belts/Make/Size.
17. Fan RPM.
G. 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.

H. 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.

I. 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.
K. 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.

L. Sound Level Reports:
1. Location.
2. Octave bands - equipment off.
3. Octave bands - equipment on.

END OF SECTION

SECTION 23 0713 DUCT INSULATION

- PART 1 GENERAL
1.01 SECTION INCLUDES
A. Duct insulation.
B. Duct liner.
1.02 SUBMITTALS
A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled 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.

PART 2 PRODUCTS

- 2.01 REGULATORY REQUIREMENTS
A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.
2.02 GLASS FIBER, FLEXIBLE
A. Insulation: ASTM C553; flexible, noncombustible blanket.
1. K (Ks) Value: 0.36 at 75 degrees F (0.052 at 24 degrees C), when tested in accordance with ASTM C518.
2. Maximum Service Temperature: 1200 degrees F (649 degrees C).
3. Maximum Water Vapor Absorption: 5.0 percent by weight.
B. Vapor Barrier Jacket:
1. Kraft paper with glass fiber yarn and bonded to aluminumized film.
2. Moisture Vapor Permeability: 0.02 perm inch (0.029 ng Pa s m), when tested in accordance with ASTM E918/919.
3. Secure with pressure sensitive tape.
C. Vapor Barrier Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminumized film, with pressure sensitive rubber based adhesive.
D. Indoor Vapor Barrier Mastec:
1. Vinyl emulsion type acrylic or mastec, compatible with insulation, black color.

2.03 GLASS FIBER, RIGID
A. Insulation: ASTM C512; rigid, noncombustible blanket.
1. K (Ks) Value: 0.24 at 75 degrees F (0.036 at 24 degrees C), when tested in accordance with ASTM C518.
2. Maximum Service Temperature: 450 degrees F (232 degrees C).
3. Maximum Water Vapor Absorption: 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 aluminumized film.
2. Moisture Vapor Permeability: 0.02 perm inch (0.029 ng Pa s m), when tested in accordance with ASTM E918/919.
3. Secure with pressure sensitive tape.
C. Vapor Barrier Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminumized film, with pressure sensitive rubber based adhesive.
D. Indoor Vapor Barrier Finish:
1. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION
A. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
1. Minimum Service Temperature: Minus 40 degrees F (Minus 40 degrees C).
2. Maximum Service Temperature: 180 degrees F (82 degrees C).
3. Connection: Waterproof vapor barrier adhesive.
B. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.05 DUCT LINER
A. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. Comply with ASTM C616.
B. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.

PART 3 EXECUTION
3.01 EXAMINATION
A. Test ductwork for design pressure prior to 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 NAAMA National Insulation Standards.
C. Insulated Ducts Conveying Air Below Ambient Temperature:
1. Provide insulation with vapor barrier jacket.
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 connectors, 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 or Finished Spaces: Finish with canvas jacket sized for finish painting.
F. Duct and Plenum Liner Application:
1. Adhere insulation with adhesive for 90 percent coverage.
2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
3. Seal and smooth joints. Seal and coat transition joints.
4. Seal liner surface penetrations with adhesive.
5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

- 3.03 SCHEDULES
A. Exhaust Ducts Within 15 ft (3 m) of Exterior Openings: 1 inch
B. Plenums: 1 1/2 inch
C. Supply Ducts: 1-1/2 inch
END OF SECTION

SECTION 23 0913 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

- PART 1 GENERAL
1.01 SECTION INCLUDES
A. Pressure independent valves and actuators.
B. Dampers.
C. Damper Operators:
1. Electric operators.
D. Humidifiers:
1. Room humidistats.
E. Input/Output Sensors:
1. Temperature sensors.
2. Humidity sensors.
3. Static pressure (air pressure) sensors.
4. Equipment operation (current) sensors.
5. Damper position indicators.
6. Carbon dioxide sensors.
F. Thermostats:
1. Electric room thermostats.
2. Low-limit temperature cutoff switch (freezestat)
3. Line voltage thermostats.
4. Room thermostat accessories.
G. Time clocks.
H. Energy Metering:
1. Hydronic BTU (U) meters.
I. Flow Sensors:
1. Gas flow meters.
2. Flow switches.
J. Level Switches:
1. Float Sensors:
a. Float switch.
b. Top mount float type level control.
c. Free-floating level switch.

1.02 SUBMITTALS
A. Product Data: Provide description and engineering data for each control system component. Include sizing as required. Provide data for each system component and software module.
END OF SECTION

SECTION 23 3100 HVAC DUCTS AND CASINGS

- PART 1 GENERAL
1.01 SECTION INCLUDES
A. Metal ductwork.
B. Nonmetal ductwork.
C. Casings and plenums.
D. Duct cleaning.
1.02 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.
1.03 FIELD CONDITIONS
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 DUCT ASSEMBLIES
A. Rigging Requirements: Construct ductwork to comply with NFPA 90A standards.
B. Ducts: Galvanized steel, unless otherwise indicated.
C. Low Pressure Supply (Heating System): 1 inch w/g (250 Pa) pressure class, galvanized steel.
D. Low Pressure Supply (System with Cooling Coil): 1 inch w/g (250 Pa) pressure class, galvanized steel.
E. Return and Relief: 1 inch w/g (250 Pa) pressure class, galvanized steel.
F. General Exhaust: 1 inch w/g (250 Pa) pressure class, galvanized steel.
2.02 MATERIALS
A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M F5 Type B, with G60/Z180 coating.
B. Un-Galvanized Steel for Ducts: ASTM A1008/A1008M Designation CS (commercial steel), cold-rolled.
C. Aluminum for Ducts: ASTM B209 (ASTM B209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength.
D. Stainless Steel for Ducts: ASTM A666, Type 304.
E. 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 index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
F. Gasket Tape: Provide butyl rubber gasket tape for a flexible seal between transfer duct connector (TDC), transfer duct flange (TDF), applied flange connections, and angle rings connections.
G. Hanger Rod: ASTM A308/A308M, steel, galvanized, threaded both ends, threaded one end, or continuously threaded.
H. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC108.
2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC107.
3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.

2.03 DUCTWORK FABRICATION
A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.
B. No variation of duct configuration or size permitted except by written permission. Size round duct installed in place of rectangular ducts in accordance with ASHRAE (FUND) Handbook - Fundamentals.
C. Duct systems have been designed for metal duct. At the Contractor's option, fibrous glass duct may be substituted for metal duct.
D. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
E. 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 air turning vanes of perforated metal with glass fiber insulation.
F. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
G. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degree divergence upstream of equipment and 45 degree convergence downstream.
H. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).
I. 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.

2.04 MANUFACTURED DUCTWORK AND FITTINGS
A. Double Wall Insulated Round Ducts: Round spiral lockseam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with solid inner wall.
1. Manufacture in accordance with SMACNA (DCS).
2. Insulation:
a. Thickness: 1 inch (25 mm).
b. Material: Fiberglass.
B. Spiral Ducts: Round spiral lockseam duct with galvanized steel outer wall.
1. Manufacture in accordance with SMACNA (DCS).
C. Round Ducts: Round lockseam duct with galvanized steel outer wall.
1. Manufacture in accordance with SMACNA (DCS).
D. Flexible Ducts: Black polymer film supported by helically wound spring steel wire.
1. UL labeled.
2. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
3. Pressure Rating: 4 inches w/g (1000 Pa) positive and 0.5 inches w/g (175 Pa) negative.
4. Maximum Velocity: 4000 fpm (20.3 miles).
5. Temperature Range: Minus 20 degrees F to 175 degrees F (Minus 28 degrees C to 79 degrees C).

- 2.05 CASINGS AND PLENUMS
A. Fabricate casings in accordance with SMACNA (DCS) and construct for operating pressures indicated.
B. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for inspection and replacement.
C. Fabricate acoustic casings with reinforcing turned inward. Provide 16 gauge, 0.0598 inch (1.52 mm) sheet steel back facing and 22 gauge, 0.0299 inch (0.76 mm) perforated sheet steel front facing with 3/32 inch (2.4 mm) diameter holes on 5/32 inch (4 mm) centers. Construct panels 3 inches (75 mm) thick packed with 4.5 lb/cu ft (72 kg/m) minimum glass fiber insulation media, on inverted channels of 16 gauge, 0.0598 inch (1.52 mm) sheet steel.
PART 3 EXECUTION
3.01 INSTALLATION
A. Install, support, and seal ducts in accordance with SMACNA (DCS).
B. Install in accordance with manufacturer's instructions.
C. During construction provide temporary closure of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
D. Flexible Ducts: Connect to metal ducts with mechanical fastener.
E. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
F. Provide openings in ductwork where required to accommodate thermostats and controllers. Provide pilot tube openings where required for testing of systems, complete with metal cap with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
G. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
H. 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.
I. Use double nuts and lock washers on threaded rod supports.
J. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

- 3.02 CLEANING
A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean the air at a time. Protect equipment that could be harmed by excessive dirt with temporary filters, or bypass during cleaning.
END OF SECTION

SECTION 23 3300 AIR DUCT ACCESSORIES

- PART 1 GENERAL
1.01 SECTION INCLUDES
A. Air turning devices/extractors.
B. Backdraft dampers - metal.
C. Duct access doors.
D. Duct test holes.
E. Flexible duct connectors.
F. Volume control dampers.
1.02 SUBMITTALS
A. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
B. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:
1. Extra Fusible Links: One of each type and size.
1.03 DELIVERY, STORAGE, AND HANDLING
A. Protect dampers from damage to operating linkages and blades.
PART 2 PRODUCTS
2.01 AIR TURNING DEVICES/EXTRACTORS
A. Multi-blade device with blades attached to pivoting frame and bracket, steel construction, with push-pull operator strap.
2.02 BACKDRAFT DAMPERS - METAL
A. Gravelly Backdraft Dampers: Size 12x12 inches (300x300 mm) or Smaller, Furnished with Air Moving Equipment. Air moving equipment manufacturer's standard construction.
B. Multi-Blade: Parallel Action Gravelly Balanced Backdraft Dampers. Galvanized steel, with center pivoted blades of maximum 6 inch (150 mm) width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin adjustment device to permit setting for varying differential static pressure.
2.04 DUCT ACCESS DOORS
A. Fabricate in accordance with SMACNA (DCS) 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.
B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.
2.07 FLEXIBLE DUCT CONNECTORS
A. Fabricate in accordance with SMACNA (DCS) 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).
2. Metal: 1/8 inch (75 mm) wide, 24 gauge, 0.0239 inch (0.61 mm) thick galvanized steel.
2.09 VOLUME CONTROL DAMPERS
A. Fabricate in accordance with SMACNA (DCS) and as indicated.
B. Splitter Dampers:
1. Material: Same gauge as duct to 24 inches (600 mm) size in either direction, and two gauges heavier for sizes over 24 inches (600 mm).
2. Blade: Fabricate of double thickness sheet metal to streamline shape, secured with continuous hinge or rod.
3. Operator: Minimum 1/4 inch (6 mm) diameter rod in self aligning, universal joint action, flanged bushing with set screw.
C. Single Blade Dampers:
1. Fabricate for duct sizes up to 6 by 30 inch (150 by 760 mm).
2. Blade: 24 gauge, 0.0239 inch (0.61 mm), minimum.
D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 6 by 72 inch (200 by 1825 mm). Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
1. Blade: 18 gauge, 0.0478 inch (1.21 mm), minimum.
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 (760 mm) provide regulator at both ends.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS).
B. Provide backdraft 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, and 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 by 8 inch (200 by 200 mm) size for hand access, size for shoulder access, and as indicated. Provide 4 by 4 inch (100 by 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. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
F. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.
G. 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.
H. Use splitter dampers only where indicated.
I. Provide balancing dampers on high velocity systems where indicated.
J. 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



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