CHAPTER 16
DUCT SYSTEMS

User notes:

About this chapter: *Chapter 16 addresses duct construction for HVAC and most exhaust systems. This chapter covers duct materials, duct construction, duct installation, duct insulation properties, duct sealing, above-ground and underground ducts, return air intake locations and air plenums.*

Code development reminder: *Code change proposals to this chapter will be considered by the IRC—Plumbing/Mechanical Code Development Committee during the 2018 (Group A) Code Development Cycle. See explanation on page iv.*

SECTION M1601
DUCT CONSTRUCTION

M1601.1 Duct design. *Duct systems* serving heating, cooling and *ventilation equipment* shall be installed in accordance with the provisions of this section and ACCA Manual D, the appliance manufacturer's installation instructions or other *approved* methods.

[W] M1601.1.1 Above-ground duct systems. Above-ground *duct systems* shall conform to the following:

1. *Equipment* connected to *duct systems* shall be designed to limit discharge air temperature to not greater than 250°F (121°C).
2. Factory-made ducts shall be listed and labeled in accordance with UL 181 and installed in accordance with the manufacturer's instructions.
3. Fibrous glass duct construction shall conform to the SMACNA *Fibrous Glass Duct Construction Standards* or NAIMA *Fibrous Glass Duct Construction Standards.*
4. Field-fabricated and shop-fabricated metal and flexible duct constructions shall conform to the SMACNA HVAC *Duct Construction Standards—Metal and Flexible* except as allowed by Table M1601.1.1. Galvanized steel shall conform to ASTM A653.
5. The use of gypsum products to construct return air ducts or plenums is permitted, provided that the air temperature does not exceed 125°F (52°C) and exposed surfaces are not subject to condensation.
6. *Duct systems* shall be constructed of materials having a flame spread index of not greater than 200.
7. Stud wall cavities and the spaces between solid floor joists shall not be used as a duct or an air plenum in new construction. For existing systems, stud wall cavities and the spaces between solid floor joists to be used as air plenums shall comply with the following conditions:
    7.1. These cavities or spaces shall not be used as a plenum for supply air.
    7.2. These cavities or spaces shall not be part of a required fire-resistance-rated assembly.
    7.3. Stud wall cavities shall not convey air from more than one floor level.
    7.4. Stud wall cavities and joist-space plenums shall be isolated from adjacent concealed spaces by tight-fitting fireblocking in accordance with Section R602.8.
    7.5. Stud wall cavities in the outside walls of building envelope assemblies shall not be utilized as air plenums.
8. Volume dampers, equipment and other means of supply, return and exhaust air adjustment used in system balancing shall be provided with access.

M1601.1.2 Underground duct systems. Underground *duct systems* shall be constructed of *approved* concrete, clay, metal or plastic. The maximum design temperature for systems utilizing plastic duct and fittings shall be 150°F (66°C). Metal ducts shall be protected from corrosion in an *approved* manner or shall be completely encased in concrete not less than 2 inches (51 mm) thick. Nonmetallic ducts shall be installed in accordance with the manufacturer's instructions. Plastic pipe and fitting materials shall conform to cell classification 12454-B of ASTM D1248 or ASTM D1784 and external loading properties of ASTM D2412. Ducts shall slope to a drainage point that has access. Ducts shall be sealed, secured and tested prior to encasing the ducts in concrete or direct burial. Duct tightness shall be verified as required by Section N1103.3. Metallic ducts having an *approved* protective coating and nonmetallic ducts shall be installed in accordance with the manufacturer's instructions.

M1601.2 Vibration isolators. Vibration isolators installed between mechanical *equipment* and metal ducts shall be fabricated from *approved* materials and shall not exceed 10 inches (254 mm) in length.

M1601.3 Duct insulation materials. Duct insulation materials shall conform to the following requirements:

1. Duct coverings and linings, including adhesives where used, shall have a flame spread index not higher than 25, and a smoke-developed index not over 50 when tested in accordance with ASTM E84 or UL 723, using the specimen preparation and mounting procedures of ASTM E2231.

   Exception: Spray application of polyurethane foam to the exterior of ducts in *attics* and crawl spaces shall be permitted subject to all of the following:

   1. The flame spread index is not greater than 25 and the smoke-developed index is not greater than 450 at the specified installed thickness.
   2. The foam plastic is protected in accordance with the ignition barrier requirements of Sections R316.5.3 and R316.5.4.
   3. The foam plastic complies with the requirements of Section R316.

2. Duct coverings and linings shall not flame, glow, smolder or smoke when tested in accordance with ASTM C411 at the temperature to which they are exposed in service. The test temperature shall not fall below 250°F (121°C). Coverings and linings shall be listed and labeled.
3. External reflective duct insulation shall be legibly printed or identified at intervals not greater than 36 inches (914 mm) with the name of the manufacturer, the product *R*-value at the specified installed thickness and the flame spread and smoke-developed indices. The installed thickness of the external duct insulation shall include the enclosed airspace(s). The product *R*-value for external reflective duct insulation shall be determined in accordance with ASTM C1668.
4. External duct insulation and factory-insulated flexible ducts shall be legibly printed or identified at intervals not longer than 36 inches (914 mm) with the name of the manufacturer, the thermal resistance *R*-value at the specified installed thickness and the flame spread and smoke-developed indices of the composite materials. Spray polyurethane foam manufacturers shall provide the same product information and properties, at the nominal installed thickness, to the customer in writing at the time of foam application. Nonreflective duct insulation product *R*-values shall be based on insulation only, excluding air films, vapor retarders or other duct components, and shall be based on tested C-values at 75°F (24°C) mean temperature at the installed thickness, in accordance with recognized industry procedures. The installed thickness of duct insulation used to determine its *R*-value shall be determined as follows:

TABLE M1601.1.1
DUCT CONSTRUCTION MINIMUM SHEET METAL THICKNESS FOR SINGLE DWELLING UNITS[a]

ROUND DUCT DIAMETER (inches)	STATIC PRESSURE			
	1/2-inch water gage		1-inch water gage	
	Thickness (inches)		Thickness (inches)	
	Galvanized	Aluminum	Galvanized	Aluminum
< 12	0.013	0.018	0.013	0.018
12 to 14	0.013	0.018	0.016	0.023
15 to 17	0.016	0.023	0.019	0.027
18	0.016	0.023	0.024	0.034
19 to 20	0.019	0.027	0.024	0.034
RECTANGULAR DUCT DIMENSION (inches)	STATIC PRESSURE			
	1/2-inch water gage		1-inch water gage	
	Thickness (inches)		Thickness (inches)	
	Galvanized	Aluminum	Galvanized	Aluminum
≤ 8	0.013	0.018	0.013	0.018
9 to 10	0.013	0.018	0.016	0.023
11 to 12	0.016	0.023	0.019	0.027
13 to 16	0.019	0.027	0.019	0.027
17 to 18	0.019	0.027	0.024	0.034
19 to 20	0.024	0.034	0.024	0.034

For SI: 1 inch = 25.4 mm, 1 inch water gage = 249 Pa.

a. Ductwork that exceeds 20 inches by dimension or exceeds a pressure of 1 inch water gage shall be constructed in accordance with SMACNA *HVAC Duct*

4.1. For duct board, duct liner and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.

4.2. For ductwrap, the installed thickness shall be assumed to be 75 percent (25-percent compression) of nominal thickness.

4.3. For factory-made flexible air ducts, The installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.

4.4. For spray polyurethane foam, the aged *R*-value per inch measured in accordance with recognized industry standards shall be provided to the customer in writing at the time of foam application. In addition, the total *R*-value for the nominal application thickness shall be provided.

M1601.4 Installation. Duct installation shall comply with Sections M1601.4.1 through M1601.4.10.

M1601.4.1 Joints, seams and connections. Longitudinal and transverse joints, seams and connections in metallic and nonmetallic ducts shall be constructed as specified in SMACNA HVAC *Duct Construction Standards—Metal and Flexible* and NAIMA *Fibrous Glass Duct Construction Standards*. Joints, longitudinal and transverse seams, and connections in ductwork shall be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, liquid sealants or tapes. Tapes and mastics used to seal fibrous glass ductwork shall be *listed* and *labeled* in accordance with UL 181A and shall be marked "181A-P" for pressure-sensitive tape, "181 A-M" for mastic or "181 A-H" for heat-sensitive tape.

Tapes and mastics used to seal metallic and flexible air ducts and flexible air connectors shall comply with UL 181B and shall be marked "181 B-FX" for pressure-sensitive tape or "181 BM" for mastic. Duct connections to flanges of air distribution system equipment shall be sealed and mechanically fastened. Mechanical fasteners for use with flexible nonmetallic air ducts shall comply with UL 181B and shall be marked 181B-C. Crimp joints for round metallic ducts shall have a contact lap of not less than 1 inch (25 mm) and shall be mechanically fastened by means of not less than three sheet-metal screws or rivets equally spaced around the joint.

Closure systems used to seal all ductwork shall be installed in accordance with the manufacturers' instructions.

Exceptions:

1. Spray polyurethane foam shall be permitted to be applied without additional joint seals.
2. Where a duct connection is made that is partially without access, three screws or rivets shall be equally spaced on the exposed portion of the joint so as to prevent a hinge effect.
3. For ducts having a static pressure classification of less than 2 inches of water column (500 Pa), additional closure systems shall not be required for continuously welded joints and seams and locking-type joints and seams. This exception shall not apply to snap-lock and button-lock type joints and seams that are located outside of conditioned spaces.

M1601.4.2 Duct lap. Crimp joints for round and oval metal ducts shall be lapped not less than 1 inch (25 mm) and the male end of the duct shall extend into the adjoining duct in the direction of airflow.

M1601.4.3 Plastic duct joints. Joints between plastic ducts and plastic fittings shall be made in accordance with the manufacturer's installation instructions.

M1601.4.4 Support. Factory-made ducts listed in accordance with UL 181 shall be supported in accordance with the manufacturer's installation instructions. Field- and shop-fabricated fibrous glass ducts shall be supported in accordance with the SMACNA *Fibrous Glass Duct Construction Standards* or the NAIMA *Fibrous Glass Duct Construction Standards*. Field- and shop-fabricated metal and flexible ducts shall be supported in accordance with the SMACNA HVAC *Duct Construction Standards—Metal and Flexible*.

M1601.4.5 Fireblocking. Duct installations shall be fireblocked in accordance with Section R602.8.

M1601.4.6 Duct insulation. Duct insulation shall be installed in accordance with the following requirements:

1. A vapor retarder having a permeance of not greater than 0.05 perm [2.87 ng/(s · m^2 · Pa)] in accordance with ASTM E96, or aluminum foil with a thickness of not less than 2 mils (0.05 mm), shall be installed on the exterior of insulation on cooling supply ducts that pass through unconditioned spaces conducive to condensation except where the insulation is spray polyurethane foam with a water vapor permeance of not greater than 3 perms per inch [1722 ng/(s · m^2 · Pa)] at the installed thickness.
2. Outdoor *duct systems* shall be protected against the elements.
3. Duct coverings shall not penetrate a fireblocked wall or floor.

M1601.4.7 Factory-made air ducts. Factory-made air ducts shall not be installed in or on the ground, in tile or metal pipe, or within masonry or concrete.

M1601.4.8 Duct separation. Ducts shall be installed with not less than 4 inches (102 mm) separation from earth except where they meet the requirements of Section M1601.1.2.

M1601.4.9 Ducts located in garages. Ducts in garages shall comply with the requirements of Section R302.5.2.

M1601.4.10 Flood hazard areas. In flood hazard areas as established by Table R301.2(1), *duct systems* shall be located or installed in accordance with Section R322.1.6.

M1601.5 Under-floor plenums. Under-floor plenums shall be prohibited in new structures. Modification or repairs to under-floor plenums in existing structures shall conform to the requirements of this section.

M1601.5.1 General. The space shall be cleaned of loose combustible materials and scrap, and shall be tightly enclosed. The ground surface of the space shall be covered with a moisture barrier having a thickness of not less than 4 mils (0.1 mm). Plumbing waste cleanouts shall not be located within the space.

Exception: Plumbing waste cleanouts shall be permitted to be located in unvented crawl spaces that receive *conditioned air* in accordance with Section R408.3.

M1601.5.2 Materials. The under-floor space, including the sidewall insulation, shall be formed by materials having flame spread index values not greater than 200 when tested in accordance with ASTM E84 or UL 723.

M1601.5.3 Furnace connections. A duct shall extend from the furnace supply outlet to not less than 6 inches (152 mm) below the combustible framing. This duct shall comply with the provisions of Section M1601.1. A noncombustible receptacle shall be installed below any floor opening into the plenum in accordance with the following requirements:

1. The receptacle shall be securely suspended from the floor members and shall be not more than 18 inches (457 mm) below the floor opening.
2. The area of the receptacle shall extend 3 inches (76 mm) beyond the opening on all sides.
3. The perimeter of the receptacle shall have a vertical lip not less than 1 inch (25 mm) in height at the open sides.

M1601.5.4 Access. Access to an under-floor plenum shall be provided through an opening in the floor with minimum dimensions of 18 inches by 24 inches (457 mm by 610 mm).

M1601.5.5 Furnace controls. The furnace shall be equipped with an automatic control that will start the air-circulating fan when the air in the furnace bonnet reaches a temperature not higher than 150°F (66°C). The furnace shall additionally be equipped with an *approved* automatic control that limits the outlet air temperature to 200°F (93°C).

M1601.6 Independent garage HVAC systems. Furnaces and air-handling systems that supply air to living spaces shall not supply air to or return air from a garage.

SECTION M1602
RETURN AIR

M1602.1 Outdoor air openings. Outdoor intake openings shall be located in accordance with Section R303.5.1. Opening protection shall be in accordance with Section R303.6

M1602.2 Return air openings. Return air openings for heating, ventilation and air-conditioning systems shall comply with all of the following:

1. Openings shall not be located less than 10 feet (3048 mm) measured in any direction from an open combustion chamber or draft hood of another appliance located in the same room or space.
2. The amount of return air taken from any room or space shall be not greater than the flow rate of supply air delivered to such room or space.
3. Return and transfer openings shall be sized in accordance with the appliance or equipment manufacturer's installation instructions, Manual D or the design of the registered design professional.
4. Return air shall not be taken from a closet, bathroom, toilet room, kitchen, garage, mechanical room, boiler room, furnace room or unconditioned attic.

   Exceptions:

   1. Taking return air from a kitchen is not prohibited where such return air openings serve the kitchen only, and are located not less than 10 feet (3048 mm) from the cooking appliances.
   2. Dedicated forced-air systems serving only the garage shall not be prohibited from obtaining return air from the garage.
5. For other than dedicated HVAC systems, return air shall not be taken from indoor swimming pool enclosures and associated deck areas except where the air in such spaces is dehumidified,
6. Taking return air from an unconditioned crawl space shall not be accomplished through a direct connection to the return side of a forced-air furnace. Transfer openings in the crawl space enclosure shall not be prohibited.
7. Return air from one dwelling unit shall not be discharged into another dwelling unit.