

**SECTION 23 31 00
HVAC DUCTS AND CASINGS**

SPEC WRITER NOTES:

1. Delete between // // if not applicable to project. Also delete any other item or paragraph not applicable in the Section and renumber the paragraphs.
2. Provide the year of latest edition to each publication given in paragraph APPLICABLE PUBLICATIONS.
3. References to pressure in this section are gauge pressure unless otherwise noted.

PART 1 - GENERAL

1.1 DESCRIPTION

- A. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Ductwork and accessories for HVAC including the following:
 1. Supply air, return air, outside air, exhaust, make-up air, and relief systems.
 2. Exhaust duct with HEPA filters for //Autopsy Suite// //Negative Pressure Isolation Room// //Biological Safety Cabinets// //Radioisotope Hoods//.
 3. Exhaust duct for chemical fume hoods, kitchen hood exhaust (grease) and "wet exhaust" ducts.
- C. Definitions:
 1. Seal or Sealing: Use of liquid or mastic sealant, with or without compatible tape overlay, or gasketing of flanged joints, to keep air leakage at duct joints, seams and connections to an acceptable minimum.
 2. Duct Pressure Classification: SMACNA HVAC Duct Construction Standards, Metal and Flexible.
 3. Exposed Duct: Exposed to view in a finished room//, exposed to weather//.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 07 84 00, FIRESTOPPING.
- E. //Section 08 90 00, LOUVERS and VENTS.//

- F. //Section 11 53 13, LABORATORY FUME HOODS.//
- G. //Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.//
- H. //Section 22 11 00, FACILITY WATER DISTRIBUTION.//
- I. //Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION.//
- J. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- K. //Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.//
- L. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.
- M. //Section 23 07 11, HVAC and BOILER PLANT INSULATION.//
- N. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- O. //Section 23 34 00, HVAC FANS.//
- P. Section 23 36 00, AIR TERMINAL UNITS.
- Q. //Section 23 38 13, COMMERCIAL-KITCHEN HOODS.//
- R. Section 23 40 00, HVAC AIR CLEANING DEVICES.
- S. //Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.//
- T. Section 23 82 00, CONVECTION HEATING and COOLING UNITS.
- U. Section 23 82 16, AIR COILS.
- V. //Section 28 31 00, FIRE DETECTION and ALARM.//

1.3 APPLICABLE PUBLICATIONS

SPEC WRITER NOTES:

1. Make material requirements agree with requirements specified in the referenced Applicable Publications. Verify and update the publication list to that which applies to the project unless the reference applies to all HVAC systems. Publications that apply to all HVAC systems may not be specifically referenced in the body of the specification but shall form a part of this specification.
2. Insert the year of approved latest edition of the publications between the brackets // // and delete the brackets if applicable to this project.

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standards will govern.
- B. American Society of Civil Engineers (ASCE):

7-//2016//.....Minimum Design Loads for Associated Criteria
for Buildings and Other Structures

C. American Society for Testing and Materials (ASTM):

A653/A653M-//2020//.....Standard Specification for Steel Sheet,
Zinc-Coated (Galvanized) or Zinc-Iron Alloy-
Coated (Galvannealed) by the Hot-Dip Process

A1011/A1011-//2018a//...Standard Specification for Steel, Sheet and
Strip, Hot-Rolled, Carbon, Structural, High-
Strength Low-Alloy, High Strength Low-Alloy
with Improved Formability, and Ultra-High
Strength

B209-//2021//.....Standard Specification for Aluminum and
Aluminum-Alloy Sheet and Plate

C1071-//2019//.....Standard Specification for Fibrous Glass Duct
Lining Insulation (Thermal and Sound Absorbing
Material)

E1-//2014 (R2020)//.....Standard Specification for ASTM Liquid-in-Glass
Thermometers

E77-//2014 (R2021)//.....Standard Test Method for Inspection and
Verification of Thermometers

E84-//2021a//.....Standard Test Method for Surface Burning
Characteristics of Building Materials

D. National Fire Protection Association (NFPA):

90A-//2021//.....Standard for the Installation of
Air-Conditioning and Ventilating Systems

96-//2021//.....Standard for Ventilation Control and Fire
Protection of Commercial Cooking Operations

E. Sheet Metal and Air Conditioning Contractors National Association
(SMACNA):

006-//2020//.....HVAC Duct Construction Standards, Metal and
Flexible, 4th Edition

016-//2012//.....HVAC Air Duct Leakage Test Manual, 2nd Edition
//2016//.....Fibrous Glass Duct Construction Standards, 7th
Edition

F. Underwriters Laboratories, Inc. (UL):

181-//2013 (R2017)//.....Standard for Factory-Made Air Ducts and Air
Connectors

555-//2006 (R2020)//Standard for Fire Dampers

555S-//2014(R2020)//....Standard for Smoke Dampers

G. Department of Veterans Affairs (VA):

PG-18-10-//2015//.....Physical Security Design Manual for VA Mission
Critical Facilities

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 XX XX, SECTION TITLE", with applicable paragraph identification.
- C. Manufacturer's Literature and Data Including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
 1. Rectangular Ducts:
 - a. Schedules of duct systems, materials and selected SMACNA construction alternatives for joints, sealing, gauge and reinforcement.
 - b. Duct liner.
 - c. Sealants and gaskets.
 - d. Access doors.
 2. Round and Flat Oval Ducts:
 - a. Manufacturer's details for duct fittings.
 - b. Sealants and gaskets.
 - c. Access sections.
 - d. Installation instructions.
 3. Volume dampers, backdraft dampers.
 4. Upper hanger attachments.
 5. Fire dampers, fire doors, and smoke dampers with installation instructions.
 6. Sound attenuators, including pressure drop and acoustic performance.
 7. Flexible ducts and clamps, with manufacturer's installation instructions.
 8. Flexible connections.
 9. Instrument test fittings.
 10. Details and design analysis of alternate or optional duct systems.

- D. Coordination Drawings: Refer to paragraph SUBMITTALS in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

SPEC WRITER NOTE: O&M Manuals shall be submitted for content review as part of closeout documents.

- E. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replaceable parts, and troubleshooting guide:
1. Include complete list indicating all components of the systems.
 2. Include complete diagrams of the internal wiring for each item of equipment.
 3. Diagrams shall have their terminals identified to facilitate installation, operation, and maintenance.

1.5 QUALITY ASSURANCE

- A. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopREFERRED.gov>.
- B. Refer to Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for additional sustainable design requirements.
- C. Fire Safety Code: Comply with NFPA 90A.
- D. Duct System Construction and Installation: Referenced SMACNA Standards are the minimum acceptable quality.
- E. Duct Sealing, Air Leakage Criteria, and Air Leakage Tests: Ducts shall be sealed as per duct sealing requirements of SMACNA HVAC Air Duct Leakage Test Manual for duct pressure classes shown in the contract documents.
- F. Duct accessories exposed to the air stream, such as dampers of all types (except smoke dampers) and access openings, shall be of the same material as the duct or provide at least the same level of corrosion resistance.

1.6 AS-BUILT DOCUMENTATION

- A. Comply with requirements in paragraph AS-BUILT DOCUMENTATION of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

PART 2 - PRODUCTS

SPEC WRITER NOTE: The following ductwork is prohibited:

1. Fibrous glass ductwork (VA discourages using fibrous glass ductwork. Verify with VA before specifying fibrous glass)
2. Underground Ductwork
3. Concrete Ductwork

2.1 DUCT MATERIALS AND SEALANTS

- A. General: Except for systems specified otherwise, construct ducts, casings, and accessories of galvanized sheet steel, ASTM A653/A653M, coating G90; or, aluminum sheet, ASTM B209, alloy 1100, 3003 or 5052.
- B. Specified Corrosion Resistant Systems: Stainless-steel sheet, Class 302 or 304, Condition A (annealed) Finish No. 4 for exposed ducts and Finish No. 2B for concealed duct or ducts located in mechanical rooms.
- C. Optional Duct Materials:
 1. Grease Duct: Double wall factory-built grease duct, UL labeled and complying with NFPA 96 may be furnished in lieu of specified materials for kitchen and grill hood exhaust duct. Installation and accessories shall comply with the manufacturers catalog data. Outer jacket of exposed ductwork shall be stainless-steel. Square and rectangular duct shown in the contract documents will have to be converted to equivalent round size.
- D. Joint Sealing: Refer to SMACNA HVAC Duct Construction Standards, Metal and Flexible.
 1. Sealant: Elastomeric compound, gun or brush grade, maximum 25 flame spread, and 50 smoke developed (dry state) compounded specifically for sealing ductwork as recommended by the manufacturer. Generally, provide liquid sealant, with or without compatible tape, for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger. Oil base caulking and glazing compounds are prohibited because they do not retain elasticity and bond.
 2. Tape: Use only tape specifically designated by the sealant manufacturer and apply only over wet sealant. Pressure sensitive tape shall not be used on bare metal or on dry sealant.
 3. Gaskets in Flanged Joints: Soft neoprene.
- E. Approved factory-made joints may be used.

2.2 DUCT CONSTRUCTION AND INSTALLATION

- A. Regardless of the pressure classifications outlined in the SMACNA Standards, fabricate and seal the ductwork in accordance with the following pressure classifications:

SPEC WRITER NOTE: Show pressure classifications on the floor plans.

B. Duct Pressure Classification:

1. 0 to 13 mm (0 to 1/2 inch)
2. 13 mm to 25 mm (1/2 inch to 1 inch)
3. 25 mm to 50 mm (1 inch to 2 inch)
4. 50 mm to 75 mm (2 inch to 3 inch)
5. 75 mm to 100 mm (3 inch to 4 inch)

C. Seal Class: All ductwork shall receive Class A Seal.

SPEC WRITER NOTE: Duct specified to be stainless-steel should be shown cross-hatched in the contract documents.

D. Operating Room/Cystoscopy Room Supply Air: All supply air ductwork on the downstream side of the terminal final HEPA filter serving an operating room or cystoscopy room shall be fabricated from welded stainless-steel, including all components of the air distribution system up to and including the supply air outlet.

E. Wet Air Exhaust Ducts and Accessories: Ducts for dishwashers, scullery hood, cart washers, manual cart washers, cage washers, steam sterilizer hoods and orthotics hoods shall be 1.3 mm (18 gauge) stainless-steel made liquid tight with continuous external weld for all seams and joints. Provide neoprene gaskets at flanged connections. Where ducts are not self-draining back to the equipment, provide low point drain pocket with copper drain pipe to sanitary sewer. Provide access door in side of duct at drain pockets.

SPEC WRITER NOTE: Terminal humidifiers shall be used only for special cases where a central humidifier cannot be utilized. In general, the humidifiers should be located in the air handling unit. Terminal humidifiers shall not be used for the operating suite, including operating rooms and cystoscopy rooms.

F. //Provide a welded stainless-steel duct section for housing the duct-mounted terminal humidifiers. Ductwork shall be at least 914 mm (3 feet) long on the upstream side and 1829 mm (6 feet) long on the downstream side. Slope the ductwork against the direction of airflow and provide drain connections.//

G. Kitchen and Grill Hood (Ventilator) Exhaust Ducts: Comply with NFPA 96.

1. Material: 1.6 mm (16 gauge) steel sheet (black iron), ASTM A1011/A1011M, or 1.3 mm (18 gauge) stainless-steel. Use stainless-steel for exposed duct in occupied areas. See Optional Duct Materials.
 2. Construction: Liquid tight with continuous external weld for all seams and joints. Where ducts are not self-draining back to the equipment, provide low point drain pocket with copper drain pipe to sanitary sewer. Provide access doors or panels for duct cleaning inside of horizontal duct at drain pockets, at 6.1 m (20 feet) intervals, and at each change of direction.
 3. Access doors or panels shall be of the same material and thickness of the duct with gaskets and sealants that are rated 815 degrees C (1500 degrees F) and shall be grease-tight.
 4. Grease Duct: Double-wall factory-built grease duct, UL labeled and complying with NFPA 96 may be furnished in lieu of specified materials for kitchen and grill hood exhaust. Installation and accessories shall comply with the manufacturers catalog data. Outer jacket of exposed ductwork shall be stainless-steel. Square and rectangular duct shown in the contract documents will have to be converted to equivalent round size.
- H. Radioisotope H3, Hood Exhaust and Associated Ductwork: 1.3 mm (18 gauge) all welded stainless-steel duct.
- I. Laboratory Hood, Exhaust and Associated Ductwork: 1.3 mm (18 gauge) all welded stainless-steel.
- J. Biological Safety Cabinet, H12, Hood Exhaust and Associated Ductwork: 1.3 mm (18 gauge) all welded stainless-steel.
- K. Perchloric Acid H14, Hood Exhaust: 1.3 mm (18 gauge) stainless-steel, liquid tight welded construction. Provide water wash down system in the hood and all associated ductwork to the exhaust air outlet. Coordinate the wash down system requirements with the specified hood.
- L. Duct for Negative Pressure Up to 750 Pa (3 inch WG): Provide for exhaust duct between HEPA filters and exhaust fan inlet including systems for Autopsy Suite exhaust.
1. Round Duct: Galvanized steel, spiral lock seam construction with standard slip joints.
 2. Rectangular Duct: Galvanized steel, minimum 1.0 mm (20 gauge), Pittsburgh lock seam, companion angle joints 32 mm by 3.2 mm (1-1/4 by 1/8 inch) minimum at no greater than 2.4 m (8 feet) spacing.

Approved pre-manufactured joints are acceptable in lieu of companion angles.

- M. Round and Flat Oval Ducts: Furnish duct and fittings made by the same manufacturer to ensure good fit of slip joints. When submitted and approved in advance, round and flat oval duct, with size converted on the basis of equal pressure drop, may be furnished in lieu of rectangular duct design shown in the contract documents.
1. Elbows: Diameters 75 through 203 mm (3 through 8 inches) shall be two sections die stamped, all others shall be gored construction, maximum 18 degree angle, with all seams continuously welded or standing seam. Coat galvanized areas of fittings damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.
 2. Provide bell mouth, conical tees or taps, laterals, reducers, and other low loss fittings as shown in SMACNA HVAC Duct Construction Standards, Metal and Flexible.
 3. Ribbed Duct Option: Lighter gauge round/oval duct and fittings may be furnished provided certified tests indicating that the rigidity and performance is equivalent to SMACNA standard gauge ducts are submitted.
 - a. Ducts: Manufacturer's published standard gauge, G90 coating, spiral lock seam construction with an intermediate standing rib.
 - b. Fittings: May be manufacturer's standard as shown in published catalogs, fabricated by spot welding and bonding with neoprene base cement or machine formed seam in lieu of continuous welded seams.
 4. Provide flat side reinforcement of oval ducts as recommended by the manufacturer and SMACNA HVAC Duct Construction Standards, Metal and Flexible. Because of high pressure loss, do not use internal tie-rod reinforcement unless approved by the COR.
- N. VA Type A and B Canopy Hoods, Reagent Grade Water Treatment Room and Battery Charging Room Exhausts: Constructed of 1.3 mm (18 gauge) stainless-steel.
- O. Casings and Plenums: Construct in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, including curbs, access doors, pipe penetrations, eliminators and drain pans. Access doors shall be hollow metal, insulated, with latches and door pulls, 508 mm (20 inches) wide by 1219 to 1372 mm (48 to 54 inches) high. Provide

view port in the doors where shown. Provide drain for outside air louver plenum. Outside air plenum shall have exterior insulation. Drain piping shall be routed to the nearest floor drain.

- P. Volume Dampers: Single blade or opposed blade, multi-louver type as detailed in SMACNA Standards. Refer to SMACNA for Single Blade and Multi-blade Volume Dampers.
- Q. Duct Hangers and Supports: Refer to SMACNA Standards. Avoid use of trapeze hangers for round duct.
- R. //Ductwork in excess of 620 cm² (96 square inches) shall be protected unless the duct has one dimension less than 152 mm (6 inches) if it passes through the areas listed below. Refer to the Physical Security Design Manual for VA Mission Critical Facilities. This applies to the following:
 - 1. Agent cashier spaces
 - 2. Perimeter partitions of caches
 - 3. Perimeter partitions of computer rooms
 - 4. Perimeter of a COOP sites
 - 5. Perimeter partitions of Entrances
 - 6. Security control centers (SCC)//

SPEC WRITER NOTES:

- 1. For Outside air ducts, supply air ducts, and any other ducts under positive pressure duct liner is prohibited. Provide exterior insulation only.
- 2. Factory-fabricated sound attenuators are preferred to acoustic duct liner for acoustic treatment of return, relief and general exhaust ducts. The use of duct liner should be minimized.

2.3 DUCT LINER (WHERE INDICATED IN THE CONTRACT DOCUMENTS)

- A. Duct sizes shown in the contract documents for lined duct are clear opening inside lining.
- B. Duct liner is only permitted to be used for return, relief and general exhaust ducts. Duct liner is prohibited for outside air ducts, supply air ducts or any other positive pressure ductwork (provide exterior insulation only).
- C. Rectangular Duct or Casing Liner: ASTM C1071, Type I (flexible), or Type II (board), 25 mm (1 inch) minimum thickness, applied with mechanical fasteners and 100 percent coverage of adhesive in conformance with SMACNA.

2.4 DUCT ACCESS DOORS, PANELS AND SECTIONS

- A. Provide access doors, sized and located for maintenance work, upstream, in the following locations:
 - 1. Each duct mounted coil and humidifier.
 - 2. Each fire damper (for link service), smoke damper and automatic control damper.
 - 3. Each duct mounted smoke detector.
 - 4. For cleaning operating room supply air duct and kitchen hood exhaust duct, locate access doors at 6.1 m (20 feet) intervals and at each change in duct direction.
- B. Openings shall be as large as feasible in small ducts, 305 mm by 305 mm (12 inch by 12 inch) minimum where possible. Access sections in insulated ducts shall be double-wall, insulated. Transparent shatterproof covers are preferred for uninsulated ducts.
 - 1. For Rectangular Ducts: Refer to SMACNA HVAC Duct Construction Standards, Metal and Flexible.
 - 2. For Round and Flat Oval Ducts: Refer to SMACNA HVAC Duct Construction Standards, Metal and Flexible.

2.5 FIRE DAMPERS

- A. Galvanized steel, interlocking blade type, UL listing and label, 1-1/2-hour rating, 70 degrees C (158 degrees F) fusible line, 100 percent free opening with no part of the blade stack or damper frame in the air stream.
- B. Fire dampers in wet air exhaust shall be of stainless-steel construction, all others may be galvanized steel.
- C. Minimum Requirements for Fire Dampers:
 - 1. The damper frame may be of design and length as to function as the mounting sleeve, thus eliminating the need for a separate sleeve, as allowed by UL 555. Otherwise provide sleeves and mounting angles, minimum 1.9 mm (14 gauge), required to provide installation equivalent to the damper manufacturer's UL test installation.
 - 2. Submit manufacturer's installation instructions conforming to UL rating test.

2.6 SMOKE DAMPERS

- A. Maximum air velocity, through free area of open damper, and pressure loss: Low pressure and medium pressure duct (supply, return, exhaust, outside air): 457 m/min (1500 fpm). Maximum static pressure loss: 32 Pa (0.13 inch WG).

- B. Leakage: Class I.
- C. Maximum Air Leakage, Closed Damper: 0.32 cubic meters /min/square meter (4.0 cfm per square foot) at 750 Pa (3 inch WG) differential pressure.
- D. Minimum Requirements for Dampers:
 - 1. Shall comply with requirements of UL 555S, except for the Fire Endurance and Hose Stream Test.
 - 2. Frame: Galvanized steel channel with side, top and bottom stops or seals.
 - 3. Blades: Galvanized steel, parallel type preferably, 305 mm (12 inch) maximum width, edges sealed with neoprene, rubber or felt, if required to meet minimum leakage. Airfoil (streamlined) type for minimum noise generation and pressure drop are preferred for duct mounted dampers.
 - 4. Shafts: Galvanized steel.
 - 5. Bearings: Nylon, bronze sleeve or ball type.
 - 6. Hardware: Zinc plated.
 - 7. Operation: Automatic open/close. No smoke damper that requires manual reset or link replacement after actuation is acceptable. See contract documents for required control operation.
- E. Motor Operator (Actuator): Provide pneumatic or electric as required by the automatic control system, externally mounted on stand-offs to allow complete insulation coverage.

2.7 FIRE DOORS

- A. Galvanized steel, interlocking blade type, UL listing and label, 71 degrees C (160 degrees F) fusible link, 3-hour rating and approved for openings in Class A fire walls with rating up to 4 hours, 100 percent free opening with no part of the blade stack or damper frame in the air stream.

2.8 FLEXIBLE AIR DUCT

- A. General: Factory-fabricated, complying with NFPA 90A for connectors not passing through floors of buildings. Flexible ducts shall not penetrate any fire or smoke barrier which is required to have a fire resistance rating of one hour or more. Flexible duct length shall not exceed 1.5 m (5 feet). Provide insulated acoustical air duct connectors in supply air duct systems and elsewhere as shown.
- B. Flexible ducts shall be listed by Underwriters Laboratories, Inc., complying with UL 181. Ducts greater than 203 mm (8 inches) in diameter

shall be Class 1. Ducts less than 203 mm (8 inches) in diameter shall be Class 1 or Class 2.

- C. Insulated Flexible Air Duct: Factory-fabricated including mineral fiber insulation with maximum C factor of 0.25 at 24 degrees C (75 degrees F) mean temperature, encased with a low permeability moisture barrier outer jacket, having a puncture resistance of not less than 50 Beach Units. Acoustic insertion loss shall not be less than 3 dB per 300 mm (foot) of straight duct, at 500 Hz, based on 152 mm (6 inch) duct, of 762 m/min (2500 fpm).
- D. Application Criteria:
 - 1. Temperature Range: -18 to 93 degrees C (0 to 200 degrees F) internal.
 - 2. Maximum Working Velocity: 1219 m/min (4000 fpm).
 - 3. Minimum Working Pressure, Inches of Water Gauge: 2500 Pa (10 inches WG) positive, 500 Pa (2 inches WG) negative.
- E. Duct Clamps: 100 percent nylon strap, 80 kg (176 pounds) minimum loop tensile strength manufactured for this purpose or stainless-steel strap with cadmium plated worm gear tightening device. Apply clamps with sealant and as approved for UL 181, Class 1 installation.
- F. Flexible air duct is prohibited in operating room suites, SPS processing spaces, Pharmacy compounding spaces, Protective Environment spaces, Isolation Rooms, Clean Rooms, Bio-containment Laboratories, Research Laboratories, and Clinical Laboratories.

2.9 FLEXIBLE DUCT CONNECTIONS

- A. Where duct connections are made to fans, air terminal units, and air handling units, install a non-combustible flexible connection of 822 g (29 ounces) neoprene coated fiberglass fabric approximately 152 mm (6 inches) wide. For connections exposed to sun and weather provide hypalon coating in lieu of neoprene. Burning characteristics shall conform to NFPA 90A. Securely fasten flexible connections to round ducts with stainless-steel or zinc-coated iron draw bands with worm gear fastener. For rectangular connections, crimp fabric to sheet metal and fasten sheet metal to ducts by screws 50 mm (2 inches) on center. Fabric shall not be stressed other than by air pressure. Allow at least 25 mm (one inch) slack to ensure that no vibration is transmitted.

2.10 SOUND ATTENUATING UNITS

- A. Casing, not less than 1.0 mm (20 gauge) galvanized sheet steel, or 1.3 mm (18 gauge) aluminum fitted with suitable flanges to make clean

airtight connections to ductwork. Sound-absorbent material faced with glass fiber cloth and covered with not less than 0.6 mm (24 gauge) or heavier galvanized perforated sheet steel, or 0.85 mm (22 gauge) or heavier perforated aluminum. Perforations shall not exceed 4 mm (5/32 inch) diameter, approximately 25 percent free area. Sound absorbent material shall be long glass fiber acoustic blanket meeting requirements of NFPA 90A.

- B. Entire unit shall be completely air tight and free of vibration and buckling at internal static pressures up to 2000 Pa (8 inches WG) at operating velocities.
- C. Pressure drop through each unit: Not to exceed indicated value at design air quantities indicated.
- D. Submit complete independent laboratory test data showing pressure drop and acoustical performance.
- E. Cap open ends of attenuators at factory with plastic, heavy duty paper, cardboard, or other appropriate material to prevent entrance of dirt, water, or any other foreign matter to inside of attenuator. Caps shall not be removed until attenuator is installed in duct system.

2.11 PREFABRICATED ROOF CURBS

- A. Galvanized steel or extruded aluminum 305 mm (12 inches) above finish roof service, continuous welded corner seams, treated wood nailer, 38 mm (1-1/2 inch) thick, 48 kg/cubic meter (3 pound/cubic feet) density rigid mineral fiberboard insulation with metal liner, built-in cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level.

2.12 FIRESTOPPING MATERIAL

- A. Refer to Section 07 84 00, FIRESTOPPING.

2.13 //SEISMIC RESTRAINT FOR DUCTWORK

- A. Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.//

2.14 DUCT MOUNTED THERMOMETER (AIR)

- A. Stem Type Thermometers: ASTM E1, 7 inch scale, red appearing mercury, lens front tube, cast aluminum case with enamel finish and clear glass or polycarbonate window, brass stem, 2 percent of scale accuracy to ASTM E77 scale calibrated in degrees Fahrenheit.
- B. Thermometer Supports:

1. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
2. Flange: 75 mm (3 inch) outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.15 DUCT MOUNTED TEMPERATURE SENSOR (AIR)

- A. Refer to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

2.16 INSTRUMENT TEST FITTINGS

- A. Manufactured type with a minimum 50 mm (2 inch) length for insulated duct, and a minimum 25 mm (1 inch) length for duct not insulated. Test hole shall have a flat gasket for rectangular ducts and a concave gasket for round ducts at the base, and a screw cap to prevent air leakage.
- B. Provide instrument test holes at each duct or casing mounted temperature sensor or transmitter, and at entering and leaving side of each heating coil, cooling coil, and heat recovery unit.

2.17 AIR FLOW CONTROL VALVES (AFCV)

- A. Refer to Section 23 36 00, AIR TERMINAL UNITS and Section 23 82 00, CONVECTION HEATING and COOLING UNITS.

SPEC WRITER NOTE: When contract documents indicate ducts piercing lead lined X-ray rooms include the following.

2.18 LEAD COVERED DUCT

- A. Sheet Lead: 3.2 mm (1/8 inch) thick, securely installed, free of waves, lumps or wrinkles and with as few joints as possible.
- B. Joints shall be made to obtain X-ray absorption equivalent to adjacent sheet lead and finished smooth and neat.

2.19 ELECTROSTATIC SHIELDING

- A. At the point of penetration of shielded rooms ducts shall be made electrically discontinuous by means of a flexible, nonconductive connection outside shielded room.
- B. Metallic duct portion inside shielded room shall be electrically bonded to shielding.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. If an installation is unsatisfactory to the COR, the contractor shall correct the installation at no additional cost or time to the Government.

- B. Comply with provisions of Section 23 05 11, COMMON WORK RESULTS FOR HVAC, particularly regarding coordination with other trades and work in existing buildings.
- C. Fabricate and install ductwork and accessories in accordance with referenced SMACNA Standards:
1. Contract documents show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, boxes, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets at no additional cost to the Government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes in the contract documents are inside dimensions which shall be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.
 2. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards. Provide streamliner, when an obstruction cannot be avoided and must be taken in by a duct. Repair galvanized areas with galvanizing repair compound.
 3. Provide bolted construction and tie-rod reinforcement in accordance with SMACNA Standards.
 4. Construct casings, eliminators, and pipe penetrations in accordance with SMACNA Standards. Design casing access doors to swing against air pressure so that pressure helps to maintain a tight seal.
- D. Install duct hangers and supports in accordance with SMACNA Standards.
- E. Install fire dampers and smoke dampers in accordance with the manufacturer's instructions to conform to the installation used for the rating test. Install fire dampers and smoke dampers at locations indicated and where ducts penetrate fire rated and/or smoke rated walls, shafts and where required by the COR. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges per UL and NFPA. Demonstrate resetting of fire dampers and operation of smoke dampers to the COR.

- F. Seal openings around duct penetrations of floors and fire rated partitions with fire stop material as required by NFPA 90A.
- G. Flexible Duct Installation: Refer to SMACNA Standards. Ducts shall be continuous, single pieces not over 1.5 m (5 feet) long per NFPA 90A, as straight and short as feasible, adequately supported. Centerline radius of bends shall be not less than two duct diameters. Make connections with clamps as recommended by SMACNA. Clamp per SMACNA with one clamp on the core duct and one on the insulation jacket. Flexible ducts shall not penetrate floors, or any chase or partition designated as a fire or smoke barrier, including corridor partitions fire rated one hour or two hours. Support ducts SMACNA Standards.
- H. Where diffusers, registers and grilles cannot be installed to avoid seeing inside the duct, paint the inside of the duct with flat black paint to reduce visibility.
- I. Control Damper Installation:
 - 1. Provide necessary blank-off plates required to install dampers that are smaller than duct size. Provide necessary transitions required to install dampers larger than duct size.
 - 2. Assemble multiple sections dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.
 - 3. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation, and affix and seal permanently in place, only after stratification problem has been eliminated.
 - 4. Install all damper control/adjustment devices on stand-offs to allow complete coverage of insulation.
- J. Air Flow Measuring Devices: Install units with minimum straight run distances, upstream and downstream as recommended by the manufacturer.
- K. Low Pressure Duct Liner: Install in accordance with SMACNA Standards.
- L. Protection and Cleaning: Adequately protect equipment and materials against physical damage. Place equipment in first class operating condition or return to source of supply for repair or replacement, as determined by COR. Protect equipment and ducts during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting. When new ducts are connected to existing ductwork, clean both new and existing ductwork by mopping and vacuum cleaning inside and outside before operation.

3.2 DUCT LEAKAGE TESTS AND REPAIR

- A. Ductwork leakage testing shall be performed by the Testing and Balancing Contractor directly contracted by the General Contractor and independent of the Sheet Metal Contractor.
- B. Ductwork leakage testing shall be performed for the entire air distribution system (including all supply, return, exhaust and relief ductwork), section by section, including fans, coils and filter sections. //Based upon satisfactory initial duct leakage test results, the scope of the testing may be reduced by the COR on ductwork constructed to the 500 Pa (2 inches WG) duct pressure classification. In no case shall the leakage testing of ductwork constructed above the 500 Pa (2 inches WG) duct pressure classification or ductwork located in shafts or other inaccessible areas be eliminated.//
- C. Test procedure, apparatus and report shall conform to SMACNA HVAC Air Duct Leakage Test Manual. The maximum leakage rate allowed is 4 percent of the design air flow rate.

SPEC WRITER NOTE: Show pressure classifications on the floor plans; based on the classifications listed in this section. See ductwork symbols (CAD DETAIL NO. 23 05 11-11.DWG) for the notations to be used while showing duct pressure classifications on the floor plan.

- D. All ductwork shall be leak tested first before enclosed in a shaft or covered in other inaccessible areas.
- E. All tests shall be performed in the presence of the COR and the Test and Balance agency. The Test and Balance agency shall measure and record duct leakage and report to the COR and identify leakage source with excessive leakage.
- F. If any portion of the duct system tested fails to meet the permissible leakage level, the Contractor shall rectify sealing of ductwork to bring it into compliance and shall retest it until acceptable leakage is demonstrated to the COR.
- G. All tests and necessary repairs shall be completed prior to insulation or concealment of ductwork.
- H. Make sure all openings used for testing flow and temperatures by TAB Contractor are sealed properly.

SPEC WRITER NOTE: Specify wind velocity as per Fig. 1 in Handbook ASCE 7 where wind velocity exceeds 90 mph in coastal areas.

3.3 //DUCTWORK EXPOSED TO WIND VELOCITY

- A. Provide additional support and bracing to all exposed ductwork installed on the roof or outside the building to withstand wind velocity of 145 km/h (90mph).//

3.4 TESTING, ADJUSTING, AND BALANCING (TAB)

- A. Refer to Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.

3.5 OPERATING AND PERFORMANCE TESTS

- A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

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