SECTION 233100 - HVAC DUCTS AND CASINGS

This Section includes materials, construction, supports, and cleaning for ductwork.

Vibration and seismic controls for HVAC piping and equipment are included in Section 230548.

Manufacturers found in SpecAgent for this Section were identified as representative and not as an endorsement for meeting requirements of this Specification.

This Section includes performance, proprietary, and descriptive specifications. Edit to avoid conflicting requirements.

This Section includes the term "Architect/Engineer." "Architect" is used in AIA contract documents; "Engineer" is used in EJCDC contract documents. Retain appropriate term.

See Drawing Coordination Considerations for information needed to coordinate this Specification Section with Drawings.

1. GENERAL
	* + 1. SUMMARY
				1. Section Includes:

Duct materials.

Glass-fiber ducts.

Flexible ducts.

Insulated flexible ducts.

Single-wall, spiral round ducts.

Single-wall, spiral flat oval ducts.

Double-wall, insulated, spiral round ducts.

Double-wall, insulated, spiral flat oval ducts.

PVC-coated steel ducts.

Glass-fiber-reinforced plastic round ducts.

Double-wall, insulated, glass-fiber-reinforced plastic round ducts.

Slab duct ventilation system.

Transverse duct connection system.

Casings.

Ductwork fabrication.

Glass-fiber ductwork fabrication.

Buried underground duct fabrication.

Kitchen hood exhaust ductwork fabrication.

Duct cleaning.

* + - * 1. Related Requirements:

List other Sections directly related to or affecting Work of this Section. Include Sections specifying information expected to be found in this Section as well as Sections required to describe complete system or assembly requirements.

Section 033000 - Cast-in-Place Concrete: Requirements for concrete curbs as specified in this Section.

Section 099000 - Painting and Coating: Requirements for painting or coating as specified in this Section.

Section 114000 - Foodservice Equipment: Requirements for kitchen range hoods for placement by this Section.

Section 233300 - Air Duct Accessories: Requirements for duct accessories as specified in this Section.

* + - 1. REFERENCE STANDARDS

List reference standards included within text of this Section, with designations, numbers, and complete document titles.

* + - * 1. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

ASHRAE Handbook - Fundamentals.

* + - * 1. American Welding Society:

AWS D1.1 - Structural Welding Code - Steel.

AWS D1.2 - Structural Welding Code - Aluminum.

AWS D9.1 - Sheet Metal Welding Code.

* + - * 1. ASTM International:

ASTM A36 - Standard Specification for Carbon Structural Steel.

ASTM A90 - Standard Test Method for Weight [**Mass**] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.

ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

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

TM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

ASTM C14 - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.

ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

* + - * 1. International Code Council:

International Energy Conservation Code (IECC).

International Mechanical Code (IMC).

* + - * 1. NFPA:

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

NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

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

* + - * 1. Sheet Metal and Air Conditioning Contractors' National Association:

SMACNA 016 - HVAC Air Duct Leakage Test Manual.

SMACNA 1767 - Kitchen Ventilation Systems and Food Service Equipment Guidelines.

SMACNA 1884 - Fibrous Glass Duct Construction Standards.

SMACNA 1966 - HVAC Duct Construction Standards - Metal and Flexible.

* + - * 1. UL:

UL 181 - Factory-Made Air Ducts and Air Connectors.

UL 181A - Closure Systems for Use With Rigid Air Ducts.

UL 1978 - Grease Ducts.

* + - 1. PREINSTALLATION MEETINGS
				1. Section 013000 - Administrative Requirements: Requirements for preinstallation meeting.
				2. Convene minimum [**one week**] [**<\_\_\_\_\_\_\_\_> weeks**] prior to commencing Work of this Section.
			2. SUBMITTALS

Only request submittals needed to verify compliance with Project requirements.

* + - * 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. Section 013300 - Submittal Procedures: Requirements for submittals.
				5. Product Data: Submit manufacturer information for [**duct materials**] [**, duct liner**] [**, duct connectors**] [**, and**] <**\_\_\_\_\_\_\_\_**>.
				6. Shop Drawings:

Submit duct fabrication drawings, drawn to scale not smaller than <**\_\_\_\_\_\_\_\_**> inch equals 1 foot, on sheets same size as Contract Drawings, indicating following:

Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other Work.

Duct layout that further indicates pressure classifications and sizes in plan view; exhaust duct systems that further indicate classification of materials handled as specified in this Section.

Fittings.

Reinforcing details and spacing.

Seam and joint construction details.

Penetrations through fire-rated and other walls.

Terminal unit, coil, and humidifier installations.

Hangers and supports, including methods for vibration isolation and building and duct attachment.

Include following paragraph for submission of physical samples for selection of finish, color, texture, and other properties.

* + - * 1. Samples: Submit [**two**] <**\_\_\_\_\_\_\_\_**> typical shop-fabricated [**duct fittings**] <**\_\_\_\_\_\_\_\_**>.
				2. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
				3. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.

Include separate paragraphs for additional certifications.

Include following paragraph when Contractor is responsible for designing products or assemblies. List affected products when Section specifies more than one product.

* + - * 1. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for following:

Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

Materials, fabrication, assembly, and spacing of hangers and supports.

Sheet metal thicknesses.

Joint and seam construction and sealing.

Reinforcement details and spacing.

* + - * 1. Test and Evaluation Reports: Indicate pressure tests performed, including date, section tested, test pressure, and leakage rate according to SMACNA 016 “HVAC Air Duct Leakage Test Manual”.
				2. Manufacturer Instructions:

Submit detailed instructions on installation requirements, including storage and handling procedures.

Submit special procedures for glass-fiber ducts.

* + - * 1. Qualifications Statements:

Coordinate following subparagraphs with requirements specified in QUALIFICATIONS Article.

Submit qualifications for manufacturer, installer, and licensed professional.

Submit manufacturer's approval of installer.

Welders: Qualify procedures and personnel according to AWS D1.1 “Structural Welding Code – Steel” for hangers and supports, AWS D1.2 “Structural Welding Code – Aluminum” for aluminum supports, and AWS D9.1 “Sheet Metal Welding Code” for duct joint and seam welding.

* + - 1. CLOSEOUT SUBMITTALS
				1. Project Record Documents:

Record actual locations of ducts and duct fittings.

Record changes in fitting location and type.

Show additional fittings used.

* + - 1. QUALITY ASSURANCE

Include this Article to specify compliance with overall reference standards affecting products and installation included in this Section.

* + - * 1. Perform Work according to SMACNA 1884 “Fibrous Glass Duct Construction Standards” and 1966.

Consider using NFPA 90B for one- or two-family dwellings, spaces not exceeding 25,000 cu. ft, and buildings of combustible construction up to three stories in height. Consider using NFPA 96 for commercial kitchens.

* + - * 1. Construct ductwork to [**NFPA 90A**] [**, NFPA 90B**] [**, and**] [**NFPA 96**] [**standard**] [**standards**].

In following paragraph insert "State of \_\_\_\_\_\_\_\_ Department of Transportation," "Municipality of \_\_\_\_\_\_\_\_ Department of Public Works," or other agency as appropriate.

* + - * 1. Perform Work according to <**\_\_\_\_\_\_\_\_**> standards.

Include following paragraph only when cost of acquiring specified standards is justified.

* + - * 1. Maintain <**\_\_\_\_\_\_\_\_**> [**copy**] [**copies**] of each standard affecting Work of this Section on Site.
			1. QUALIFICATIONS

Coordinate following paragraphs with requirements specified in SUBMITTALS Article.

* + - * 1. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum [**three**] <**\_\_\_\_\_\_\_\_**> years' [**documented**] experience.
				2. Installer: Company specializing in performing Work of this Section with minimum [**three**] <**\_\_\_\_\_\_\_\_**> years' [**documented**] experience [**and approved by manufacturer**].
				3. Welders: AWS qualified within previous 12 months for employed weld types.
				4. Licensed Professional: [**Professional Engineer**] <**\_\_\_\_\_\_\_\_**> experienced in design of specified Work and licensed [**at Project location**] [**in State of <\_\_\_\_\_\_\_\_>**].
			1. DELIVERY, STORAGE, AND HANDLING
				1. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
				2. Store materials according to manufacturer instructions.
				3. Protection:

Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

Provide additional protection according to manufacturer instructions.

* + - 1. AMBIENT CONDITIONS
				1. Section 015000 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.
				2. Minimum Conditions: Do not install duct sealant when temperatures are less than those recommended by sealant manufacturer.
				3. Subsequent Conditions: Maintain temperatures during and after installation of duct sealant.
			2. EXISTING CONDITIONS
				1. Field Measurements:

Verify field measurements prior to fabrication.

Indicate field measurements on Shop Drawings.

* + - 1. WARRANTY

This Article extends warranty period beyond one year. Extended warranties may increase construction costs and Owner enforcement responsibilities. Specify warranties with caution.

* + - * 1. Furnish [**five**] <**\_\_\_\_\_\_\_\_**>-year manufacturer's warranty for ducts.
1. PRODUCTS
	* + 1. DUCTS
				1. Performance and Design Criteria:

Restrict statements to identify system performance requirements or functional criteria only.

Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission of [**Director’s Representative**].

Size round ducts installed in place of rectangular ducts according to ASHRAE Handbook - Fundamentals.

* + - * 1. Materials:

Insert required coating designation when specifying galvanized steel. Use G (Z) coating classes for zinc coatings and A (ZF) coating classes for zinc-iron alloy coatings for reduced spangle.

* + - * 1. Galvanized-Steel Ducts:

Material: ASTM A653 “Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process” galvanized-steel sheet.

Quality: Lock forming.

Finish: [**G60**] [**G90**] zinc coating according to ASTM A90 “Standard Test Method for Weight [**Mass**] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings”.

* + - * 1. Steel Ducts: Comply with ASTM [**A1008**] [**A1011**] [**A568**].
				2. Aluminum Ducts:

Material: ASTM B209 “Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate” aluminum sheet Alloy 3003-H14.

Connectors and Bar Stock: Aluminum Alloy 6061-T6 or equivalent strength.

* + - * 1. Stainless-Steel Ducts: Comply with ASTM [**A240**] [**A666**], Type [**304**] [**316**] <**\_\_\_\_\_\_\_\_**>.
				2. Concrete Ducts:

Description: Hub-and-spigot concrete sewer pipe with ASTM C443 “Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets” joints and rubber gaskets.

Comply with ASTM C14 “Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe”.

* + - * 1. Fasteners: Rivets, bolts, or sheet metal screws.
				2. Hanger Rod:

Material: [**Galvanized**] steel.

Comply with ASTM A36 “Standard Specification for Carbon Structural Steel”.

Type: Threaded [**both ends**] [**one end**] [**continuously**].

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

In following paragraph insert "State of \_\_\_\_\_\_\_\_ Department of Transportation," "Municipality of \_\_\_\_\_\_\_\_ Department of Public Works," or other agency as appropriate.

* + - * 1. Furnish materials according to <**\_\_\_\_\_\_\_\_**> standards.
			1. GLASS-FIBER DUCTS
				1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

CertainTeed; SAINT-GOBAIN.

Johns Manville; a Berkshire Hathaway company.

Knauf Insulation.

Owens Corning.

Approved equivalent.

Insert descriptive specifications below to identify Project requirements and to eliminate conflicts with products specified above.

* + - * 1. Description:

Rigid glass fiber with aluminum foil, glass scrim, and kraft or plastic jacket vapor barrier.

Comply with UL 181 “Factory-Made Air Ducts and Air Connectors.

Thickness: [**1 inch**] [**1-1/2 inches**] [**<\_\_\_\_\_\_\_\_> inches**].

Maximum Thermal Conductivity: [**0.23**] <**\_\_\_\_\_\_\_\_**> Btu/sq. ft. x h x deg. F at 75 degrees F.

* + - 1. FLEXIBLE DUCTS
				1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

McGill AirFlow LLC.

Thermaflex; a Flex-Tek Group company.

Ward Industries; a brand of Hart & Cooley, Inc.

Approved equivalent.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

In following subparagraph insert "State of \_\_\_\_\_\_\_\_ Department of Transportation," "Municipality of \_\_\_\_\_\_\_\_ Department of Public Works," or other agency as appropriate.

Furnish materials according to <**\_\_\_\_\_\_\_\_**> standards.

Insert descriptive specifications below to identify Project requirements and to eliminate conflicts with products specified above.

* + - * 1. Description:

Two-ply vinyl film supported by helical-wound spring steel wire.

Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.

Maximum Velocity: 4,000 fpm.

Temperature Range: Minus 10 to plus 160 degrees F.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Description:

UL-labeled black polymer film supported by helical-wound spring steel wire.

Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.

Maximum Velocity: 4,000 fpm.

Temperature Range: Minus 20 to plus 175 degrees F.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Description:

UL-labeled multiple layers of aluminum laminate supported by helical-wound spring steel wire.

Pressure Rating: 10-inch wg positive and 1.0-inch negative.

Maximum Velocity: 4,000 fpm.

Temperature Range: Minus 20 to plus 210 degrees F.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Description:

UL 181 “Factory-Made Air Ducts and Air Connectors”, Class 1, aluminum laminate and polyester film with latex adhesive supported by helical-wound spring steel wire.

Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.

Maximum Velocity: 4,000 fpm.

Temperature Range: Minus 20 to plus 210 degrees F.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Description:

UL 181 “Factory-Made Air Ducts and Air Connectors”, Class 0, interlocking spiral of aluminum foil.

Pressure Rating: 8-inch wg positive or negative.

Maximum Velocity: 5,000 fpm.

Temperature Range: Minus 100 to plus 432 degrees F.

* + - 1. INSULATED FLEXIBLE DUCTS
				1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

McGill AirFlow LLC.

Thermaflex; a Flex-Tek Group company.

Ward Industries; a brand of Hart & Cooley, Inc.

Approved equivalent.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

In following subparagraph insert "State of \_\_\_\_\_\_\_\_ Department of Transportation," "Municipality of \_\_\_\_\_\_\_\_ Department of Public Works," or other agency as appropriate.

Furnish materials according to <**\_\_\_\_\_\_\_\_**> standards.

Insert descriptive specifications below to identify Project requirements and to eliminate conflicts with products specified above.

* + - * 1. Description:

Two-ply vinyl film supported by helical-wound spring steel wire.

Insulation: Fiberglass.

Vapor Barrier Film: [**Polyethylene (PE)**] [**Aluminized**].

Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.

Maximum Velocity: 4,000 fpm.

Temperature Range: Minus 10 to plus 160 degrees F.

Thermal Resistance: <**\_\_\_\_\_\_\_\_**> sq. ft. x h x deg. F/Btu.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Description:

Black polymer film supported by helical-wound spring steel wire.

Insulation: Fiberglass.

Vapor Barrier Film: [**PE**] [**Aluminized**].

Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.

Maximum Velocity: 4,000 fpm.

Temperature Range: Minus 20 to plus 175 degrees F.

Thermal Resistance: <**\_\_\_\_\_\_\_\_**> sq. ft. x h x deg. F/Btu.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Description:

Multiple layers of aluminum laminate supported by helical-wound spring steel wire.

Insulation: Fiberglass.

Vapor Barrier Film: [**PE**] [**Aluminized**].

Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.

Maximum Velocity: 4,000 fpm.

Temperature Range: Minus 20 to plus 210 degrees F.

Thermal Resistance: <**\_\_\_\_\_\_\_\_**> sq. ft. x h x deg. F/Btu.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Description:

UL 181 “Factory-Made Air Ducts and Air Connectors, Class 1, aluminum laminate and polyester film with latex adhesive supported by helical-wound spring steel wire.

Insulation: Fiberglass.

Vapor Barrier Film: [**PE**] [**Aluminized**].

Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.

Maximum Velocity: 4,000 fpm.

Temperature Range: Minus 20 to plus 210 degrees F.

Thermal Resistance: <**\_\_\_\_\_\_\_\_**> sq. ft. x h x deg. F/Btu.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Description:

UL 181 “Factory-Made Air Ducts and Air Connectors”, Class 0, interlocking spiral of aluminum foil.

Insulation: Fiberglass.

Vapor Barrier Film: [**PE**] [**Aluminized**].

Pressure Rating: 8-inch wg positive or negative.

Maximum Velocity: 5,000 fpm.

Temperature Range: Minus 20 to plus 250 degrees F.

Thermal Resistance: <**\_\_\_\_\_\_\_\_**> sq. ft. x h x deg. F/Btu.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Description:

UL 181 “Factory-Made Air Ducts and Air Connectors”, Class 1, constructed with interior liner of round corrugated steel or aluminum duct.

Insulation: Exterior fiberglass.

Vapor Barrier Film: Vinyl.

Pressure Rating: 10-inch wg positive or negative.

Maximum Velocity: 4,000 fpm.

Temperature Range: Minus 20 to plus 210 degrees F.

Thermal Resistance: <**\_\_\_\_\_\_\_\_**> sq. ft. x h x deg. F/Btu.

Furnish each flexible duct section with integral clamping devices for connection to round or oval fittings.

* + - 1. SINGLE-WALL, SPIRAL ROUND DUCTS

This type of duct is also available in Type 304 or 316 stainless steel and aluminum. Modify duct gages to suit Project conditions.

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Elgen Manufacturing.

GreenSeam.

Linx Industries; a DMI company (formerly Lindab).

MKT Metal Manufacturing.

McGill AirFlow LLC.

Nordfab Ducting.

SEMCO, LLC; part of FlaktGroup.

SHAPE Manufacturing Inc.

Set Duct Manufacturing.

Sheet Metal Connectors, Inc.

Spiral Manufacturing Co., Inc.

Stamped Fittings Inc.

Approved equivalent.

Insert descriptive specifications below to identify Project requirements and to eliminate conflicts with products specified above.

* + - * 1. Description:

UL 181 “Factory-Made Air Ducts and Air Connectors”, Class 1, round spiral lockseam duct.

Material: Galvanized steel.

Following paragraph specifies optional coating for steel ductwork for use in underground or corrosive applications.

* + - * 1. Duct Coating:

Material: PVC.

Thickness: 4 mils on outside and [**2 mils**] [**1 mil**] on inside.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Thickness: [**2 mils**] [**1 mil**] on both inside and outside.

Temperature Range: Minus 30 to plus 200 degrees F.

Edit following list to reflect duct sizes applicable to Project.

* + - * 1. Minimum Duct Wall Thicknesses:

Diameter 2 to 14 Inches 26 gage.

16 to 26 Inches 24 gage.

28 to 36 Inches 22 gage.

38 to 50 Inches 20 gage.

52 to 60 Inches 18 gage.

* + - * 1. Minimum Fittings Wall Thicknesses:

Diameter 2 to 14 Inches 24 gage.

16 to 26 Inches 22 gage.

28 to 36 Inches 20 gage.

38 to 50 Inches 20 gage.

52 to 60 Inches 18 gage.

* + - 1. SINGLE-WALL, SPIRAL FLAT OVAL DUCTS

This type of duct is also available in Type 304 or 316 stainless steel and aluminum. Modify duct thicknesses to suit Project conditions.

* + - * 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Elgen Manufacturing.

GreenSeam.

Linx Industries; a DMI company (formerly Lindab).

MKT Metal Manufacturing.

McGill AirFlow LLC.

Nordfab Ducting.

SEMCO, LLC; part of FlaktGroup.

SHAPE Manufacturing Inc.

Set Duct Manufacturing.

Sheet Metal Connectors, Inc.

Spiral Manufacturing Co., Inc.

Stamped Fittings Inc.

Approved equivalent.

Insert descriptive specifications below to identify Project requirements and to eliminate conflicts with products specified above.

* + - * 1. Description:

Machine made from round spiral lockseam duct.

Material: Galvanized steel.

Pressure Rating: 10-inch wg.

* + - * 1. Joints:

Type: Fully welded or bolted flange.

Gasket Material: As recommended by manufacturer.

Edit following list to reflect duct sizes applicable to Project.

* + - * 1. Minimum Duct Wall Thicknesses:

Major Axis Dimension 7 to 24 Inches 24 gage.

Major Axis Dimension 25 to 48 Inches 22 gage.

Major Axis Dimension 50 to 70 Inches 20 gage.

Major Axis Dimension 72 to 82 Inches 18 gage.

Major Axis Dimension 84 Inches 16 gage.

* + - * 1. Minimum Fittings Wall Thicknesses:

Major Axis Dimension 7 to 36 Inches 20 gage.

Major Axis Dimension 37 to 60 Inches 18 gage.

Major Axis Dimension 62 Inches 16 gage.

* + - 1. DOUBLE-WALL, INSULATED, SPIRAL ROUND DUCTS
				1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Linx Industries; a DMI company (formerly Lindab).

MKT Metal Manufacturing.

McGill AirFlow LLC.

SEMCO, LLC; part of FlaktGroup.

SHAPE Manufacturing Inc.

Set Duct Manufacturing.

Sheet Metal Connectors, Inc.

Approved equivalent.

Insert descriptive specifications below to identify Project requirements and to eliminate conflicts with products specified above.

* + - * 1. Description:

Machine made from round spiral lockseam duct with light reinforcing corrugations and galvanized-steel outer wall.

Insulation:

Material: Glass fiber.

Thickness: [**1 inch**] [**2 inches**] [**3 inches**].

Inner Wall: [**Perforated**] [**Solid**] galvanized steel.

Fittings: [**Perforated**] [**Solid**] inner wall.

Following paragraph is optional coating for steel ductwork for use in underground or corrosive applications.

* + - * 1. Duct Coating:

Material: PVC.

Thickness: 4 mils on outside and [**2 mils**] [**1 mil**] on inside.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Thickness: [**2 mils**] [**1 mil**] on both inside and outside.

Temperature Range: Minus 30 to plus 200 degrees F.

Edit following list to reflect duct sizes applicable to Project.

* + - * 1. Minimum Duct Wall Thicknesses:

Diameter 2 to 14 Inches 26 gage.

Diameter 16 to 26 Inches 24 gage.

Diameter 28 to 36 Inches 22 gage.

Diameter 38 to 50 Inches 20 gage.

Diameter 52 to 60 Inches 18 gage.

* + - * 1. Minimum Fittings Wall Thicknesses:

Diameter 2 to 14 Inches 24 gage.

Diameter 16 to 26 Inches 22 gage.

Diameter 28 to 50 Inches 20 gage.

Diameter 52 to 60 Inches 18 gage.

* + - 1. DOUBLE-WALL, INSULATED, SPIRAL FLAT OVAL DUCTS
				1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Linx Industries; a DMI company (formerly Lindab).

MKT Metal Manufacturing.

McGill AirFlow LLC.

SEMCO, LLC; part of FlaktGroup.

SHAPE Manufacturing Inc.

Set Duct Manufacturing.

Sheet Metal Connectors, Inc.

Approved equivalent.

Insert descriptive specifications below to identify Project requirements and to eliminate conflicts with products specified above.

* + - * 1. Description:

Machine made from round spiral lockseam duct with light reinforcing corrugations and galvanized-steel outer wall.

Insulation:

Material: Glass fiber.

Thickness: [**1 inch**] [**2 inches**] [**3 inches**].

Inner Wall: [**Perforated**] [**Solid**] galvanized steel.

Fittings: [**Perforated**] [**Solid**] inner wall.

* + - * 1. Minimum Duct Wall Thicknesses:

Major Axis Dimension 7 to 24 Inches 24 gage.

Major Axis Dimension 25 to 48 Inches 22 gage.

Major Axis Dimension 50 to 70 Inches 20 gage.

Major Axis Dimension 72 to 82 Inches 18 gage.

Major Axis Dimension 84 Inches 16 gage.

* + - * 1. Minimum Fittings Wall Thicknesses:

Major Axis Dimension 7 to 36 Inches 20 gage.

Major Axis Dimension 37 to 60 Inches 18 gage.

Major Axis Dimension 62 Inches 16 gage.

* + - 1. GLASS-FIBER-REINFORCED PLASTIC ROUND DUCTS

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Linx Industries; a DMI company (formerly Lindab).

MKT Metal Manufacturing.

McGill AirFlow LLC.

SEMCO, LLC; part of FlaktGroup.

SHAPE Manufacturing Inc.

Set Duct Manufacturing.

Sheet Metal Connectors, Inc.

Approved equivalent.

Insert descriptive specifications below to identify Project requirements and to eliminate conflicts with products specified above.

* + - * 1. Description:

Filament wound glass-fiber-reinforced plastic with fire-retardant thixotropic resin.

[**Flame-spread index of less than 25**] [**Smoke-developed index of less than 50**] when tested according to ASTM E84 “Standard Test Method for Surface Burning Characteristics of Building Materials”.

* + - * 1. Minimum Duct and Fittings Wall Thicknesses:

Diameter 4 to 20 Inches 0.188 inch.

Diameter 22 to 36 Inches 0.220 inch.

Diameter 42 to 60 Inches 0.250 inch.

Select first option in following paragraph for underground duct installations.

* + - * 1. Joints: [**Galvanized sheet metal sleeve located inside duct, sealed and secured with screws**] [**Flanged**] <**\_\_\_\_\_\_\_\_**>.
			1. DOUBLE-WALL, INSULATED, GLASS-FIBER-REINFORCED PLASTIC ROUND DUCTS
				1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

FPR Solutions by Monoxivent

Virtual Polymer Compounds

Insert descriptive specifications below to identify Project requirements and to eliminate conflicts with products specified above.

* + - * 1. Description:

Inner and Outer Walls: Filament-wound glass-fiber-reinforced plastic with fire-retardant thixotropic resin.

[**Flame-spread index of less than 25**] [**Smoke-developed index of less than 50**] when tested according to ASTM E84 “Standard Test Method for Surface Burning Characteristics of Building Materials.

* + - * 1. Minimum Duct and Fittings Wall Thicknesses:

Diameter 4 to 20 Inches 0.188 inch.

Diameter 22 to 36 Inches 0.220 inch.

Diameter 42 to 60 Inches 0.250 inch.

* + - * 1. Insulation:

Thermal Resistance: [**5.4**] <**\_\_\_\_\_\_\_\_**> sq. ft. x h x deg. F/Btu.

Thickness: [**3/4**] <**\_\_\_\_\_\_\_\_**> inch.

Select first option in following paragraph for underground duct installations.

* + - * 1. Joints: [**Galvanized sheet metal sleeve located inside duct, sealed and secured with screws**] [**Flanged**] <**\_\_\_\_\_\_\_\_**>.
			1. SLAB DUCT VENTILATION SYSTEM
				1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Eccoduct

Approved equivalent.

Insert descriptive specifications below to identify Project requirements and to eliminate conflicts with products specified above.

Insert required coating designation if specifying galvanized steel. Use G (Z) coating classes for zinc coatings and A (ZF) coating classes for zinc-iron alloy coatings for reduced spangle.

* + - * 1. Description:

Material: Galvanized steel with <**\_\_\_\_\_\_\_\_**> coating class.

Comply with ASTM A653 “Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process”.

Type: Corrugated.

Furnish support brackets, connecting couplings, elbows, end caps, spin-in collar, and wall and soffit discharge heads.

Design: For installation in cast-in-place concrete floor assemblies.

TRANSVERSE DUCT CONNECTION SYSTEM

* + - * 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

HVAC for Life

Multiline group of companies

Approved equivalent.

Insert descriptive specifications below to identify Project requirements and to eliminate conflicts with products specified above.

* + - * 1. Description:

Interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.

Rigidity Class Connection: SMACNA [**"E."**] [**"F."**] [**"J."**]

* + - 1. CASINGS
				1. Fabricate casings according to SMACNA 1966 “HVAC Duct Construction Standards - Metal and Flexible” and construct for indicated operating pressures.
				2. Doors:

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.

[**Furnish clear wire glass observation ports minimum 6 by 6 inches in size.**]

* + - * 1. Acoustic Casings:

Fabricate acoustic casings with reinforcing turned inward.

Furnish 16-gage back facing and 22-gage perforated front facing, with 3/32-inch-diameter holes at 5/32 inch o.c.

Construct panels 3 inches thick and packed with 4.5-pcf minimum glass-fiber media, on 16-gage inverted channels.

* + - 1. FABRICATION

Consider using following paragraph for contractor-fabricated rectangular ducts.

* + - * 1. Rectangular Ducts:

According to SMACNA 1966 “HVAC Duct Construction Standards - Metal and Flexible” [**and as indicated on Drawings**].

Provide duct material, gages, reinforcing, and sealing for indicated operating pressures.

Consider using following paragraph for contractor-fabricated round ducts. Note that longitudinal seam-type, not spiral-type, round duct is specified in following paragraph. SMACNA includes section on round duct construction standards that provide wall thicknesses by duct size.

* + - * 1. Round Ducts:

According to SMACNA 1966 “HVAC Duct Construction Standards - Metal and Flexible” [**and as indicated on Drawings**].

Seams: Longitudinal.

Provide duct material, gages, reinforcing, and sealing for indicated operating pressures.

* + - * 1. Tees, Bends, and Elbows:

Minimum Radius:

1-1/2 times centerline duct width.

If not possible or if rectangular elbows are used, provide [**airfoil**] turning vanes.

If acoustical lining is indicated, furnish turning vanes of perforated metal with glass-fiber insulation.

* + - * 1. Divergence:

Increase duct sizes gradually, not exceeding 15 degrees of divergence wherever possible.

Upstream of Equipment: Maximum 30 degrees.

Downstream of Equipment: Maximum 45 degrees.

* + - * 1. Welding:

Continuously Welded Round and Oval Duct Fittings: Two gages heavier than duct gages according to SMACNA 1966 “HVAC Duct Construction Standards - Metal and Flexible”.

Cemented Slip Joints:

Minimum 4 inches.

Brazed or electric welded.

Prime coat welded joints.

* + - * 1. Takeoffs:

Provide standard 45-degree lateral wye takeoffs.

If not possible due to space limitations, provide 90-degree conical tee connections.

* + - * 1. Sealing:

Seal joints between duct sections and duct seams with welds, gaskets, mastic adhesives, mastic plus embedded fabric systems, or tape.

Sealants, Mastics, and Tapes: Comply with UL 181A “Closure Systems for Use With Rigid Air Ducts” and provide products bearing appropriate UL 181A “Closure Systems for Use With Rigid Air Ducts” markings.

* + - * 1. Glass-Fiber Ducts:

Fabricate according to SMACNA 1884 “Fibrous Glass Duct Construction Standards “[**, except as indicated on Drawings**].

Tape: [**2-inch-wide pressure-sensitive tape, according to UL 181A**] [**3-inch-wide heat-activated chemical bonding tape**].

Machine-fabricate glass-fiber ducts and fittings; only minor on-Site adjustments are permitted.

Staples for Duct Joints and Tape:

Material: Aluminum.

Size: [**3 inches wide by 2 mils thick**] [**2 inches wide by 3 mils thick**].

Do not use glass-fiber ducts within 12 inches of electric- or fuel-fired heaters.

* + - * 1. Buried Ducts:

Material: [**Concrete-encased sheet metal**] [**PVC-jacketed sheet metal**] [**Glass-fiber-reinforced plastic**] [**Concrete**] [**As indicated on Drawings**].

Metal Ductwork:

According to SMACNA 1966 “HVAC Duct Construction Standards - Metal and Flexible “[**, except as indicated on Drawings**].

Using two gages heavier material than indicated for 2-inch wg pressure class.

* + - * 1. Kitchen Hood Exhaust Ducts:

Comply with SMACNA 1767 “Kitchen Ventilation Systems and Food Service Equipment Guidelines” and NFPA 96 “Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations”.

Exposed Ducts:

Material: Stainless steel, ASTM A240 “Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications”.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Material: ASTM 666, Type [**304**] [**316**] <**\_\_\_\_\_\_\_\_**>.

Joints: Continuous external weld.

Concealed Kitchen Hood Exhaust Ducts:

Material: 16-gage carbon steel.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Material: 18-gage stainless steel, ASTM A240 “Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications” or ASTM 666, Type [**304**] [**316**] <**\_\_\_\_\_\_\_\_**>.

Joints: Continuous external weld.

Consider retaining following paragraph if cooking grease duct is required.

* + - * 1. Grease Ducts: Factory-built commercial grease ducts labeled and listed according to UL 1978 “Grease Ducts”.
			1. ACCESSORIES

Specify fasteners, adhesives, and other installation accessories that are not usually an integral part of principal products specified in this Section. Include tools furnished by manufacturer that are required to install products.

* + - * 1. Hangers and Supports:

Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

Strap and Rod Sizes:

Comply with SMACNA 1966 “HVAC Duct Construction Standards - Metal and Flexible.

Glass-Fiber-Reinforced Ducts: Comply with SMACNA 1884 “Fibrous Glass Duct Construction Standards”.

Trapeze and Riser Supports:

Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

Supports for Aluminum Ducts: Aluminum or galvanized steel, coated with zinc chromate.

1. EXECUTION
	* + 1. EXAMINATION
				1. Verify sizes of equipment connections before fabricating transitions.
			2. PREPARATION
				1. Obtain manufacturer's inspection and acceptance of fabrication and installation at beginning of installation.
				2. Install temporary closures of metal or taped PE on open ductwork to prevent construction dust from entering ductwork system.
			3. INSTALLATION
				1. Install and seal ducts according to SMACNA 1966 “HVAC Duct Construction Standards - Metal and Flexible”.
				2. Glass-Fiber-Reinforced Ducts: Comply with SMACNA 1884 “Fibrous Glass Duct Construction Standards”.
				3. Insulated Flexible Duct Fittings:

Join each flexible duct section to main trunk duct through sheet metal fittings.

Material: Galvanized steel.

Equip fittings with factory-installed volume damper having positive locking regulator.

Provide insulation guard with fittings installed in lined ductwork.

* + - * 1. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes [**8**] <**\_\_\_\_\_\_\_\_**> inches and smaller.
				2. Hanger and Supports:

Fabricate and support ducts according to SMACNA [**1884**] [**and**] [**1966**].

Threaded Rods: Provide double nuts and lock washers.

Building Attachments:

Provide concrete inserts or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

If possible, install concrete inserts before placing concrete.

Powder-Actuated Concrete Fasteners:

Use only for slabs more than 4 inches thick.

Install after concrete is placed and completely cured.

Do not use powder-actuated concrete fasteners for seismic restraints.

Hanger Spacing:

Comply with SMACNA [**1884**] [**and**] [**1966**].

Install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

Extend strap supports down both sides of ducts and turn under bottom at least 1 inch.

Secure hanger to sides and bottom of ducts with sheet metal screws.

Hangers Exposed to View: Provide threaded rod and angle or channel supports.

Vertical Ducts:

Support with steel angles or channel secured to sides of duct with welds, bolts, sheet metal screws, or blind rivets.

Support at each floor and at maximum intervals of 16 feet.

Upper Attachments:

Attach to structures.

Selection and Sizing: Provide pull-out, tension, and shear capacities as required for supported loads and building materials.

Penetrations:

Avoid penetrations of ducts with hanger rods.

If unavoidable, provide airtight rubber grommets at penetrations.

* + - * 1. Buried Ducts:

Slope to plenums or low pump-out points at slope of [**1:500**] <**\_\_\_\_:\_\_\_\_**>.

Provide access doors for inspection.

Painting of Metal Ductwork without Factory Jacket:

One coat asphalt-based protective coating.

Seams and Joints: Two coats asphalt-based protective coating.

* + - * 1. Connect flexible ducts to metal ducts with [**adhesive**] [**liquid adhesive and tape**] [**draw bands**] [**adhesive plus sheet metal screws**].
				2. Plenum Doors:

Location: 6 to 12 inches above floor.

Arrange door swing such that fan static pressure holds door in closed position.

* + - * 1. Casings:

Floor Mounting:

Install on [**4**] <**\_\_\_\_\_\_\_\_**>-inch-high concrete curbs as specified in Section 033000 - Cast-in-Place Concrete.

At floor, rivet panels to angles 8 inches o.c.

If floors are acoustically insulated, provide liner of 18-gage galvanized expanded metal mesh, supported 12 inches o.c. and turned up 12 inches at sides with sheet metal shields.

* + - * 1. Kitchen Range Hoods:

According to NFPA 96 “Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations” and as specified in Section 114000 - Foodservice Equipment.

Provide residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for cleanout.

Exhaust Ducts: Provide stainless-steel ductwork where exposed to view, and stainless steel or carbon steel where ducts are concealed.

* + - * 1. Outdoor Ductwork: Protect ductwork and ductwork supports, linings, and coverings from weather.
				2. Exhaust Outlet Locations:

Minimum Distance from Property Lines: 3 feet.

Minimum Distance from Building Openings: 3 feet.

Minimum Distance from Outside Air Intakes: 10 feet.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

In following paragraph insert "State of \_\_\_\_\_\_\_\_ Department of Transportation," "Municipality of \_\_\_\_\_\_\_\_ Department of Public Works," or other agency as appropriate.

* + - * 1. Installation Standards: Install Work according to <**\_\_\_\_\_\_\_\_**> standards.
				2. Interface with Other Work:

Install openings in ductwork as required to accommodate thermometers and controllers.

Install pitot tube openings for testing of systems, complete with metal can with spring device or screw to prevent air leakage.

If openings are provided in insulated ductwork, install insulation material inside metal ring.

Connect diffusers or light troffer boots to low-pressure ducts [**directly or**] with 5-foot maximum length of flexible duct held in place with strap or clamp.

Connect [**air terminal units**] [**air outlets and inlets**] to supply ducts [**directly or**] with 5-foot maximum length of flexible duct; do not use flexible duct to change direction.

* + - 1. FIELD QUALITY CONTROL
				1. Testing:

Ductwork Designed for 3-Inch wg above Ambient Pressure:

Pressure test minimum 25 percent of ductwork after duct cleaning but before duct insulation is applied or ductwork is concealed.

Comply with SMACNA 016 “HVAC Air Duct Leakage Test Manual”.

Maximum Allowable Leakage: According to IECC “International Energy Conservation Code”.

Consider retaining following paragraph if cooking grease duct is required.

Concealed Grease Ducts:

Prior to concealing, wrapping, or insulating grease ductwork, or placing grease duct in service, perform leakage test according to IMC “International Mechanical Code” in presence of authority having jurisdiction.

Perform light test by pulling minimum 100-W light through duct and observing for light leaks at duct joints.

Test complete extent of duct installed, including joint at which duct connects to exhaust hood.

* + - 1. CLEANING
				1. Clean duct system and force air at high velocity through duct to remove accumulated dust.
				2. To obtain sufficient airflow, clean one half of system completely before proceeding to other half.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Consider using following paragraph for large systems only.

* + - * 1. Vacuuming:

Clean duct systems with high-power vacuum machines.

Install access openings into ductwork for cleaning purposes.

* + - * 1. Protect sensitive equipment with temporary filters or bypass during cleaning.
			1. ATTACHMENTS

When relying on separate schedules, tables, illustrations, or forms to specify product requirements, include list of each attachment. Include identical list of attachments in Project Manual table of contents.

Consider including schedule if Project contains more than one air system and pressure class.

Insert attachments following END OF SECTION. Consider following examples when developing Project schedule.

* + - * 1. Ductwork Material Schedule:

Supply - Heating Systems: Steel, aluminum, or fibrous glass.

Supply - Systems with Cooling Coils: Steel, aluminum, or fibrous glass.

Buried Supply or Return Steel: PVC-coated steel, concrete, or glass-fiber-reinforced plastic.

Return and Relief: Steel or aluminum.

General Exhaust: Steel or aluminum.

Kitchen Hood Exhaust: Steel or stainless steel.

Dishwasher Exhaust: Steel, stainless steel, or glass-fiber-reinforced plastic.

Fume Hood Exhaust: Stainless steel or glass-fiber-reinforced plastic.

Outside Air Intake: Steel.

Combustion Air: Steel.

Evaporative Condenser: Steel.

Intake and Exhaust: Steel.

Emergency Generation Ventilation: Steel.

* + - * 1. Ductwork Pressure Class Schedule:

Constant Volume Supply: 1-inch wg, regardless of velocity.

Variable-Volume, Variable-Temperature Supply: 1-inch wg, regardless of velocity.

Variable-Air-Volume Supply - Downstream of VAV Boxes: 1-inch wg, regardless of velocity.

Variable-Air-Volume Supply - Upstream of VAV Boxes: 2-inch wg.

Supply - Heating Systems: 1/2-inch wg.

Supply - Systems with Cooling Coils: 1/2-inch wg.

Buried Supply or Return: 1/2-inch wg.

Return and Relief: 1/2-inch wg.

General Exhaust: 1/2-inch wg.

Dishwasher Exhaust: 1/2-inch wg.

Fume Hood Exhaust: 2-inch wg.

Emergency Generation Ventilation: 1/2-inch wg.

END OF SECTION 233100