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## SECTION 23 30 00\_AIR DISTRIBUTION SYSTEMS

### PART 1 GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Duct Materials.
2. Flexible ducts.
3. Insulated flexible ducts.
4. Spiral round ducts.
5. Spiral flat oval ducts.
6. Glass fiber reinforced plastic round ducts.
7. Transverse duct connection system.
8. Casings and Plenums.
9. Ductwork fabrication.
10. Kitchen hood exhaust ductwork fabrication.
11. Duct Mounted Air Silencers
12. Back-draft dampers.
13. Fire and smoke dampers.
14. Duct access doors.
15. Volume control dampers.
16. Flexible duct connections.
17. Diffusers, Registers and Grilles.
18. Laminar Flow Diffusers
19. HEPA Modules
20. Door grilles.
21. Louvers.
22. Louvered penthouses.
23. Roof hoods.
24. Goosenecks.

- B. The intent of these standards are to provide input to the design team on the University's preference of manufacturers, design, equipment options and quality assurance to maintain the longevity of its assets.

1.2 Related Sections:

- A. Common Work for HVAC Systems 23 05 00
- B. Common Requirements for HVAC Systems 23 05 01
- C. Identification of HVAC Equipment and Piping 23 05 53
- D. Testing and Balancing of HVAC Systems 23 05 93
- E. HVAC Insulation 23 07 00
- F. HVAC Fans 23 34 00
- G. Air Terminal Units 23 36 00
- H. Air Handling Units 23 73 00
- I. Terminal Heating and Cooling Units 23 82 00

1.3 ENGINEERING AND DESIGN REQUIREMENTS

- A. Refer to the University Engineering Design Guidelines for all air distribution system engineering and design requirements
- B. Size louvers so that moisture will not enter the building.

1.4 SUBMITTALS

- A. Shop Drawings: Submit duct fabrication drawings, drawn to scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as Contract Documents, indicating:
  - 1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
  - 2. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust duct systems, indicate classification of materials handled as defined in this section.
  - 3. Fittings.
  - 4. Reinforcing details and spacing.
  - 5. Seam and joint construction details.
  - 6. Penetrations through fire rated and other walls.
  - 7. Terminal unit, coil, and humidifier installations.

8. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
  
- B. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.
  1. duct connectors
  2. volume control dampers
  3. duct access doors
  4. Fire dampers including locations and ratings.
  5. Smoke dampers including locations and ratings.
  6. Backdraft dampers.
  7. Flexible duct connections.
  8. Volume control dampers.
  9. Duct access doors.
  10. Duct test holes.
  
- C. Product Data: For fire and smoke dampers submit the following:
  1. Include UL ratings, dynamic ratings, leakage, pressure drop and maximum pressure data.
  2. Indicate materials, construction, dimensions, and installation details.
  3. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.
  
- D. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
  
- E. Manufacturer's Installation Instructions: Submit for Fire and Combination Smoke and Fire Dampers.
  
- F. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.
  
- G. Manufacturer's Installation Instructions: Submit special procedures for glass fiber ducts.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.
  
- B. Project Record Documents: Record actual locations of air distribution devices such as access doors, volume dampers, smoke/fire dampers instruments, grilles, diffusers, louvers,...etc.
  
- C. Operation and Maintenance Data: Submit for Combination Smoke and Fire Dampers.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.
- B. Construct ductwork to NFPA 90A standards.
- C. Construct commercial kitchen ductwork to NFPA 96 standard.
- D. Dampers tested, rated and labeled in accordance with the latest UL requirements. Shop fabricated dampers are not allowed on University of Delaware projects.
- E. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.
- F. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70.
- G. Test and rate louver performance in accordance with AMCA 500.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Cover ends of ductwork with plastic prior to delivery to job site.
- B. Protect dampers from damage to operating linkages and blades.
- C. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
- D. Storage: Store materials in a dry area indoor, protected from damage.
- E. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures during and after installation of duct sealant.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 COORDINATION

- A. Coordinate Work with all other trades on the project.

**PART 2 PRODUCTS**

2.1 DUCT MATERIALS

- A. Galvanized Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock-forming quality, having G90 zinc coating of in conformance with ASTM A90.
- B. Steel Ducts: ASTM A1008/ ASTM A1011/ ASTM A568.
- C. Aluminum Ducts: ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.
- D. Stainless Steel Ducts: ASTM A167, Type 304.
- E. Fasteners: Rivets, bolts, or sheet metal screws.
- F. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.2 FLEXIBLE DUCTS

- A. Product Description: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helical-wound spring steel wire.
  - 1. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
  - 2. Maximum Velocity: 4000 fpm.
  - 3. Temperature Range: -20 degrees F to 210 degrees F.

2.3 INSULATED FLEXIBLE DUCTS

- A. Product Description: Two ply vinyl film supported by helical wound spring steel wire; fiberglass insulation; polyethylene vapor barrier film.
  - 1. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
  - 2. Maximum Velocity: 4000 fpm.
  - 3. Temperature Range: -10 degrees F to 160 degrees F.
  - 4. Thermal Resistance: 4.2square feet-hour-degree F per BTU.

2.4 SPIRAL ROUND DUCTS

- A. Product Description: UL 181, Class 1, round spiral lockseam duct

2.5 SPIRAL FLAT OVAL DUCTS

- A. Product Description: Machine made from round spiral lockseam duct rated for 10 inches wg pressure.
- B. Joints: Either fully welded or bolted flange with gasket material in accordance with manufacturer's recommendations.

2.6 GLASS FIBER REINFORCED PLASTIC ROUND DUCTS

- A. Product Description: Filament wound glass fiber reinforced plastic with fire retardant thixotropic resin with flame spread less than 25 smoke developed less than 50 when tested in accordance with ASTM E84.
- B. Joints: 304 Stainless Steel sheet metal sleeve located inside duct, sealed and secured with screws.

2.7 TRANSVERSE DUCT CONNECTION SYSTEM

- A. Manufacturers:
  - 1. Ductmate.
  - 2. Nexus.
  - 3. Ruskin.
  - 4. Ward Industries
- B. Product Description: SMACNA "J" rated rigidity class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.

2.8 CASINGS AND PLENUMS

- A. Fabricate casings and plenums in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and construct for operating pressures indicated.
- B. Reinforce access door frames with steel angles tied to horizontal and vertical plenum supporting angles. Furnish hinged access doors where indicated or required for access to equipment for cleaning and inspection.
- C. Fabricate acoustic casings with reinforcing turned inward. Furnish 16 gage back facing and 22 gage perforated front facing with 3/32 inch diameter holes on 5/32 inch centers. Construct panels 3 inches thick packed with 4.5 lb./cu ft minimum glass fiber media, on inverted channels of 16 gage.

## 2.9 DUCTWORK FABRICATION

- A. Fabricate and support rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Fabricate and support round ducts with longitudinal seams in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible (Round Duct Construction Standards). Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- C. Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide airfoil turning vanes
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- E. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
- F. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.
- G. Fabricate duct to achieve a maximum of 1% duct leakage.

## 2.10 GLASS FIBER DUCT FABRICATION

- A. Fabricate in accordance with SMACNA Fibrous Glass Duct Construction Standards.

## 2.11 KITCHEN HOOD EXHAUST DUCTWORK FABRICATION

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and NFPA 96.

## 2.12 STANDARD DUCT MOUNTED AIR SILENCERS

- A. Manufacturers:
  - 1. Industrial Air Control (IAC)
  - 2. Engineered Acoustics
  - 3. Ruskin Manufacturing
  - 4. Semco
  - 5. United McGill

6. Vibro Acoustics.

- B. Configuration: Consulting engineering firm shall determine configuration
- C. Fabricate in accordance with ASTM publication E-477-99, Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
- D. Internal liner shall be constructed of perforated metal.
- E. Fill shall be an inorganic vermin and moisture proof sound absorption media compressed a minimum of 5%. Fill shall have a flame spread rating of 25 and smoke development rating of 50.
- F. Duct connections shall be flanged.

2.13 FIRE AND SMOKE DAMPERS

- A. Acceptable Manufacturers:
  - 1. Arrow United Industries
  - 2. Cesco Products
  - 3. Lloyd Industries
  - 4. NCA Manufacturing.
  - 5. Ruskin Manufacturing.
  - 6. Vent Products
- B. Fabricate in accordance with NFPA 90A, UL 555, and UL 555S.
- C. Fire Resistance: Shall match or exceed the rating of the wall in which the damper is concealed
- D. Leakage Rating: Class II, maximum of 20 cfm at 4 inches wg differential pressure.
- E. Damper Temperature Rating: 350 degrees F.
- F. Blades: Style: Airfoil-shaped, single piece, double skin.
- G. Bearings: Stainless steel pressed into frame.
- H. Seals: Silicone blade edge seals and flexible stainless steel jamb seals.
- I. Linkage: Concealed in frame.
- J. Release Device: Close in controlled manner and allow damper to be automatically reset.



- K. Actuator:
  - 1. Type: Electric 24 volt, 60 hertz, two-position, fail close.
  - 2. Mounting: External.
- L. Fusible Link Release Temperature: 165 degrees F.
- M. Factory installed sleeve and mounting angles. Furnish silicone caulk factory applied to sleeve at damper frame to comply with leakage rating requirements.

#### 2.14 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1 inch thick insulation with sheet metal cover.
  - 1. Less than 12 inches square, secure with sash locks.
  - 2. Up to 18 inches Square: Furnish two hinges and two sash locks.
  - 3. Up to 24 x 48 inches: Three hinges and two compression latches with outside handles.
  - 4. Larger Sizes: Furnish additional hinge.
  - 5. Access panels with sheet metal screw fasteners are not acceptable.

#### 2.15 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized frame channel with suitable hardware.
- C. End Bearings: Except in round ductwork 12 inches and smaller, furnish end bearings. On multiple blade dampers, furnish oil-impregnated nylon or sintered bronze bearings. Furnish closed end bearings on ducts having pressure classification over 2 inches wg.
- D. Quadrants:
  - 1. Furnish locking, indicating quadrant regulators on single and multi-blade dampers.
  - 2. On insulated ducts mount quadrant regulators on standoff mounting brackets, bases, or adapters.
  - 3. Where rod lengths exceed 30 inches furnish regulator at both ends.

2.16 ROUND AND RECTANGULAR DIFFUSERS AND CEILING MOUNTED GRILLES

- A. Acceptable Manufacturers:
  - 1. Carnes.
  - 2. Krueger
  - 3. MetalAire
  - 4. Nailor
  - 5. Price
  - 6. Titus
  - 7. Tuttle and Bailey
- B. Accessories: Butterfly damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.17 LINEAR SLOT DIFFUSERS AND GRILLES

- A. Acceptable Manufacturers:
  - 1. Carnes.
  - 2. Krueger
  - 3. MetalAire
  - 4. Nailor
  - 5. Price
  - 6. Titus
  - 7. Tuttle and Bailey
- B. Plenum: Integral, galvanized steel, insulated.
- C. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.18 LAMINAR FLOW DIFFUSERS

- A. Acceptable Manufacturers:
  - 1. Carnes Model DLAC
  - 2. Krueger Model 5000
  - 3. Precision Air Products Model Lami-Vent
  - 4. Titus Model TLF
  - 5. Tuttle and Bailey Model CRD
- B. Type: non aspirating laminar flow, diffuser face assembly shall be one-piece design with integral solid perimeter frame, free area shall be no less than 22%
- C. Damper: Round Butterfly.

2.19 HEPA MODULES

- A. Acceptable Manufacturers:
  - 1. Carnes Model DLAC
  - 2. Krueger Model 5000
  - 3. Precision Air Products Model HEPA-Vent
  - 4. Titus Model TLF
  - 5. Tuttle and Bailey Model TENSOR
- B. Type: Laminar flow, diffuser face assembly shall be one-piece design with integral solid perimeter frame
- C. Fabrication: Aluminum extrusions with factory off-white electrocoated finish.
- D. Frame: Flush Mounted
- E. Filter: 2" Thick HEPA filter

2.20 WALL SUPPLY, RETURN AND EXHAUST REGISTERS/GRILLES

- A. Acceptable Manufacturers:
  - 1. Carnes.
  - 2. Krueger
  - 3. MetalAire
  - 4. Nailor
  - 5. Price
  - 6. Titus
  - 7. Tuttle and Bailey
- B. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

2.21 DOOR GRILLES

- A. Acceptable Manufacturers:
  - 1. Carnes.
  - 2. Krueger
  - 3. MetalAire
  - 4. Nailor
  - 5. Price
  - 6. Titus
  - 7. Tuttle and Bailey

2.22 LOUVERS

- A. Acceptable Manufacturers:
  - 1. Arrow United Industries
  - 2. Cesco Products
  - 3. Lloyd Industries
  - 4. NCA Manufacturing.
  - 5. Ruskin Manufacturing.
- B. Product Description: Double drainable hurricane rated storm louvers
- C. Mounting: Furnish with angle flange or masonry strap anchors for installation.
- D. Bird Screen: Bird screen with 1/2 inch square mesh for exhaust and 3/4 inch for intake. Insect screens are not allowed.

2.23 LOUVERED PENTHOUSE

- A. Acceptable Manufacturers:
  - 1. Greenheck Corp.
  - 2. Penn Ventilator Company
- B. Provide with bird screen. Insect screens are not permitted.
- C. Roof Curb: 18 inch high, self-flashing galvanized steel construction with continuously welded seams, built-in cant strips, 1 inch insulation and curb bottom and factory installed nailer strip.

2.24 ROOF HOODS

- A. Acceptable Manufacturers:
  - 1. Greenheck Corp.
  - 2. Penn Ventilator Company
- B. Provide with bird screen. Insect screens are not permitted.
- C. Roof Curb 18 inch high self-flashing galvanized steel construction with continuously welded seams, built-in cant strips, 1 inch insulation and curb bottom and factory installed nailer strip.

2.25 GOOSENECKS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, of minimum 18 gage galvanized steel.

- B. Roof Curb 18 inch high self-flashing galvanized steel construction with continuously welded seams, built-in cant strips, 1 inch insulation and curb bottom and factory installed nailer strip.

### **PART 3 EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify sizes of equipment connections before fabricating transitions.
- B. Verify rated walls are ready for fire damper installation.
- C. Verify ducts and equipment installation are ready for accessories.
- D. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.
- E. Verify inlet and outlet locations.
- F. Verify ceiling and wall systems are ready for diffuser/grille installation

#### **3.2 INSTALLATION**

- A. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Install fibreglass ducts in accordance with SMACNA Fibrous Glass Duct Construction Standards. Obtain manufacturer's inspection and acceptance of fabrication and installation at beginning of installation.
- C. During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- D. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes 8 inch and smaller.
- E. Install duct hangers and supports in accordance with Section 23 05 29
- F. Use double nuts and lock washers on threaded rod supports.
- G. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
- H. Install kitchen range hoods in accordance with NFPA 96.

- I. Install in accordance with NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- J. Access Doors: The following are the University of Delaware minimum requirements:
  - 1. Before and after each duct mounted filter.
  - 2. Before and after each duct mounted coil.
  - 3. Before and after each duct mounted fan.
  - 4. Before and after each automatic control damper.
  - 5. Before and after each fire damper/smoke damper/combo fire and smoke damper.
  - 6. Downstream of each VAV box.
  - 7. Install at locations for cleaning kitchen exhaust ductwork in accordance with NFPA 96.
- K. Install diffusers to ductwork with airtight connection.
- L. Install balancing dampers on all branch duct and on all duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly.
- M. Flexible insulated duct shall be no longer than 6 feet in length.
- N. Fasten flexible duct to equipment, diffuser or grille with stainless steel draw bands.
- O. Do not use flexible duct to make 90 degree turns. Rigid elbows shall be used to make 90 degree turns.

### 3.3 DEMONSTRATION

- A. Demonstrate re-setting of fire dampers to Owner's representative.

### 3.4 INTERFACE WITH OTHER PRODUCTS

- A. Install openings in ductwork where required to accommodate thermometers and controllers. Install pitot tube openings for testing of systems. Install pitot tube complete with metal can with spring device or screw to prevent air leakage. Where openings are provided in insulated ductwork, install insulation material inside metal ring.
- B. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

**3.5 CLEANING**

- A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air flow, clean one half of system completely before proceeding to other half. Protect equipment with potential to be harmed by excessive dirt with temporary filters, or bypass during cleaning.
  
- B. Clean duct systems with high power vacuum machines. Protect equipment with potential to be harmed by excessive dirt with filters, or bypass during cleaning. Install access openings into ductwork for cleaning purposes.

**END OF SECTION**