

CHAPTER 16

DUCT SYSTEMS

SECTION M1601 DUCT CONSTRUCTION

M1601.1 Duct design. *Duct systems* serving heating, cooling and *ventilation equipment* shall be fabricated in accordance with the provisions of this section and ACCA Manual D or other *approved* methods based on the following:

1. Calculation of the supply air for each room shall be based on the greater of the heating load or sensible cooling load for that room.
2. Duct size shall be determined by the supply air requirements of each room, the available static pressure and the total equivalent length of the various duct runs.
3. Friction loss data shall correspond to the type of material used in duct construction.

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 a maximum of 250°F (121°C) and shall meet the applicable requirements of Section M1601.4 and Table M1601.4.
2. Factory-made air ducts shall be constructed of Class 0 or Class 1 materials as designated in Table M1601.1.1(1) and shall meet the applicable requirements of Section M1601.4 and Table M1601.4.
3. Fibrous duct construction shall conform to the SMACNA Fibrous Glass Duct Construction Standards or NAIMA Fibrous Glass Duct Construction Standards and shall meet the applicable requirements of Section M1601.4 and Table M1601.4.
4. Metallic ducts shall meet the applicable requirements of Section M1601.4 and Table M1601.4. Minimum

thickness of metal duct material shall be as listed in Table M1601.1.1(2). Galvanized steel shall conform to ASTM A 653.

5. 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), that exposed surfaces are not subject to condensation, and that applicable criteria of Section M1601.4 and Table M1601.4 are met.
6. *Duct systems* shall be constructed of materials having a flame spread index not greater than 200.
7. 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 fire blocking in accordance with Section R602.8.
8. Cavities designed to deliver air from or return air to the conditioning system such as plenums, mechanical closets, enclosed support platforms, cases, air shafts, etc. shall be lined with an air barrier and sealed in accordance with the applicable requirements of Section M1601.4 and Table M1601.4 and shall be insulated in accordance with Section 403.2.1 of the *Florida Building Code, Energy Conservation*.

**TABLE M1601.1.1(2)
GAGES OF METAL DUCTS AND PLENUMS USED FOR HEATING OR COOLING^a**

DUCT SIZE	GALVANIZED		ALUMINUM
	Minimum Thickness (inches)	Equivalent Galvanized Sheet No.	Minimum Thickness (inches)
Round ducts and enclosed rectangular ducts			
14 inches or less	0.0157	28	0.0175
16 and 18 inches	0.0187	26	0.018
20 inches and over	0.0236	24	0.023
Exposed rectangular ducts			
14 inches or less	0.0157	28	0.0175
Over 14 ^a inches	0.0187	26	0.018

For SI: 1 inch = 25.4 mm.

a. For duct gages and reinforcement requirements at static pressures of 1/2 inch, 1 inch and 2 inches w.g., SMACNA *Duct Construction Standard*, Tables 2-1; 2-2 and 2-3 shall apply.

TABLE M1601.1.1(1)
CLASSIFICATION OF FACTORY-MADE AIR DUCTS

DUCT CLASS	MAXIMUM FLAME-SPREAD INDEX
0	0
1	25

M1601.1.2 Underground duct systems. Underground *duct systems* shall be constructed of *approved* concrete, clay, metal or plastic. The maximum duct temperature for plastic ducts shall not be greater than 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 installation instructions. Plastic pipe and fitting materials shall conform to cell classification 12454-B of ASTM D 1248 or ASTM D 1784 and external loading properties of ASTM D 2412. All ducts shall slope to an accessible point for drainage. Where encased in concrete, ducts shall be sealed and secured prior to any concrete being poured. Metallic ducts having an *approved* protective coating and nonmetallic ducts shall be installed in accordance with the manufacturer’s installation instructions.

M1601.2 Flexible air ducts and flexible air connectors, general. Flexible air ducts, both metallic and nonmetallic, shall comply with Sections M1601.2.1, M1601.2.2, M1601.2.5 and M1601.2.7. Flexible air connectors, both metallic and nonmetallic, shall comply with Sections M1601.2.3 through M1601.2.7.

M1601.2.1 Flexible air ducts. Flexible air ducts, both metallic and nonmetallic, shall be tested in accordance with UL 181. Such ducts shall be listed and labeled as Class 0 or Class 1 flexible air ducts and shall be installed in accordance with Section M1307.

M1601.2.2 Duct length. Flexible air ducts shall not be limited in length.

M1601.2.3 Flexible air connectors. Flexible air connectors, both metallic and nonmetallic, shall be tested in accordance with UL181. Such connectors shall be listed and labeled as Class 0 or Class 1 flexible air connectors and shall be installed in accordance with Section M1307.

M1601.2.4 Connector length. Flexible air connectors shall be limited in length to 14 feet (4267 mm).

M1601.2.5 Air temperature. The design temperature of air to be conveyed in flexible air ducts and flexible air connectors shall be less than 250°F (121°C).

M1601.2.6 Flexible air duct and air connector clearance. Flexible air ducts and air connectors shall be installed with a minimum clearance to an appliance as specified in the appliance manufacturer’s installation instructions.

M1601.2.7 Penetrations prohibited. Flexible air ducts and flexible air connectors shall not pass through any fire-resistance-rated assembly. Flexible air connectors shall not pass through any wall, floor or ceiling.

M1601.3 Duct insulation materials. See Section 403.2.1 of the *Florida Building Code, Energy Conservation*, for duct insulation *R*-value requirements. 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 E 84 or UL 723, using the specimen preparation and mounting procedures of ASTM E 2231.

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 C 411 at the temperature to which they are exposed in service. The test temperature shall not fall below 250°F (121°C).
 3. 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 indexes 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. All 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:
 - 3.1. For duct board, duct liner and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.
 - 3.2. For ductwrap, the installed thickness shall be assumed to be 75 percent (25-percent compression) of nominal thickness.
 - 3.3. 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.
 - 3.4. 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 Duct installation. An air distribution system shall be designed and installed to supply the required distribution of air. The installation of an air distribution system shall not affect the fire protection requirements specified in the building code. Ducts shall be constructed, braced, reinforced and installed to provide structural strength and durability. All transverse joints, longitudinal seams and fitting connections shall be securely fastened and sealed in accordance with the applicable standards of this section.

All enclosures which form the primary air containment passageways for air distribution systems shall be considered ducts or plenum chambers and shall be constructed and sealed in accordance with the applicable criteria of Table M1601.4 and this section. Duct installation shall comply with Sections M1601.4.1 through M1601.4.13.

See Section 403.2.2. of the *Florida Building Code, Energy Conservation*, for duct testing requirements.

M1601.4.1 Duct installation, general.

M1601.4.1.1 Mechanical fastening. All joints between sections of air ducts and plenums, between intermediate and terminal fittings and other components of air distribution systems, and between subsections of these components shall be mechanically fastened to secure the sections independently of the closure system(s).

M1601.4.1.2 Sealing. Air distribution system components shall be sealed with approved closure systems in accordance with the specific criteria found in Table M1601.4.

M1601.4.1.3 Space provided. Sufficient space shall be provided adjacent to all mechanical components located in or forming a part of the air distribution system to assure adequate access for: (1) construction and sealing in accordance with the requirements of Section M1601.4; (2) inspection; and (3) cleaning and maintenance. A minimum of 4 inches (102 mm) is considered sufficient space around air-handling units.

Exception: Retrofit or replacement units not part of a renovation.

M1601.4.1.4 Product application. Closure products shall be applied to the air barriers of air distribution system components being joined in order to form a continuous barrier or they may be applied in accordance with the manufacturer's instructions or appropriate industry installation standard where more restrictive.

M1601.4.1.5 Surface preparation. The surfaces upon which closure products are to be applied shall be clean and dry in accordance with the manufacturer's installation instructions.

M1601.4.1.6 Approved mechanical attachments. Approved mechanical attachments for air distribution system components include screws, rivets, welds, interlocking joints crimped and rolled, staples, twist in (screw attachment), and compression systems created by bend tabs or screw tabs and flanges or by clinching straps. Mechanical attachments shall be selected from Table M1601.4 to be appropriate to the duct system type.

M1601.4.1.7 Approved closure systems. The following closure systems and materials are approved for air distribution construction and sealing for the applications and pressure classes shown in Table M1601.4.

1. Metal closures.
 - a. Welds applied continuously along metal seams or joints through which air could leak.
 - b. Snaplock seams, and grooved, standing, double-corner, single-corner and Pittsburgh-lock seams, as defined by SMACNA, as well as all other rolled mechanical seams. All seams shall be rolled or crimped.
2. Gasketing, which achieves a 25/50 flame spread/smoke-density-development rating under ASTM E 84 or UL 723, provided that it is used only between mated surfaces which are mechanically fastened with sufficient force to compress the gasket and to fill all voids and cracks through which air leakage would otherwise occur.
3. Mastic closures. Mastics shall be placed over the entire joint between mated surfaces. Mastics shall not be diluted. Approved mastics include the following:
 - a. Mastic or mastic-plus-embedded fabric systems applied to fibrous glass ductboard that are listed and labeled in accordance with UL 181A, Part III.
 - b. Mastic or mastic-plus-embedded fabric systems applied to nonmetal flexible duct that are listed and labeled in accordance with UL 181B, Part II.
 - c. Mastic ribbons, which achieve a 25/50 flame spread/smoke density development rating under ASTM E 84 or UL 723, provided that they may be used only in flange-joints and lap-joints, such that the mastic resides between two parallel surfaces of the air barrier and that those surfaces are mechanically fastened.
4. Tapes. Tapes shall be applied such that they extend not less than 1 inch onto each of the mated surfaces and shall totally cover the joint. When used on rectangular ducts, tapes shall be used only on joints between parallel rigid surfaces and on right angle joints. Approved tapes include the following:
 - a. Pressure-sensitive tapes.
 1. Pressure-sensitive tapes applied to fibrous glass ductboard that are listed and labeled in accordance with UL 181A, Part I.
 2. Pressure-sensitive tapes applied to nonmetal flexible duct that are listed and labeled in accordance with UL 181B, Part I.
 - b. Heat-activated tapes applied to fibrous glass ductboard that are listed and labeled in accordance with UL 181A, Part II.

5. Aerosol sealant. Such sealants shall be installed by manufacturer-certified installers following manufacturer instructions and shall achieve 25/50 flame spread/smoke-density-development ratings under ASTM E 84 or UL 723.
6. Spray polyurethane foam shall be permitted to be applied without additional joint seals.

M1601.4.1.8 Cavities of the building structure. Cavities in framed spaces, such as dropped soffits and walls, shall not be used to deliver air from or return air to the conditioning system unless they contain an air duct insert which is insulated in accordance with Section 403.2.1 of the *Florida Building Code, Energy Conservation*, and

constructed and sealed in accordance with the requirements of Table M1601.4, appropriate for the duct materials used.

Exception: Return air plenums.

M1601.4.2 Plastic duct joints. Reserved.

M1601.4.3 Support.

M1601.4.3.1 Metal ducts. Metal ducts shall be supported by 1/2-inch (13 mm) wide 1-gage metal straps or 12-gage galvanized wire at intervals not exceeding 10 feet (3048 mm) or other approved means.

**TABLE M1601.4
DUCT SYSTEM CONSTRUCTION AND SEALING**

DUCT TYPE/CONNECTION	SEALING REQUIREMENTS	MECHANICAL ATTACHMENT	TEST STANDARD
Metal duct, rigid and flexible Pressures less than 1-inch water gauge	Closure systems as described in Section M1601.4.1.7: 1. Continuous welds. 2. Snaplock seams, and grooved, standing, double-corner, single-corner and Pittsburgh-lock seams and all other rolled mechanical seams. 3. Mastic, mastic-plus-embedded fabric, or mastic ribbons. 4. Gaskets. 5. Pressure-sensitive tape. 6. Aerosol sealant	Mechanical attachments approved: 1. Continuous welds. 2. Snaplock seams, and grooved, standing, double-corner, single-corner and Pittsburgh-lock seams and all other rolled mechanical seams. Crimp joints for round metal ducts shall have a contact lap of at least 1 1/2 inches (38 mm). Round metal ducts shall be mechanically fastened by means of at least three sheet-metal screws or rivets equally spaced around the joint. ¹	SMACNA HVAC Air Duct Leakage Test Manual
Pressures 1-inch water gauge or greater	Closure systems as described in Section M1601.4.1.7: 1. Continuous welds. 2. Mastic or mastic-plus-embedded fabric systems. 3. Gaskets.	Mechanical attachments approved: 1. Continuous welds Round metal ducts shall be mechanically fastened by means of at least three sheet-metal screws or rivets equally spaced around the joint. ¹	
High pressure duct systems designed to operate at pressures greater than 3-inch water gauge (4-inch water gauge pressure class)	The tested duct leakage class, at a test pressure equal to the design duct pressure class rating, shall be equal to or less than Leakage Class 6. Leakage testing may be limited to representative sections of the duct system but in no case shall such tested sections include less than 25 percent of the total installed duct area for the designated pressure class.		
Plastic duct	See Section M1601.1.2.	Joints between plastic ducts and plastic fittings shall be made in accordance with the manufacturer's installation instructions.	ASTM D 2412
Fibrous glass duct, rigid.	All joints, seams and duct wall penetrations between sections of duct and between duct and other distribution system components shall be sealed with closure systems as described in Section M1601.4.1.7: 1. Heat-activated tapes. 2. Pressure-sensitive tapes. 3. Mastics or mastic-plus-embedded fabric systems.	Mechanically fastened per standard to secure the sections independent of the closure system(s). Attachments of ductwork to air-handling equipment shall be by mechanical fasteners in accordance with Section M1601.4.1.1. Where access is limited, two fasteners on one side shall be acceptable.	NAIMA Fibrous Glass Duct Construction Standards. UL 181 UL 181A

continued

**TABLE M1601.4—continued
DUCT SYSTEM CONSTRUCTION AND SEALING**

DUCT TYPE/CONNECTION	SEALING REQUIREMENTS	MECHANICAL ATTACHMENT	TEST STANDARD
Flexible duct systems, nonmetal.	All duct collar fittings shall have a minimum $\frac{5}{8}$ inch (16 mm) integral flange for sealing to other components and a minimum 3-inch (76 mm) shaft for insertion into the inner duct core. Flexible ducts having porous inner cores shall not be used. Exception: Ducts having a nonporous liner between the porous inner core and the outer jacket. Fastening and sealing requirements shall be applied to such intermediate liners.	Flexible nonmetal ducts shall be joined to all other air distribution system components by either terminal or intermediate fittings. Mechanical fasteners for use with flexible nonmetallic air ducts shall comply with UL 181B and shall be marked 181B-C.	
Duct core to duct fitting	The reinforced lining shall be sealed to the duct fitting using one of the following sealing materials which conforms to the approved closure and mechanical attachment requirements of Section M1601.4.1.7: 1. Gasketing. 2. Mastic, mastic-plus-embedded fabric, or mastic ribbons. 3. Pressure-sensitive tape. 4. Aerosol sealants, provided that their use is consistent with UL 181.	The reinforced core shall be mechanically attached to the duct fitting by a drawband installed directly over the wire-reinforced core and the duct fitting. The duct fitting shall extend a minimum of 2 inches (51 mm) into each section of duct core. When the flexible duct is larger than 12 inches (303 mm) in diameter or the design pressure exceeds 1-inch water gauge, the drawband shall be secured by a raised bead or indented groove on the fitting.	UL 181 UL 181B
Duct outer jacket to duct collar fitting	The outer jacket of a flexible duct section shall be secured at the juncture of the air distribution system component and intermediate or terminal fitting in such a way as to prevent excess condensation. The outer jacket of a flexible duct section shall not be interposed between the flange of the duct fitting and the flexible duct, rigid fibrous glass duct board, or sheet metal to which it is mated.		ADC FDPIS
Duct collar fitting to rigid duct	The duct collar fitting's integral flange shall be sealed to the rigid duct board or sheet metal using one of the following closure systems/materials which conforms to the approved closure and mechanical attachment standards of Section M1601.4.1.7: 1. Gasketing. 2. Mastic or mastic-plus-embedded fabric systems. 3. Mastic ribbons when used to attach a duct collar to sheet metal. 4. Pressure-sensitive tape. 5. Aerosol sealants, provided that their use is consistent with UL181.	The duct collar fitting shall be mechanically attached to the rigid duct board or sheet metal by appropriate mechanical fasteners, either screws, spin-in flanges, or dovetail flanges.	
Terminal and intermediate fittings. Fittings and joints between dissimilar duct types	Approved closure systems shall be as designated by air distribution system component material type in Section M1601.4.1.7. Exception: When the components of a joint are fibrous glass duct board and metal duct, including collar fittings and metal equipment housings, the closure systems approved for fibrous glass duct shall be used.		
Terminal fittings and air ducts to building envelope components	Terminal fittings and air ducts which penetrate the building envelope shall be mechanically attached to the structure and sealed to the envelope component penetrated and shall use one of the following closure systems/materials which conform to the approved closure and mechanical application requirements of Section M1601.4.1.7: 1. Mastics or mastic-plus-embedded fabrics. 2. Gaskets used in terminal fitting/grille assemblies which compress the gasket material between the fitting and the wall, ceiling or floor sheathing.		
Air-handling units.	Air-handling units located outside the conditioned space shall be sealed using approved closure systems described in Section M1601.4.1.7 for metallic ducts.	All air-handling units shall be mechanically attached to other air distribution system components.	

continued

**TABLE M1601.4—continued
DUCT SYSTEM CONSTRUCTION AND SEALING**

DUCT TYPE/CONNECTION	SEALING REQUIREMENTS	MECHANICAL ATTACHMENT	TEST STANDARD
Return plenums.	<p>Building cavities which will be used as return air plenums shall meet Section M1601.4.1.8 and shall be lined with a continuous air barrier made of durable nonporous materials. All penetrations to the air barrier shall be sealed with a suitable long-life mastic material.</p> <p>Exception: Surfaces between the plenum and conditioned spaces from which the return/mixed air is drawn.</p> <p>Roof decks above building cavities used as a return air plenum shall be insulated to at least R-19.</p>		
Mechanical closets.	<p>All joints between the air barriers of walls, ceiling, floor and door framing and all penetrations of the air barrier shall be sealed to the air barrier with approved closure systems. Through-wall, through-floor and through-ceiling air passageways into the closet shall be framed and sealed to form an air-tight passageway.</p> <p>Exception: Air passageways into the closet from conditioned space that are specifically designed for return air flow.</p> <p>The following air barriers are approved for use in mechanical closets:</p> <ol style="list-style-type: none"> 1. One-half-inch-thick (12.7 mm) or greater gypsum wallboard, sealed with joint compound over taped joints between gypsum wallboard panels. 2. Other panelized materials having inward facing surfaces with an air porosity no greater than that of a duct product meeting Section 22 of UL 181 which are sealed on all interior surfaces to create a continuous air barrier by one of the following: <ol style="list-style-type: none"> a. Sealants complying with the product and application standards of this table for fibrous glass ductboard or b. A suitable long-life caulk or mastic for all applications. 		
Enclosed support platforms in unconditioned spaces.	<p>Enclosed support platforms located between the return air inlet(s) from conditioned space and the inlet of the air-handling unit or furnace, shall contain a duct section constructed entirely of rigid metal, rigid fibrous glass duct board, or flexible duct which is constructed and sealed according to the applicable requirements of this table and insulated according to the requirements of Section 403.2.1 of the <i>Florida Building Code, Energy Conservation</i>.</p> <ol style="list-style-type: none"> 1. No portion of the building structure, including adjoining walls, floors and ceilings, shall be in contact with the return air stream or function as a component of this duct section. 2. The duct section shall not be penetrated by a refrigerant line, chase, refrigerant line, wiring, pipe or any object other than a component of the air distribution system. 3. Through-wall, through-floor and through-ceiling penetrations into the duct system shall contain a branch duct fabricated of rigid fibrous glass duct board or rigid metal and shall extend to and be sealed by both the duct section and the grille side wall surface. 	The branch duct shall be fabricated and attached to the duct insert in accordance with requirements for the duct type used.	

1. Where a duct connection is made that is partially inaccessible, three screws or rivets shall be equally spaced on the exposed portion of the joint so as to prevent a hinge effect.

M1601.4.3.2 Rigid nonmetal ducts. Rigid nonmetallic ducts shall be supported in accordance with the manufacturer’s installation instructions.

M1601.4.3.3 Flexible ducts. Flexible ducts shall be configured and supported so as to prevent the use of excess duct material, prevent duct dislocation or damage, and prevent constriction of the duct below the rated duct diameter in accordance with the following requirements:

1. Ducts shall be installed fully extended. The total extended length of duct material shall not exceed 5 percent of the minimum required length for that run.

2. Bends shall maintain a center line radius of not less than one duct diameter.

3. Terminal devices shall be supported independently of the flexible duct.

4. Horizontal duct shall be supported at intervals not greater than 5 feet (1524 mm). Duct sag between supports shall not exceed 1/2 inch (12.7 mm) per foot of length. Supports shall be provided within 1 1/2 feet (38 mm) of intermediate fittings and between intermediate fittings and bends. Ceiling joists and rigid duct or equipment may be considered to be supports.

5. Vertical duct shall be stabilized with support straps at intervals not greater than 6 feet (1829 mm).
6. Hangers, saddles and other supports shall meet the duct manufacturer's recommendations and shall be of sufficient width to prevent restriction of the internal duct diameter. In no case shall the material supporting the flexible duct that is in direct contact with it be less than 1½ inches (38 mm) wide.

M1601.4.4 Fireblocking. Duct installations shall be fireblocked in accordance with Section R602.1.2.

M1601.4.5 Duct insulation installation. Duct insulation shall be installed in accordance with the following requirements:

1. A vapor retarder having a maximum permeance of 0.05 perm [2.87 ng/(s · m² · Pa)] in accordance with ASTM E 96, or aluminum foil with a minimum thickness of 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 maximum water vapor permeance of 3 perm per inch [1722 ng/(s · m² · Pa)] at the installed thickness.
2. Exterior *duct systems* shall be protected against the elements.
3. Duct coverings shall not penetrate a fireblocked wall or floor.

M1601.4.6 Factory-made air ducts.

M1601.4.6.1 Prohibited locations. Factory-made air ducts shall not be installed in or on the ground, in tile or metal pipe, or within masonry or concrete.

M1601.4.6.2 [IRC M1601.2.1] 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.

M1601.4.7 Duct separation. Ducts shall be installed with at least 4 inches (102 mm) separation from earth, except where they meet the requirements of Section M1601.1.2.

M1601.4.8 Ducts located in garages. Ducts in garages shall comply with the requirements of Section R302.5.2.

M1601.4.9 Flood hazard areas. In areas prone to flooding, as established by Table R301.2(1), duct systems shall be located or installed in accordance with Section R322.1.6.

M1601.4.10 Condensation. Provisions shall be made to prevent the formation of condensation on the exterior of any duct.

M1601.4.11 Mechanical protection. Ducts installed in locations where they are exposed to mechanical damage by vehicles or from other causes shall be protected by approved barriers.

M1601.4.12 Weather protection. All ducts including linings, coverings and vibration isolation connectors installed

on the exterior of the building shall be adequately protected against the elements.

M1601.4.13 Registers, grilles and diffusers. Duct registers, grilles and diffusers shall be installed in accordance with the manufacturer's installation instructions, and shall have a flame spread rating not over 25 without evidence of continued progressive combustion and a smoke-developed rating not over 50 when tested in accordance with ASTM E 84. Balancing dampers or other means of supply air adjustment shall be provided in the branch ducts or at each individual duct register, grille or diffuser.

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 minimum thickness of 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 E 84.

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 not be 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 at least 1 inch (25 mm) high 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 Return air. Return air shall be taken from inside the *dwelling*. Dilution of return air with outdoor air shall be permitted.

M1602.2 Prohibited sources. Outdoor and return air for a forced-air heating or cooling system shall not be taken from the following locations:

1. Closer than 10 feet (3048 mm) to an *appliance* vent outlet, a vent opening from a plumbing drainage system or the discharge outlet of an exhaust fan, unless the outlet is 3 feet (914 mm) above the outside air inlet.
2. Where flammable vapors are present; or where located less than 10 feet (3048 mm) above the surface of any abutting public way or driveway; or where located at grade level by a sidewalk, street, alley or driveway.
3. A room or space, the volume of which is less than 25 percent of the entire volume served by the system. Where connected by a permanent opening having an area sized in accordance with ACCA Manual D, adjoining rooms or spaces shall be considered as a single room or space for the purpose of determining the volume of the rooms or spaces.

Exception: The minimum volume requirement shall not apply where the amount of return air taken from a room or space is less than or equal to the amount of supply air delivered to the room or space.

4. A closet, bathroom, toilet room, kitchen, garage, mechanical room, boiler room, furnace room, unconditioned *attic* or other *dwelling unit*.
5. A room or space containing a fuel-burning *appliance* where such room or space serves as the sole source of return air.

Exceptions:

1. The fuel-burning *appliance* is a direct-vent *appliance* or an *appliance* not requiring a vent in accordance with Section M1801.1 or Chapter 24.
2. The room or space complies with the following requirements:
 - 2.1. The return air shall be taken from a room or space having a volume exceeding 1 cubic foot for each 10 Btu/h (9.6 L/W) of combined input rating of all fuel-burning *appliances* therein.
 - 2.2. The volume of supply air discharged back into the same space shall be approximately equal to the volume of return air taken from the space.
 - 2.3. Return-air inlets shall not be located within 10 feet (3048 mm) of any *appliance* firebox or draft hood in the same room or space.
3. Rooms or spaces containing solid-fuel burning *appliances*, if return-air inlets are located not

less than 10 feet (3048 mm) from the firebox of those *appliances*.

6. An unconditioned crawl space by means of direct connection to the return side of a forced air system. Transfer openings in the crawl space enclosure shall not be prohibited.

M1602.3 Inlet opening protection. Outdoor air inlets shall be covered with screens having openings that are not less than 1/4 inch (6.4 mm) and not greater than 1/2 inch (12.7 mm).

M1602.4 Balanced Return Air. Restricted return air occurs in buildings when returns are located in central zones and closed interior doors impede air flow to the return grill or when ceiling spaces are used as return plenums and fire walls restrict air movement from one portion of the return plenum to another. Provisions shall be made in both residential and commercial buildings to avoid unbalanced air flows and pressure differentials caused by restricted return air. Pressure differentials across closed doors where returns are centrally located shall be limited to 0.01 inch WC (2.5 pascals) or less. Pressure differentials across fire walls in ceiling space plenums shall be limited to 0.01 inch WC (2.5 pascals) by providing air duct pathways or air transfer pathways from the high pressure zone to the low zone.

Exceptions:

1. Transfer ducts may achieve this by increasing the return transfer 1 1/2 times the cross sectional area (square inches) of the supply duct entering the room or space it is serving and the door having at least an unrestricted 1 inch undercut to achieve proper return air balance.
2. Transfer grilles shall use 50 square inches (of grille area) to 100 cfm (of supply air) for sizing through-the-wall transfer grilles and using an unrestricted 1 inch undercutting of doors to achieve proper return air balance.
3. Habitable rooms only shall be required to meet these requirements for proper balanced return air excluding bathrooms, closets, storage rooms and laundry rooms, except that all supply air into the master suite shall be included.