SECTION 233119.13 - SHOP-FABRICATED HVAC CASINGS

Revise this Section by deleting and inserting text to meet Project-specific requirements.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

This Section may include provisions for LEED 2009, LEED v4, ASHRAE 189.1, IgCC, and Green Globes. Note that some sustainable design requirements are either mandatory or optional requirements that may be inserted in the Section Text using the hypertext links. Other requirements that are associated with sustainable design, and may be considered "best practice" or retained even if a sustainable design standard is not a project requirement, are discussed in the Evaluations.

1. GENERAL
	* + 1. RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
			1. SUMMARY
				1. Section Includes:

Shop-fabricated casings.

Casing interstitial insulation.

Casing liner.

Sealant materials.

* + - 1. SUBMITTALS
				1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
				4. Product Data: For each type of the following products:

Liners and adhesives.

Sealants and gaskets.

Retain devices in subparagraph below where required.

Seismic-restraint devices.

* + - * 1. Sustainable Design Submittals:
				2. Shop Drawings: For HVAC casings.

Include plans, elevations, sections, and attachment details.

Include details of HVAC casing assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

Sheet metal thickness(es).

Insulation.

Reinforcement and spacing.

Seam and joint construction.

Access doors including frames, hinges, and latches.

Fan, filter, coil, humidifier, and other apparatus being installed in and mounted on casing.

Locations for access to internal components.

Hangers and supports including methods for building attachment, vibration isolation, [**seismic restraints,**]and casing attachment.

Interior lighting, including switches.

Retain "Seismic Qualification Data" paragraph below if required by seismic criteria applicable to Project. Coordinate with Section 230548 "Vibration and Seismic Controls for HVAC." See ASCE/SEI 7 for certification requirements for equipment and components.

* + - * 1. Seismic Qualification Data: Certificates, for shop-fabricated HVAC casings, accessories, and components, from fabricator.

Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

Retain "Welding certificates" paragraph below if retaining "Welding Qualifications" paragraph in "Quality Assurance" Article.

* + - * 1. Welding certificates.

Retain "Product Certificates" paragraph below to require submittal of product certificates from fabricator.

* + - * 1. Product Certificates: For each type of casing.

For insulation properties, for the insulation material, and complete panel assembly, from fabricator.

For static-pressure ratings of complete panel assembly, from fabricator.

Retain "Product Certificates" subparagraph and one of or both sub-subparagraphs below if acoustical performance is specified in the Section Text.

Product Certificates: For acoustical performance of each casing, from fabricator.

Show sound-absorption coefficients in each octave band. Coefficients to be equal to or lower than those scheduled when tested in accordance with ASTM C423.

Show airborne sound transmission losses. Losses to be equal to or lower than those scheduled when tested in accordance with ASTM E90.

Casing Performance: Submit calculations indicating that the proposed casing construction will achieve the required static-pressure classification, acoustical performance, and structural performance.

Retain "Field quality-control reports" paragraph below if Contractor is responsible for field quality-control testing and inspecting.

* + - * 1. Field quality-control reports.
			1. QUALITY ASSURANCE

Retain "Welding Qualifications" paragraph below if shop or field welding is required. If retaining, also retain "Welding certificates" paragraph in "Informational Submittals" Article.

* + - * 1. Welding Qualifications: Qualify procedures and personnel in accordance with [**AWS D1.1, "Structural Welding Code - Steel," for hangers and supports**] [**and**] [**AWS D9.1, "Sheet Metal Welding Code," for casing joint and seam welding**].
			1. COORDINATION
				1. Coordinate sizes and locations of concrete bases [**and roof curbs**]with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."

Delete subparagraph below if no casing on Project has a drain connection.

Verify that base height is sufficient to accommodate required drain trap depth.

Retain one of two paragraphs below to specify steel supports.

* + - * 1. Coordinate sizes and locations of steel supports. Supports are specified in Section 055000 "Metal Fabrications."
				2. Coordinate installation of roof curbs, [**equipment supports,**]and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

Delete subparagraph below if no roof curb on Project has a drain connection.

Verify that roof curb height is sufficient to accommodate required drain trap depth.

1. PRODUCTS

Manufacturers and products listed in SpecAgent and MasterWorks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications.

* + - 1. PERFORMANCE REQUIREMENTS

Retain "Static-Pressure Classes" paragraph below if static-pressure classes are not indicated on Drawings.

* + - * 1. Static-Pressure Classes:

Upstream from Fan(s): [**2**] <**Insert number**> inch wg.

Downstream from Fan(s): [**2**] [**3**] [**4**] [**6**] [**10**] <**Insert number**> inch wg.

Retain "Thermal Performance for Assembled Casing Panel" paragraph below if thermal performance properties are not indicated under specific insulation types or on Drawings.

* + - * 1. Thermal Performance for Assembled Casing Panel:

2-Inch Panel: [**0.12**] <**Insert number**> Btu/h x sq. ft. x deg F.

4-Inch Panel: [**0.06**] <**Insert number**> Btu/h x sq. ft. x deg F.

For critical applications, a table of performance by octave bands should be indicated on Drawings.

* + - * 1. Acoustical Performance for Assembled Casing Panel:

NRC: [**1.09**] [**0.94**] <**Insert number**> in accordance with ASTM C423.

STC: [**40**] [**34**] <**Insert number**> in accordance with ASTM E90.

In "Structural Performance" paragraph below, first option is per SMACNA.

* + - * 1. Structural Performance:

Fabricate casings to withstand [**133**] <**Insert number**> percent of the indicated static pressure without structural failure. Wall and roof deflection at the indicated static pressure shall not exceed [**1/8**] <**Insert deflection**> inch/foot.

Retain first subparagraph below if casing wind-load rating is required. Adjust load numbers to suit Project.

Fabricate outdoor casings to withstand wind load of [**15**] <**Insert number**> lbf/sq. ft.

Retain subparagraph below if casing snow-load rating is required. Adjust load numbers to suit Project.

Fabricate outdoor casings to withstand snow load of [**30**] <**Insert number**> lbf/sq. ft.

* + - * 1. Flammability:

Insulation and Other Materials Exposed to the Airstream:

All materials exposed to the airstream to comply with requirements of NFPA 90A or NFPA 90B when tested in accordance with ASTM E84.

Retain "ASHRAE Compliance" paragraph below if ASHRAE 62.1 compliance is required for sustainable design.

* + - * 1. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

Retain "ASHRAE/IES Compliance" paragraph below if ASHRAE/IES 90.1 compliance is required for sustainable design.

* + - * 1. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

Retain "Seismic Performance" paragraph below with "Seismic Qualification Data" paragraph in "Informational Submittals" Article for projects requiring seismic design. Delete paragraph if performance requirements are indicated on Drawings. Model building codes and ASCE/SEI 7 establish criteria for buildings subject to earthquake motions. Coordinate requirements with structural engineer.

* + - * 1. Seismic Performance: HVAC casings shall withstand the effects of earthquake motions determined in accordance with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems" [**and**] [**ASCE/SEI 7**] <**Insert requirement**>.

Retain subparagraph below to define the term "withstand" as it applies to this Project. Definition varies with type of building and occupancy and is critical to valid certification. Option is used for essential facilities where equipment must operate immediately after an earthquake.

The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

For life-safety components required to function after an earthquake (such as fire-sprinkler systems, components that contain hazardous content, and storage racks in structures open to the public), the Component Importance Factor is 1.5. For other components, the Component Importance Factor is 1.0 unless the structure is in Seismic Use Group III and component is necessary for continued operation of facility or failure of component could impair continued operation of facility, in which case the Component Importance Factor is 1.5.

Component Importance Factor: [**1.5**] [**1.0**].

See ASCE/SEI 7, Coefficients for Architectural Component Table and Seismic Coefficients for Mechanical and Electrical Components Table, for requirements to be inserted in subparagraph below.

<**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

* + - 1. GENERAL CASING FABRICATION REQUIREMENTS
				1. General Casing Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 9, "Equipments and Casings," for acceptable construction details related to required static-pressure classes.
				2. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 9, "Equipment and Casings," for acceptable materials, material thicknesses, and casing construction methods unless otherwise indicated. Sheet metal materials to be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

Fabricate casings with more than 3-inch wg negative static pressure in accordance with SMACNA's "Rectangular Industrial Duct Construction Standards."

Fabricate casings with more than 2-inch wg positive static pressure in accordance with SMACNA's "Rectangular Industrial Duct Construction Standards."

* + - * 1. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

Exterior-Surface Galvanized Coating Designation: [**G60**] [**G90**].

Interior-Surface Galvanized Coating Designation:

Sections Not Exposed to Moisture: [**G60**] [**G90**].

Sections Housing and Downstream from Cooling Coil and Humidifiers: [**G90**].

* + - * 1. Stainless Steel: ASTM A480/A480M, [**Type 304**] [**Type 316**], and having a [**No. 2D**] <**Insert finish**> finish.

Antimicrobial coating in "Shop-Applied Antimicrobial Coating" paragraph below is an optional feature and usually applied only after casing fabrication. See the Evaluations for discussion on coatings.

* + - * 1. Shop-Applied Antimicrobial Coating:

Apply to the interior sheet metal surfaces of casing in contact with the airstream. Apply untreated clear coating to the exterior surface.

Use only antimicrobial compound tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

Coating Hardness: 2H minimum when tested in accordance with ASTM D3363.

Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 in accordance with UL 723; certified by an NRTL.

Applied Coating Color: [**Standard**] [**Black**] [**White**].

* + - * 1. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

Retain "Sealing Requirement" paragraph below if seal class or leakage class is not indicated on Drawings.

* + - * 1. Sealing Requirement: SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class A. Seal all seams, joints, connections, and abutments to building.
				2. Access Doors: Fabricate access doors in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 9-15, "Casing Access Doors - 2-inch wg (500 Pa)," and Figure 9-16, "Casing Access Doors - 3-10-inch wg (750-2500 Pa)"; and in accordance with pressure class of the plenum or casing section in which access doors are to be installed.

Size: [**20 by 54**] <**Insert dimensions**> inches.

Vision Panel: Double-glazed, wire-reinforced safety glass with an airspace between panes and sealed with interior and exterior rubber seals.

Hinges: Piano or butt hinges and latches; number and size in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

Latches: Minimum of two wedge-lever-type latches; operable from inside and outside.

Neoprene gaskets around entire perimeters of door frames.

Install doors to open against air pressure.

* + - * 1. Condensate Drain Pans: Formed sections of [**Type 304, stainless steel sheet**] [**G90 coated, galvanized sheet steel**] complying with requirements in ASHRAE 62.1. Extend pans a minimum of 12 inches past coil.

Construct pans with a double-wall having space between walls filled with foam insulation and sealed moisture tight.

Insulation: Polystyrene or polyurethane.

For units with stacked coils or stacked eliminators, provide intermediate drain pan or drain trough to collect condensate from each coil row. Provide downcomer to conduct condensate from intermediate pan or trough into lower drain pan. Intermediate drain pan, trough, and downcomer to be constructed of [**20-gauge, Type 304, stainless**] [**18-gauge galvanized**] steel.

Slope drain pan floor in a minimum of two planes to collect condensate from cooling coils (including coil piping connections and return bends), eliminators, and humidifiers when units are operating at maximum catalogued face velocity across cooling coil. All condensate to drain from pan without any standing water.

Provide dimensioned detail of condensate drain traps on Drawings. Provide separate dimensions or details for casings with differing static-pressure requirements and for draw-through and blow-through units. Also consider distance to floor drain and required pitch of pipe. Verify that there is sufficient clearance to accommodate required trap dimensions. If necessary, adjust casing elevation by increasing equipment base height, providing a depressed sump at the floor drain, or other means.

Provide trap for each drain pan connection. Dimension trap as detailed on Drawings.

* + - 1. SHOP-FABRICATED CASINGS
				1. Single- and Double-Wall Casings: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for sheet metal thickness based on indicated static-pressure class unless otherwise indicated.

Outer Panel: [**Galvanized sheet steel**] [**Type 304, stainless steel sheet**].

* + - * 1. Fabricate casings with standing seams and angle-iron reinforcements unless otherwise indicated.
				2. Fabricate close-off sheets from casing to dampers, filter frames, and coils and between stacked coils. Use [**G90 galvanized sheet steel**] [**Type 304, stainless steel sheets**] of same thickness as outer casing.
				3. Bolt close-off sheets to frame flanges and housings. Support coils on stands fabricated from galvanized-steel angles or channels.
				4. Reinforce casings with galvanized-steel angles.

Retain one of or both "Double-Wall Casing Inner Panel, Perforated" and "Double-Wall Casing Inner Panel, Solid" paragraphs below. If both perforated and solid linings are used, indicate on Drawings locations of each. Note that foam insulation should not be used in contact with perforated inner wall.

* + - * 1. Double-Wall Casing Inner Panel, Perforated: Galvanized sheet steel having 3/32-inch- diameter perforations, with overall open area of [**23**] <**Insert number**> percent. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for sheet metal thickness based on indicated static-pressure class unless otherwise indicated.
				2. Double-Wall Casing Inner Panel, Solid: Sheet steel. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for sheet metal thickness based on indicated static-pressure class unless otherwise indicated.
			1. CASING INTERSTITIAL INSULATION
				1. Casing insulation is used to fill the interstitial void between inner and outer panel wall in double-wall casing construction and provides thermal and acoustic insulation.

Retain "Interstitial Insulation, Polyurethane Foam"; "Interstitial Insulation, Fibrous Glass"; or "Interstitial Insulation, Polyurethane-Foam and Fibrous-Glass Combination" paragraph below. If the objective of interstitial insulation includes achievement of both thermal performance and sound absorption, casings using a combination of polyurethane foam and fibrous glass, or consisting of all fibrous-glass may be required. Foam provides increased structural capability at the expense of sound absorption but should not be used directly in contact with perforated inner wall.

* + - * 1. Interstitial Insulation, Polyurethane Foam: Polyurethane foam complying with requirements of NFPA 90A or NFPA 90B when tested in accordance with ASTM E84.

Engineer must determine the thickness of casing and associated insulation necessary to achieve the required thermal and acoustic isolation factors. Retain "Casing Wall Thickness" subparagraph below if all casing requirements are identical. If differing factors are required, delete subparagraph and provide a schedule on Drawings.

Casing Wall Thickness: [**2**] [**4**] <**Insert dimension**> inches.

Maximum Thermal Conductivity: [**0.27**] <**Insert conductivity**> Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

* + - * 1. Interstitial Insulation, Fibrous Glass: Fibrous-glass insulation complying with ASTM E84, NFPA 90A, or NFPA 90B; and with NAIMA AH124.

Engineer must determine the thickness of casing and associated insulation necessary to achieve the required thermal and acoustic isolation factors. Retain "Casing Wall Thickness" subparagraph below if all casing requirements are identical. If differing factors are required, delete subparagraph and provide a schedule on Drawings.

Casing Wall Thickness: [**2**] [**4**] <**Insert dimension**>inches.

Maximum Thermal Conductivity of Composite Panel: [**0.27**] <**Insert conductivity**> Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

Coat insulation with antimicrobial coating.

Cover insulation with polyester film complying with NFPA 701.

* + - * 1. Interstitial Insulation, Polyurethane-Foam and Fibrous-Glass Combination: Polyurethane foam in combination with fibrous glass for enhanced sound absorption characteristics.

Engineer must determine the thickness of each insulation material (polyurethane foam and fibrous glass) in combination necessary to achieve the required thermal and acoustic isolation factors. Retain "Polyurethane-Foam Insulation Thickness" subparagraph below if all casing requirements are identical. If differing factors are required, delete "Polyurethane-Foam Insulation Thickness" and "Fibrous-Glass Insulation Thickness" subparagraphs below and provide a schedule on Drawings.

Polyurethane-Foam Insulation Thickness: [**1**] [**2**] <**Insert dimension**> inch(es).

Fibrous-Glass Insulation Thickness: [**1**] [**2**] <**Insert dimension**> inch(es).

Maximum Thermal Conductivity of Composite Panel: [**0.27**] <**Insert conductivity**> Btu x in/h x sq. ft. x deg F at 75 deg F mean temperature.

Coat insulation with antimicrobial coating.

Cover insulation with polyester film complying with NFPA 701.

* + - * 1. Interstitial Insulation: Flexible-elastomeric duct insulation complying with ASTM C534, Type II for sheet materials and with ASTM E84 and NFPA 90A or NFPA 90B.

This material cannot be used with a thickness of greater than 2 inches.

Casing wall thickness to be [**1 inch**] [**2 inches**].

Maximum Thermal Conductivity: [**0.25**] <**Insert conductivity**> Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

* + - 1. CASING LINER
				1. Casing liner is applied to the inner side of the panel in single-wall casing construction and provides thermal and acoustic insulation. The inner surface is exposed to the airstream.

Engineer must determine the thickness of casing liner necessary to achieve the required thermal and acoustic isolation factors. If the objective of casing liner includes achievement of both thermal performance and sound absorption, consider both requirements when selecting the thickness of material required. Sustainable design systems require minimum thermal-resistance values for air distribution systems.

When specifying liner by referencing ASTM C1071, specifiers are assured of fibrous-glass products complying with stated qualifications for corrosiveness, water-vapor sorption, fungi resistance, temperature resistance, erosion resistance, odor emission, surface-burning characteristics, apparent thermal conductivity, sound absorption coefficients, and bacteria resistance.

* + - * 1. Fibrous-Glass Casing Liner: Comply with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124.

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Certainteed; SAINT-GOBAIN.

Johns Manville; a Berkshire Hathaway company.

Knauf Insulation.

Approved equivalent.

Source Limitations: Obtain casing liner from single source from single manufacturer.

Retain "Maximum Thermal Conductivity" subparagraph below to require thermal conductivity exceeding minimum requirements in ASTM C1071. Retaining subparagraph may create a restrictive proprietary specification.

Maximum Thermal Conductivity:

Option for thermal conductivity in "Type I, Flexible" and "Type II, Rigid" subparagraphs below exceeds the values in ASTM C1071. If retaining, verify availability of performance with casing liner manufacturers.

Type I, Flexible: [**0.27**] <**Insert conductivity**> Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

Type II, Rigid: [**0.23**] <**Insert conductivity**> Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

Antimicrobial coating in "Antimicrobial Erosion-Resistant Coating" subparagraph below is an optional feature for casing liner.

Antimicrobial Erosion-Resistant Coating: Apply to surface of the liner that will form the interior surface of casing to act as a moisture repellent and an erosion-resistant coating. Use only antimicrobial compound tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

[**Solvent**] [**Water**]-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.

Casing liner in "Flexible-Elastomeric Casing Liner" paragraph below is unsuitable for temperatures higher than 220 deg F (104 deg C). Most are unavailable in greater than 2-inch thickness or do not comply with NFPA 90A or NFPA 90B requirements above 2-inch thickness.

* + - * 1. Flexible-Elastomeric Casing Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C534, Type II, Grade 1, and with NFPA 90A or NFPA 90B.

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Aeroflex USA.

Armacell LLC.

K-Flex USA.

Approved equivalent.

Source Limitations: Obtain casing liner from single source from single manufacturer.

Characteristics in "Surface-Burning Characteristics" subparagraph below are available up to 2-inch thickness. Verify maximum thickness with manufacturers.

Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

* + - * 1. Natural-Fiber Casing Liner: Cotton fiber with polybinding fibers, treated with fire retardant and microbial growth inhibitor. Complying with ASTM E84 and NFPA 90A or NFPA 90B.

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Acoustical Surfaces, Inc.

Bonded Logic, Inc.

Approved equivalent.

Source Limitations: Obtain casing liner from single source from single manufacturer.

Available thicknesses are up to 2 inches. Engineer must determine the thickness of casing and associated insulation necessary to achieve the required thermal and acoustic isolation factors. Retain "Maximum Thermal Conductivity" subparagraph below if all casing requirements are identical. If differing factors are required, delete subparagraph and provide a schedule on Drawings.

Maximum Thermal Conductivity: [**0.24**] <**Insert conductivity**> Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature when tested in accordance with ASTM C518.

Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

Liner Adhesive: As recommended by insulation manufacturer and complying with ASTM E84 and NFPA 90A or NFPA 90B.

* + - * 1. Insulation Pins and Washers:

Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, [**0.106-inch-**] [**0.135-inch-**] diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, [**galvanized**] [**stainless**] steel, with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inches in diameter.

* + - * 1. Shop or Factory Application of Casing Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

Adhere a single layer of indicated thickness of casing liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of casing liner is prohibited.

Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.

Butt transverse joints without gaps, and coat joint with adhesive.

Fold and compress liner in corners of casings or cut and fit to ensure butted-edge overlapping.

Retain first subparagraph below if air velocities are 2500 fpm (12.7 m/s) or higher.

Apply adhesive coating on longitudinal seams in casings with air velocity of 2500 fpm.

Securing method in first subparagraph below is for casings with air velocities of 2500 fpm (12.7 m/s) and lower. Use caution when designing lined casings with air velocities higher than 2500 fpm (12.7 m/s). See SMACNA for requirements.

Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from casing wall. Fabricate edge facings at the following locations:

Fan discharges.

Intervals of lined casing preceding unlined duct.

Upstream edges of transverse joints in casings where air velocities are higher than 2500 fpm or where indicated.

Retain subparagraph below if casings with air velocities higher than 4000 fpm (20.3 m/s) are anticipated; indicate locations of double-wall casings on Drawings.

Secure insulation between perforated sheet metal inner wall of same thickness as specified for outer wall. Use mechanical fasteners that maintain inner wall at uniform distance from outer wall without compressing insulation.

* + - 1. SEALANT MATERIALS

See SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for a discussion on seam and joint sealing methods and their applications.

* + - * 1. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets to have a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

Retain one or more of "Water-Based Joint and Seam Sealant," "Solvent-Based Joint and Seam Sealant," and "Flanged Joint Sealant" paragraphs below. If retaining more than one, identify on Drawings which sealing system applies to which HVAC casings.

* + - * 1. Water-Based Joint and Seam Sealant:

Application Method: Brush on.

Solids Content: Minimum 65 percent.

Shore A Hardness: Minimum 20.

Water resistant.

Mold and mildew resistant.

Maximum Static-Pressure Class: 10 inch wg, positive or negative.

Service: Indoor or outdoor.

Substrate: Compatible with galvanized sheet steel or stainless steel.

If retaining "Solvent-Based Joint and Seam Sealant" paragraph below, verify acceptability with authorities having jurisdiction.

* + - * 1. Solvent-Based Joint and Seam Sealant:

Application Method: Brush on.

Base: Synthetic rubber resin.

Solvent: Toluene and heptane.

Solids Content: Minimum 60 percent.

Shore A Hardness: Minimum 60.

Water resistant.

Mold and mildew resistant.

Maximum Static-Pressure Class: 10 inch wg, positive or negative.

Service: Indoor or outdoor.

Substrate: Compatible with galvanized sheet steel or stainless steel.

* + - * 1. Flanged Joint Sealant: Comply with ASTM C920.

General: Single component, acid curing, silicone, elastomeric.

Type: S.

Grade: NS.

Class: 25.

Use: O.

* + - * 1. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
1. EXECUTION
	* + 1. EXAMINATION
				1. Examine [**concrete bases**] [**roof curbs**] [**and**] [**steel supports**] for compliance with requirements for conditions affecting installation and performance of HVAC casings. Verify that there is sufficient clearance for access and to install all piping, condensate traps, ductwork, and other fittings.
				2. Examine casing insulation materials and liners before installation. Reject casings that are wet, moisture damaged, or mold damaged.
				3. Proceed with installation only after unsatisfactory conditions have been corrected.
			2. INSTALLATION
				1. Install casings in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
				2. Equipment Mounting:

Retain first subparagraph below to require equipment to be installed on cast-in-place concrete equipment bases.

Where indicated on Drawings, install HVAC casings on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

Retain one of two subparagraphs below. Retain first for projects in seismic areas; retain second for projects not in seismic areas. Indicate vibration isolation and seismic-control device type and minimum deflection in supported equipment schedule on Drawings.

Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

* + - * 1. Apply sealant to joints, connections, and mountings.
				2. Field-cut openings for pipe and conduit penetrations through casing walls; insulate and seal in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
				3. Seal all penetrations airtight. Cover with escutcheons and gaskets, or fill with suitable compound so there is no exposed insulation. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping." Provide shaft seals where fan shafts penetrate casing.
				4. Support casings on base or foundation system. Secure and seal to base.
				5. Support components rigidly with ties, braces, brackets, [**seismic restraints,**]and anchors of types that will maintain housing shape and prevent buckling.
				6. Align casings accurately at connections, with 1/8-inch misalignment tolerance and with smooth interior surfaces.
			1. FIELD QUALITY CONTROL

Retain one of first three paragraphs below. Retain first "Testing Agency" paragraph below if Owner will hire an independent testing agency.

Retain "Testing Agency" paragraph below to require Contractor to hire an independent testing agency.

* + - * 1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

Retain "Perform tests and inspections" paragraph below to require Contractor to perform tests and inspections and retain option to require Contractor to arrange for the assistance of a shop-authorized service agent.

* + - * 1. Perform tests and inspections[**with the assistance of a shop-authorized service representative**].
				2. Tests and Inspections:

Perform field tests of all fire dampers and control dampers, demonstrating that they open and close fully and without binding or excessive friction.

Inspect all duct and casing access doors and other openings having movable covers, demonstrating that they are reasonably accessible, open and close fully without binding or excessive fiction, and when fully closed, they seal properly.

Perform field tests and inspections including air-duct leakage testing of supply-, return-, and exhaust-air ducts in accordance with SMACNA's "HVAC Air Duct Leakage Test Manual."

Test the following systems:

Sustainable design systems require compliance with ASHRAE/IES 90.1, in which Section 6.4.4.2.2 - "Duct Leakage Tests" requires leak testing of at least 25 percent of total installed duct area with a pressure class in excess of 3 inch wg (750 Pa), and all ductwork located outdoors. For sustainable design systems or ASHRAE/IES 90.1, retain first subparagraph below to define minimum requirements. Retain "Supply Air" subparagraph to define more stringent requirements.

Systems required by ASHRAE/IES 90.1.

Supply Air: [**100**] [**50**] <**Insert number**> percent of total installed duct area with a pressure class of [**3**] [**4**] <**Insert value**> inch wg or higher.

<**Insert requirements of other systems**>.

Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

Determine leakage from entire system or section of system by relating leakage to surface area of test section. Comply with requirements for leakage classification of ducts connected to casings.

Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

* + - * 1. HVAC casings will be considered defective if they do not pass tests and inspections.
				2. Prepare test and inspection reports.
			1. CLEANING

Retain this article to require cleaning of new HVAC casings to remove construction dust or existing HVAC casings indicated to remain to comply with ASHRAE 62.1, in which Section 7.2.4 - "Ventilation System Start-up" requires that distribution systems be clean of dirt and debris. Retain also for sustainable design systems.

* + - * 1. Comply with requirements for cleaning in Section 233113 "Metal Ducts."

END OF SECTION 233119.13