

**SECTION 155000 - HEATING, VENTILATING AND AIR CONDITIONING**

**PART 1 - GENERAL**

**1.01 CODES, ORDINANCES, AND PERMITS**

- A. INSTALLATION OF SYSTEMS AND EQUIPMENT PROVIDED UNDER THIS SECTION SHALL BE DONE IN STRICT ACCORDANCE WITH LOCAL AND STATE BUILDING CODE AND MECHANICAL CODE, AND CITY OR TOWN REGULATIONS HAVING JURISDICTION.
- B. ALL WORK, WHERE APPLICABLE, SHALL CONFORM TO NFPA CODES AND ALL MATERIAL SHALL BE U.L. APPROVED.
- C. ALL ELECTRICAL APPARATUS FURNISHED UNDER THIS SECTION SHALL BE APPROVED BY THE U.L. AND SHALL BE SO LABELED OR LISTED WHERE SUCH IS APPLICABLE. WHERE CUSTOM-BUILT EQUIPMENT IS SPECIFIED AND THE U.L. LABEL OR LISTING IS NOT APPLICABLE TO THE COMPLETED PRODUCT, ALL COMPONENTS USED IN THE CONSTRUCTION OF SUCH EQUIPMENT SHALL BE LABELED OR LISTED BY U.L. WHERE SUCH IS APPLICABLE TO THE COMPONENT.

**1.02 SHOP DRAWINGS**

- A. SUBMIT SHOP DRAWINGS, ON E-BUILDER, FOR ALL EQUIPMENT SCHEDULED, CONTROLS, PIPING, VALVES, DUCT STANDARDS, ETC.

**1.03 OPERATING AND MAINTENANCE INSTRUCTIONS**

- A. FURNISH UPON COMPLETION OF ALL WORK, OPERATION AND MAINTENANCE DATA FOR ALL EQUIPMENT APPROVED UNDER THIS SECTION.

**PART 2 - PRODUCTS**

**2.01 PIPE AND FITTINGS**

- A. FURNISH AND INSTALL REFRIGERANT LINE SETS.
- B. DRAIN (D) AND COLD WATER MAKE-UP PIPING SHALL BE TYPE L HARD DRAWN COPPER, ASTM B88 WITH WROUGHT COPPER ANS I B16 22 FITTINGS JOINTS SHALL BE SOLDERED, ASTM B32, WITH 96/5 SOLDER.

**2.02 PIPE HANGERS, SUPPORTS, INSERTS**

- A. CARPENTER AND PATTERSON, GRINNELL, CALCO, OR APPROVED EQUAL. FIGURE NUMBERS LISTED ARE CARPENTER AND PATTERSON NUMBERS.
- B. GENERAL. PIPING SYSTEMS SHALL BE SUPPORTED IN ACCORDANCE WITH ANS B31.1 SO AS TO MAINTAIN REQUIRED PITCH OF LINES, PREVENT VIBRATION, AND PROVIDE FOR EXPANSION AND CONTRACTION MOVEMENT.
- C. PIPING HANGERS AND SUPPORTS SHALL BE FURNISHED AND INSTALLED FOR PIPING. PROVIDE ALL COMPONENTS (I. E. INSERTS, RODS, CLAMPS, HANGERS, WASHER, LOCK NUTS, ROLLERS, ETC.) NECESSARY FOR A COMPLETE INSTALLATION.
- D. HANGERS
  - 1. HANGERS FOR REFRIGERANT PIPING SHALL BE FIGURE 100SH REFRIGERATION HANGER AND SHIELD.
  - 2. HANGERS FOR ALL OTHER PIPING SHALL BE FIGURE 1A BANDS.
  - 3. ALL HANGERS SHALL BE WITH SUPPORTING RODS AND NUTS. ROD SIZES SHALL BE AS FOLLOWS:
 

HANGERS FOR PIPES 4" AND LARGER	5/8"
HANGERS FOR PIPES 2-1/2" AND 3"	1/2"
HANGERS FOR PIPES 2" AND SMALLER	3/8"
  - 4. PIPE COVERING PROTECTION SADDLES SHALL BE SERIES 350 GALVANIZED STEEL AND SHALL BE FURNISHED FOR INSTALLATION AT EACH HANGER WHERE PIPES ARE INSULATED.
- E. UPPER ATTACHMENTS TO BUILDING STRUCTURE
  - 1. REINFORCED CONCRETE CONSTRUCTION: UPPER ATTACHMENT WELDED OR CLAMPED TO STEEL CLIP ANGLES WHICH ARE EXPANSION-BOLTED TO THE CONCRETE. EXPANSION BOLTING SHALL BE LOCATED SO THAT PIPING LOADS PLACE BOLTS IN SHEAR.
  - 2. STRUCTURAL FRAMING: UPPER ATTACHMENTS WELDED OR CLAMPED TO STRUCTURAL STEEL MEMBERS. ADDITIONAL STEEL MEMBERS MAY BE NECESSARY IN SOME SUPPORT LOCATIONS WHERE PIPING LOCATIONS DIFFER FROM THAT KNOWN ON CONTRACT DRAWINGS.
  - 3. SUBMIT DETAILS FOR APPROVAL.

**2.03 SHEET METAL WORK**

- A. FURNISH ALL SHEET METAL WORK AND ACCESSORIES SPECIFIED HEREIN.
- B. REFERENCES TO "DUCT MANUAL" HEREIN REFER TO THE LATEST EDITION OF THE HVAC DUCT CONSTRUCTION STANDARDS AS PUBLISHED BY THE SHEET METAL AND AIR CONDITIONING CONTRACTOR NATIONAL ASSOCIATION, INC (HEREINAFTER REFERRED TO AS SMACNA).
- C. ALL DUCTS SHALL BE OF GALVANIZED STEEL, CONSTRUCTION AS SPECIFIED. PROPERLY STIFFENED TO PREVENT DRUMMING WHEN THE FANS ARE IN OPERATION.
- D. ALL GALVANIZED DUCT THICKNESS SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF SMACNA FOR THE SERVICE INDICATED.
- E. SEAL ALL LOW PRESSURE DUCT JOINTS (CLASS B) AND MEDIUM PRESSURE DUCTS (CLASS A) WITH SEALANT AS MANUFACTURED BY MINNESOTA MINING COMPANY, FOSTER, GENERAL ELECTRIC, OR APPROVED EQUAL. EXCESS SEALANT MUST BE REMOVED IMMEDIATELY TO AVOID A NEAT APPEARANCE.
- F. ALL LOW PRESSURE DUCTS SHALL BE FABRICATED FOR 2 INCHES WATER GAUGE PRESSURE.
- G. FLEXIBLE CONNECTIONS SHALL BE 4" (1/2") WIDE CONNECTIONS, IN ACCORDANCE WITH FIG. 2-19 OF THE DUCT MANUAL, CONSTRUCTED OF VENT-GLASS HEAVY GLASS FABRIC DOUBLE COATED WITH NEOPRENE AND SHALL BE AS MANUFACTURED BY VENT-GLASS, INC. FLEXIBLE CONNECTIONS SHALL MEET THE REQUIREMENTS OF THE NATIONAL BOARD OF FIRE UNDERWRITERS. EXTERIOR FLEXIBLE CONNECTION SHALL BE WEATHER TIGHT.
- H. HANGERS AND SUPPORTING SYSTEMS SHALL BE IN ACCORDANCE WITH FIGURE 4-1 THROUGH 4-4 AND TABLES 4-1 THROUGH 4-4 OF THE DUCT MANUAL.

**2.04 DUCTWORK ACCESSORIES**

**A. MANUAL VOLUME DAMPERS**

- 1. MANUAL VOLUME DAMPERS SHALL BE PROVIDED WHERE SHOWN ON THE DRAWINGS AT EVERY BRANCH TAKE OFF FROM THE MAIN DUCT, AND ELSEWHERE AS REQUIRED BY LOCAL AND STATE CODES. DAMPERS SHALL BE SINGLE OR MULTIPLE BLADE TYPE WITH SLEEVE BEARINGS, GALVANIZED STEEL INTERLOCKING BLADES, AND A LIGHT GAGE STEEL FRAME. IN DUCTS OVER 16" DEEP PROVIDE MULTIPLE OPPOSED BLADE TYPE GAUGE OPERATED DAMPERS WITH A MAXIMUM BLADE WIDTH OF 8". DAMPER OPERATING ROD SHALL BE FULL BLADE LENGTH EXTENDED THROUGH THE DUCT TO EXTERNALLY MOUNTED BEARING PLATES. ON INSULATED DUCTWORK, BEARING PLATES SHALL BE INSTALLED FLUSH WITH INSULATION FINISH. FASTENED TO THE DUCT OPERATING LEVER SHALL BE OF THE INDICATING TYPE WITH LOCKING QUADRANT. VOLUME DAMPERS LOCATED ABOVE HARD CEILING SHALL BE EQUIPPED WITH CABLE OPERATORS AT FACE OF DIFFUSER OR REGISTER.

**B. ACCESS DOORS**

- 1. IN DUCTWORK UP TO 2 INCH PRESSURE CLASS
  - a. FRAME: 24 GAUGE GALVANIZED STEEL WITH SEAL.
  - b. DOOR: HINGED, WITH 24 GAUGE GALVANIZED STEEL EXTERIOR AND INTERIOR PANELS.
  - c. LOCKS: DOORS 16" AND UNDER, ONE LOCK DOORS OVER 16", TWO LOCKS.
  - d. SEALS: FOAM GASKET.
  - e. INSULATED: IN ACCORDANCE WITH APPLICABLE CODES.

**2.05 DUCT INSULATION**

- A. INSULATION SHALL COMPLY WITH LATEST EDITION OF IECC, ALL APPLICABLE CODES AND REQUIREMENTS OF THE AUTHORITY HAVING JURISDICTION. ALL SUPPLY AND RETURN AIR DUCTS AND PLENUMS SHALL BE INSULATED WITH A MINIMUM OF R-6 INSULATION WITHIN THE BUILDING AND WITH A MINIMUM OF R-8 INSULATION WHEN LOCATED OUTSIDE THE CONDITIONED ENVELOPE.
- B. MINERAL-FIBER BLANKET INSULATION: MINERAL OR GLASS FIBERS BONDED WITH A THERMOSETTING RESIN. COMPLY WITH ASTM C 553, TYPE II AND ASTM C 1290, TYPE III WITH FACTORY-APPLIED FSK JACKET.
  - 1. PRODUCTS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE ONE OF THE FOLLOWING:
    - a. CERTANTEED CORP., SOFT TOUCH DUCT WRAP.
    - b. JOHNS MANVILLE, MICROLITE.
    - c. KNAUF INSULATION, FRIENDLY FEEL DUCT WRAP.
    - d. MANSON INSULATION INC., ALLEY WRAP.
    - e. OWENS CORNING, SOFTBALL SERVICE DUCT WRAP.
  - 2. THERMAL CONDUCTIVITY (K-VALUE) AT 75°F (24°C) MEAN TEMPERATURE IS 0.29 BTU X IN./HR. X FT. X DEGREE F. (0.043 W/M X K) OR LESS.
- C. MINERAL-FIBER BOARD INSULATION: MINERAL OR GLASS FIBERS BONDED WITH A THERMOSETTING RESIN. COMPLY WITH ASTM C 612, TYPE IA OR TYPE IB. FOR DUCT AND PLENUM APPLICATIONS, PROVIDE INSULATION WITH FACTORY-APPLIED FSK JACKET.
  - 1. PRODUCTS: SUBJECT TO COMPLIANCE WITH REQUIREMENTS, PROVIDE ONE OF THE FOLLOWING:
    - a. CERTANTEED CORP., COMMERCIAL BOARD.
    - b. JOHNS MANVILLE, 800 SERIES SPIN-GLAS.
    - c. KNAUF INSULATION, INSULATION BOARD.
    - d. MANSON INSULATION INC., AK BOARD.
    - e. OWENS CORNING, FIBERGLAS 700 SERIES.
  - 2. THERMAL CONDUCTIVITY (K-VALUE) AT 75°F (24°C) MEAN TEMPERATURE IS 0.23 BTU X IN./HR. X FT. X DEGREE F. (0.033 W/M X K) OR LESS.

**2.06 VIBRATION ISOLATION**

- A. GENERAL
  - 1. ALL VIBRATION ISOLATORS SHALL BE THE PRODUCT OF A SINGLE APPROVED MANUFACTURER.
  - 2. MODEL NUMBERS HEREINAFTER SPECIFIED ARE FROM MASON INDUSTRIES. OTHER EQUIVALENT UNITS BY CONSOLIDATED KINETICS, VIBRATION MOUNTINGS AND CONTROLS OR APPROVED EQUAL ARE ACCEPTABLE.
- B. ALL VIBRATION ISOLATORS FOR MECHANICAL EQUIPMENT HUNG IN CEILING SHALL BE SELECTED IN ACCORDANCE WITH THE WEIGHT DISTRIBUTION OF THE EQUIPMENT TO BE SERVED SO AS TO PRODUCE A UNIFORM DEFLECTION. DEFLECTIONS SHALL BE AS HEREINBEFORE SPECIFIED.
- C. SUBMITTALS SHALL INCLUDE ALL SPRING DEFLECTIONS, SPRING DIAMETERS, SCALE DRAWINGS, ATTACHMENT DETAILS, AND RATED CAPACITY INDICATING ADEQUACY FOR EACH PIECE OF EQUIPMENT SERVED.

**2.07 AIR OUTLETS**

- A. SUPPLY AIR DEVICES: PRICE, TITUS OR METAL-AIRE. ALL AIR OUTLET FINISHES AND COLOR SHALL BE AS SELECTED BY THE ARCHITECT AND/OR ENGINEER.
  - 1. CEILING DIFFUSERS (SD): FURNISH AND INSTALL PRICE MODEL AVMDA DIFFUSERS OF THE SIZES AND MOUNTING TYPES SHOWN ON THE PLANS AND AIR DISTRIBUTION SCHEDULE. DIFFUSERS SHALL CONSIST OF AN OUTER FRAME ASSEMBLY, WHICH FACILITATES MOUNTING IN THE APPLICATION SHOWN. A COLLAR THAT ALLOWS CONNECTION TO THE SQUARE (OR RECTANGULAR) DUCT SIZE INDICATED SHALL BE AN INTEGRAL PART OF THE FRAME ASSEMBLY. AN INNER CORE ASSEMBLY CONSISTING OF FIXED LOUVERS CAPABLE OF PRODUCING THE AIR FLOW DISCHARGE PATTERN INDICATED ON THE PLANS SHALL BE FULLY REMOVABLE FROM THE INSTALLED DIFFUSER FRAME FOR ACCESS TO ANY DAMPERS OR OTHER DUCTWORK COMPONENTS LOCATED IN OR NEAR THE DIFFUSER NECK. A SET OF ADJUSTMENT VANES SHALL BE PROVIDED ON EACH SIDE OF THE DIFFUSER TO ALLOW FOR FIELD ADJUSTMENT FROM HORIZONTAL TO VERTICAL. AIR FLOW DISCHARGE FINISH SHALL BE B12 WHITE POWDER COAT. PAINT FINISH SHALL PASS 500 HOURS OF SALT SPRAY EXPOSURE WITH NO MEASURABLE CREEP IN ACCORDANCE WITH ASTM D1654 AND 1000 HOURS WITH NO RUSTING OR BLISTERING AS PER ASTM D610 AND ASTM D714. SUPPLY CAPACITIES TO BE AS SCHEDULED ON THE CONTRACT DRAWINGS.
  - 2. SUPPLY REGISTERS (SR): ALUMINUM CONSTRUCTION WITH 1-1/2" (1/4") OVERLAP MARGIN, COUNTERSUNK SCREW HOLES, 1/2" MOUNTING SCREWS. SUPPLY REGISTERS SHALL ADJUSTABLE VERTICAL FACE BARS, 3/4" ON CENTER WITH REAR DIFFUSING FINES. PROVIDE WITH INTEGRAL OPPOSED BLADE DAMPER DESIGNED FOR SCREWDRIVER OPERATION ONLY WHERE SHOWN ON DRAWINGS.
  - 3. LINEAR DIFFUSERS (LD): SUPPLY AND INSTALL DIFFUSERS OF SIZES AND CAPACITIES AS SHOWN ON THE DRAWINGS. DIFFUSER SHALL BE SUPPLIED WITH AN EXTRUDED ALUMINUM CENTER-TEE PAINTED B12 WHITE = WHITE DUCTWORK. DIFFUSER SHALL FEATURE CURVED EXTRUDED ALUMINUM PATTERN CONTROLLERS, FACTORY INSTALLED FOR THE SPECIFIED AIR PATTERN. PATTERN CONTROLLERS SHALL BE CAPABLE OF FIELD ADJUSTMENT FOR HORIZONTAL AIR PATTERNS TOWARDS OR AWAY FROM THE INLET AND VERTICAL PATTERN CONTROLLERS TO BE PAINTED BLACK. THE DIFFUSER PLENUM SHALL BE CONSTRUCTED OF OUT COATED STEEL WITH 1" (1/4") LINING. THE INTERIOR OF THE PLENUM SHALL BE FACTORY FINISHED IN MATCH TO WORK.
- B. EXHAUST (EG) AND RETURN-AIR (RG) GRILLES: PRICE, METAL-AIRE OR SIMILAR MAKE AND CONSTRUCTION AS SUPPLY-AIR REGISTERS.
- C. PROVIDE DIFFUSER FRAME TYPE (LAY-IN, SURFACE MOUNT, SPLIT IN OR OUT) TO MATCH CEILING TYPE.
- D. INTERIOR OF DUCTWORK VISIBLE THROUGH REGISTERS, GRILLES AND DIFFUSERS SHALL BE PAINTED BLACK.

**2.08 DUCT LINER**

- A. FLEXIBLE DUCT SHALL HAVE FLEXIBLE LINER INSULATION IN THE FOLLOWING LOCATIONS:
  - 10 FEET DOWNSTREAM OF ALL FANS.
- B. DUCT LINER SHALL BE FLEXIBLE, FABRICATED FROM GLASS FIBERS BONDED WITH THERMOSETTING RESIN. AIRSTREAM SURFACE TO BE PROTECTED WITH AN ACRYLIC SURFACE COATING THAT DOES NOT SUPPORT MICROBIAL GROWTH AS PER ASTM C1011 AND ASTM C1104. DUCT LINER TO BE 1 INCH THICK, 1-1/2 LB. PER CU. FT. DENSITY.

**PART 3 - EXECUTION**

**3.01 GENERAL**

- A. INSTALL ALL ITEMS SPECIFIED UNDER PART 2 - PRODUCTS, ACCORDING TO THE APPLICABLE MANUFACTURER'S RECOMMENDATIONS AND SHOP DRAWINGS, THE DETAILS SHOWN ON THE DRAWINGS AND AS SPECIFIED UNDER THIS SECTION. PROVIDE ALL REQUIRED HANGERS AND SUPPORTS.

**3.02 BALANCING, ADJUSTING, OPERATING, AND INSTRUCTIONS**

- A. HVAC CONTRACTOR SHALL PROVIDE ADDITIONAL SHEAVES, DRIVES, BELTS, ETC. AS REQUIRED FOR BALANCING OF ALL FANS WITHIN THE SPECIFIED FAN HORSEPOWER AT NO EXTRA COST TO THE PROJECT.
- B. AIR SYSTEMS
  - 1. SYSTEMS SHALL BE ADJUSTED AND BALANCED SO THAT AIR QUANTITIES AT OUTLETS ARE AS INDICATED ON THE DRAWINGS AND SO THAT THE DISTRIBUTION FROM SUPPLY OUTLETS IS FREE FROM DRAFTS, AND UNIFORM OVER THE FACE OF EACH OUTLET.
  - 2. IF NECESSARY, PROVIDE AND INSTALL MOTOR SHEAVES FOR ROOF TOP UNITS AND AIR HANDLERS UNITS.
  - 3. ADJUSTMENTS SHALL BE MADE BY THE BALANCING COMPANY TO VOLUME DAMPERS AT AIR OUTLETS TO PRODUCE THE LEAST PRESSURE DROP CONSISTENT WITH VOLUME REQUIREMENTS.
  - 4. AFTER COMPLETION OF BALANCING AND ADJUSTING, SETTINGS OF DAMPERS, SHALL BE PERMANENTLY MARKED BY THE BALANCING COMPANY SO THAT THEY CAN BE RESTORED IF DISTURBED AT ANY TIME.
  - 5. DIRECT READING VELOCITY METERS MAY BE USED BY THE BALANCING COMPANY FOR COMPARATIVE ADJUSTMENT OF INDIVIDUAL OUTLETS, BUT AIR QUANTITIES IN DUCTS HAVE VELOCITY OF 1,000 FEET PER MINUTE OR GREATER, SHALL BE MEASURED BY MEANS OF PITOT TUBES AND INCLINED GAUGE MANOMETERS. INSTRUMENT TEST OPENING ENCLOSURES AS SPECIFIED SHALL BE PROVIDED AS REQUIRED.
  - 6. ADJUSTMENT OF THE TEMPERATURE CONTROLS SHALL BE COORDINATED BY THE PERSON IN CHARGE OF THE BALANCING AND ADJUSTING AND SHALL BE PERFORMED COINCIDENTAL THEREWITH. IN CONJUNCTION WITH THE AUTOMATIC TEMPERATURE CONTROL SYSTEM, SIMULATE A COMPLETE CYCLE OF OPERATION FOR EACH SYSTEM.
  - 7. AFTER COMPLETION OF THE TESTING, BALANCING AND ADJUSTING OF THE AIR SYSTEMS, SIX COPIES OF A REPORT SHOWING THE FOLLOWING INFORMATION SHALL BE SUBMITTED TO THE ENGINEER FOR REVIEW AND APPROVAL. THE REPORT SHALL BE ARRANGED AS FOLLOWS:
    - a. LOCATION OF EACH AIR OUTLET OR INLET.
    - b. DIMENSIONS OR SIZE OF EACH OUTLET OR INLET.
    - c. TYPE: DIFFUSER, GRILLE, REGISTER, SUPPLY, RETURN EXHAUST, AND AK VALUE FOR EACH.
    - d. CFM OF AIR AS INDICATED ON DRAWINGS FOR EACH OUTLET OR INLET.
    - e. CFM OF AIR AS MEASURED, AFTER EACH COMPLETE SYSTEM HAS BEEN BALANCED AND ADJUSTED, FOR EACH OUTLET OR INLET. AFTER EACH COMPLETE SYSTEM HAS BEEN BALANCED AND ADJUSTED, THE TOTAL CFM AT FAN DISCHARGE, STATIC PRESSURE AT FAN OUTLET, TOTAL STATIC PRESSURE FOR APPARATUS, FAN SPEED, MOTOR AMPERAGE FOR EACH PHASE AND VOLTAGE SHALL BE LISTED.

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HVAC SPECIFICATIONS

SHEET: M003