

**4101:2-6-01 Duct systems.**

[Comment: When a reference is made within this rule to a federal statutory provision, an industry consensus standard, or any other technical publication, the specific date and title of the publication as well as the name and address of the promulgating agency are listed in rule 4101:2-15-01 of the Administrative Code. The application of the referenced standards shall be limited and as prescribed in section 102.5 of rule 4101:1-1-01 of the Administrative Code.]

**SECTION 601**  
**GENERAL**

**601.1 Scope.** Duct systems used for the movement of air in air-conditioning, heating, ventilating and exhaust systems shall conform to the provisions of this chapter except as otherwise specified in Chapters 5 and 7.

**Exception:** Ducts discharging combustible material directly into any combustion chamber shall conform to the requirements of NFPA 82.

**601.2 Air movement in egress elements.** Corridors shall not serve as supply, return, exhaust, relief or ventilation air ducts.

**Exceptions:**

1. Use of a corridor as a source of makeup air for exhaust systems in rooms that open directly onto such corridors, including toilet rooms, bathrooms, dressing rooms, smoking lounges and janitor closets, shall be permitted, provided that each such corridor is directly supplied with outdoor air at a rate greater than the rate of makeup air taken from the corridor.
2. Where located within a dwelling unit, the use of corridors for conveying return air shall not be prohibited.
3. Where located within tenant spaces of 1,000 square feet (93 m<sup>2</sup>) or less in area, use of corridors for conveying return air is permitted.
4. Incidental air movement from pressurized rooms within health care facilities, provided that the corridor is not the primary source of supply or return to the room.

**601.2.1 Corridor ceiling.** Use of the space between the corridor ceiling and the floor or roof structure above as a return air plenum is permitted for one or more of the following conditions:

1. The corridor is not required to be of fire-resistance-rated construction;
2. The corridor is separated from the plenum by fire-resistance-rated construction;
3. The air-handling system serving the corridor is shut down upon activation of

- the air-handling unit smoke detectors required by this code;
4. The air-handling system serving the corridor is shut down upon detection of sprinkler waterflow where the building is equipped throughout with an automatic sprinkler system; or
  5. The space between the corridor ceiling and the floor or roof structure above the corridor is used as a component of an approved engineered smoke control system.

**601.3 Exits.** Equipment and ductwork for exit enclosure ventilation shall comply with one of the following items:

1. Such equipment and ductwork shall be located exterior to the building and shall be directly connected to the exit enclosure by ductwork enclosed in construction as required by the *building code* for shafts.
2. Where such equipment and ductwork is located within the exit enclosure, the intake air shall be taken directly from the outdoors and the *exhaust air* shall be discharged directly to the outdoors, or such air shall be conveyed through ducts enclosed in construction as required by the *building code* for shafts.
3. Where located within the building, such *equipment* and ductwork shall be separated from the remainder of the building, including other mechanical *equipment*, with construction as required by the *building code* for shafts.

In each case, openings into fire-resistance-rated construction shall be limited to those needed for maintenance and operation and shall be protected by self-closing fire-resistancerated devices in accordance with the *building code* for enclosure wall opening protectives. Exit enclosure ventilation systems shall be independent of other building ventilation systems.

**601.4 Contamination prevention.** Exhaust ducts under positive pressure, chimneys and vents shall not extend into or pass through ducts or plenums.

**Exception:** Exhaust systems located in ceiling return air plenums over spaces that are permitted to have 10 percent recirculation in accordance with Section 403.2.1, Item 4. The exhaust duct joints, seams and connections shall comply with Section 603.9.

## **SECTION 602**

### **PLENUMS**

**602.1 General.** Supply, return, exhaust, relief and ventilation air plenums shall be limited to uninhabited crawl spaces, areas above a ceiling or below the floor, attic spaces and mechanical equipment rooms. Plenums shall be limited to one fire area. Fuel-fired appliances shall not be installed within a plenum.

**602.2 Construction.** Plenum enclosures shall be constructed of materials

permitted for the type of construction classification of the building.

The use of gypsum boards to form plenums shall be limited to systems where the air temperatures do not exceed 125°F (52°C) and the building and mechanical system design conditions are such that the gypsum board surface temperature will be maintained above the airstream dew-point temperature. Air plenums formed by gypsum boards shall not be incorporated in air-handling systems utilizing evaporative coolers.

**602.2.1 Materials within plenums.** Except as required by Sections 602.2.1.1 through 602.2.1.6, materials within plenums shall be noncombustible or shall have a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with ASTM E 84 or UL 723.

**Exceptions:**

1. Rigid and flexible ducts and connectors shall conform to Section 603.
2. Duct coverings, linings, tape and connectors shall conform to Sections 603 and 604.
3. This section shall not apply to materials exposed within plenums in one-, two-, and three-family dwellings.
4. This section shall not apply to smoke detectors.
5. Combustible materials fully enclosed within continuous noncombustible raceways or enclosures, approved gypsum board assemblies or within materials listed and labeled for such application.

**602.2.1.1 Wiring.** Combustible electrical or electronic wiring methods and materials, optical fiber cable, and optical fiber raceway exposed within a plenum shall have a peak optical density not greater than 0.50, an average optical density not greater than 0.15, and a flame spread not greater than 5 feet (1524 mm) when tested in accordance with NFPA 262. Only type OFNP (plenum rated nonconductive optical fiber cable) shall be installed in plenum-rated optical fiber raceways. Wiring, cable, and raceways addressed in this section shall be listed and labeled as plenum rated and shall be installed in accordance with NFPA 70.

**Exception:** *Wiring methods installed in accordance with section 645.5 of NFPA 70 are permitted for electrical installations in plenums of information technology equipment areas and information technology equipment rooms that comply with the construction requirements of NFPA 75 and Article 645 of NFPA 70. The information technology equipment area shall be separated from other areas of the building by a minimum of a one-hour fire barrier constructed in accordance with the building code. The information technology equipment room shall be separated from other areas of the building and the information technology equipment area by a minimum of a one-hour fire barrier constructed in accordance with the*

*building code.*

**602.2.1.2 Fire sprinkler piping.** Plastic fire sprinkler piping exposed within a plenum shall be used only in wet pipe systems and shall have a peak optical density not greater than 0.50, an average optical density not greater than 0.15, and a flame spread of not greater than 5 feet (1524 mm) when tested in accordance with UL 1887. Piping shall be listed and labeled.

**602.2.1.3 Pneumatic tubing.** Combustible pneumatic tubing exposed within a plenum shall have a peak optical density not greater than 0.50, an average optical density not greater than 0.15, and a flame spread of not greater than 5 feet (1524 mm) when tested in accordance with UL 1820. Combustible pneumatic tubing shall be listed and labeled.

**602.2.1.4 Electrical equipment in plenums.** Electrical equipment exposed within a plenum shall comply with Sections 602.2.1.4.1 and 602.2.1.4.2.

**602.2.1.4.1 Equipment in metallic enclosures.** Electrical equipment with metallic enclosures exposed within a plenum shall be permitted.

**602.2.1.4.2 Equipment in combustible enclosures.** Electrical equipment with combustible enclosures exposed within a plenum shall be listed and labeled for such use in accordance with UL 2043.

**602.2.1.5 Foam plastic insulation.** Foam plastic insulation used as wall or ceiling finish in plenums shall exhibit a flame spread index of 75 or less and a smoke-developed index of 450 or less when tested in accordance with ASTM E 84 or UL 723 and shall also comply with Section 602.2.1.5.1, 602.2.1.5.2 or 602.2.1.5.3.

**602.2.1.5.1 Separation required.** The foam plastic insulation shall be separated from the plenum by a thermal barrier complying with Section 2603.4 of the *building code*.

**602.2.1.5.2 Approval.** The foam plastic insulation shall be approved based on tests conducted in accordance with Section 2603.9 of the *building code*.

**602.2.1.5.3 Covering.** The foam plastic insulation shall be covered by corrosion-resistant steel having a base metal thickness of not less than 0.0160 inch (0.4 mm).

**602.2.1.6 Semiconductor fabrication areas.** Group H, Division 5 fabrication areas and the areas above and below the fabrication area that share a common air recirculation path with the fabrication area shall not be subject to the provisions of Section 602.2.1.

**602.3 Stud cavity and joist space plenums.** Stud wall cavities and the spaces between solid floor joists to be utilized as air plenums shall comply with the

following conditions:

1. Such cavities or spaces shall not be utilized as a plenum for supply air.
2. Such cavities or spaces shall not be part of a required fire-resistance-rated assembly.
3. Stud wall cavities shall not convey air from more than one floor level.
4. Stud wall cavities and joist space plenums shall comply with the floor penetration protection requirements of the *building code*.
5. Stud wall cavities and joist space plenums shall be isolated from adjacent concealed spaces by approved fireblocking as required in the *building code*.

**602.4 Flood hazard.** For structures located in flood hazard areas, plenum spaces shall be located above the design flood elevation or shall be designed and constructed to prevent water from entering or accumulating within the plenum spaces during floods up to the design flood elevation. If the plenum spaces are located below the design flood elevation, they shall be capable of resisting hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the design flood elevation.

## **SECTION 603**

### **DUCT CONSTRUCTION AND INSTALLATION**

**603.1 General.** 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.

**603.2 Duct sizing.** Ducts installed within a single dwelling unit shall be sized in accordance with “ACCA Manual D” or other approved methods. Ducts installed within all other buildings shall be sized in accordance with the “ASHRAE Handbook of Fundamentals” or other equivalent computation procedure.

**603.3 Duct classification.** Ducts shall be classified based on the maximum operating pressure of the duct at pressures of positive or negative 0.5, 1.0, 2.0, 3.0, 4.0, 6.0 or 10.0 inches (1 inch w.c. = 248.7 Pa) of water column. The pressure classification of ducts shall equal or exceed the design pressure of the air distribution in which the ducts are utilized.

**603.4 Metallic ducts.** All metallic ducts shall be constructed as specified in the “SMACNA HVAC Duct Construction Standards—Metal and Flexible”.

**Exception:** Ducts installed within single dwelling units shall have a minimum thickness as specified in Table 603.4.

**603.4.1 Minimum fasteners.** Round metallic ducts shall be mechanically

fastened by means of at least three sheet metal screws or rivets spaced equally around the joint.

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

**603.5 Nonmetallic ducts.** Nonmetallic ducts shall be constructed with Class 0 or Class 1 duct material in accordance with UL 181. Fibrous duct construction shall conform to the “SMACNA Fibrous Glass Duct Construction Standards” or “NAIMA Fibrous Glass Duct Construction Standards”. The maximum air temperature within nonmetallic ducts shall not exceed 250°F (121°C).

**603.5.1 Gypsum ducts.** The use of gypsum boards to form air shafts (ducts) shall be limited to return air systems where the air temperatures do not exceed 125°F (52°C) and the gypsum board surface temperature is maintained above the airstream dew-point temperature. Air ducts formed by gypsum boards shall not be incorporated in air-handling systems utilizing evaporative coolers.

**603.6 Flexible air ducts and flexible air connectors.** Flexible air ducts, both metallic and nonmetallic, shall comply with Sections 603.6.1, 603.6.1.1, 603.6.3 and 603.6.4. Flexible air connectors, both metallic and nonmetallic, shall comply with Sections 603.6.2 through 603.6.4.

**603.6.1 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 304.1.

**603.6.1.1 Duct length.** Flexible air ducts shall not be limited in length.

**603.6.2 Flexible air connectors.** Flexible air connectors, both metallic and nonmetallic, shall be tested in accordance with UL 181. Such connectors shall be listed and labeled as Class 0 or Class 1 flexible air connectors and shall be installed in accordance with Section 304.1.

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

**603.6.2.2 Connector penetration limitations.** Flexible air connectors shall not pass through any wall, floor or ceiling.

**603.6.3 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).

**603.6.4 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.

**603.7 Rigid duct penetrations.** Duct system penetrations of walls, floors, ceilings and roofs and air transfer openings in such building components shall be protected as required by Section 607. Ducts in a private garage and ducts penetrating the walls or ceilings separating a dwelling from a private garage shall be continuous and constructed of a minimum 26 gage [0.0187 inch (0.4712 mm)] galvanized sheet metal and shall not have openings into the garage. Fire and smoke dampers are not required in such ducts passing through the wall or ceiling separating a *dwelling* from a private garage except where required by Chapter 7 of the *building code*.

**TABLE 603.4**  
**DUCT CONSTRUCTION MINIMUM SHEET METAL THICKNESSES**  
**FOR SINGLE DWELLING UNITS**

<b><u>DUCT SIZE</u></b>	<b><u>GALVANIZED</u></b>		<b><u>ALUMINUM MINIMUM THICKNESS (in.)</u></b>
	<b><u>Minimum thickness (in.)</u></b>	<b><u>Equivalent galvanized gage no.</u></b>	
<u>Round ducts and enclosed rectangular ducts</u>			
<u>14 inches or less</u>	<u>0.0157</u>	<u>28</u>	<u>0.0175</u>
<u>16 and 18 inches</u>	<u>0.0187</u>	<u>26</u>	<u>0.018</u>
<u>20 inches and over</u>	<u>0.0236</u>	<u>24</u>	<u>0.023</u>
<u>Exposed rectangular ducts</u>			
<u>14 inches or less</u>	<u>0.0157</u>	<u>28</u>	<u>0.0175</u>
<u>Over 14 inches*</u>	<u>0.0187</u>	<u>26</u>	<u>0.018</u>

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

a. For duct gages and reinforcement requirements at static pressures of 1/2-inch, 1-inch and 2-inch w.g., "SMACNA HVAC Duct Construction Standards", Tables 2-1, 2-2, and 2-3, shall apply.

**603.8 Underground ducts.** Ducts shall be approved for underground installation. Metallic ducts not having an approved protective coating shall be completely encased in a minimum of 2 inches (51 mm) of concrete.

**603.8.1 Slope.** Ducts shall have a minimum slope of  $\frac{1}{8}$  inch per foot (10.4 mm/m) to allow drainage to a point provided with access.

**603.8.2 Sealing.** Ducts shall be sealed and secured prior to pouring the concrete encasement.

**603.8.3 Plastic ducts and fittings.** Plastic ducts shall be constructed of PVC having a minimum pipe stiffness of 8 psi (55 kPa) at 5-percent deflection when tested in accordance with ASTM D 2412. Plastic duct fittings shall be constructed of either PVC or high-density polyethylene. Plastic duct and fittings shall be utilized in underground installations only. The maximum design temperature for systems utilizing plastic duct and fittings shall be 150°F (66°C).

**603.9 Joints, seams and connections.** All 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*”. All 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. Closure systems used to seal ductwork listed and labeled in accordance with UL 181A shall be marked “181A-P” for pressure-sensitive tape, “181 A-M” for mastic or “181 A-H” for heat-sensitive tape. Closure systems used to seal flexible air ducts and flexible air connectors shall comply with UL 181B and shall be marked “181B-FX” for pressure-sensitive tape or “181B-M” 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.” Closure systems used to seal metal ductwork shall be installed in accordance with the manufacturer’s installation instructions. Unlisted duct tape is not permitted as a sealant on any metal ducts.

**Exception:** Continuously welded and locking-type longitudinal joints and seams in ducts operating at static pressures less than 2 inches of water column (500 Pa) pressure classification shall not require additional closure systems.

**603.10 Supports.** Ducts shall be supported with approved hangers at intervals not exceeding 10 feet (3048 mm) or by other approved duct support systems designed in accordance with the *building code*. Flexible and other factory-made ducts shall be supported in accordance with the manufacturer’s installation instructions.

**603.11 Furnace connections.** Ducts connecting to a furnace shall have a *clearance* to combustibles in accordance with the furnace manufacturer’s installation instructions.

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

**603.13 Flood hazard areas.** For structures in flood hazard areas, ducts shall be



located above the design flood elevation or shall be designed and constructed to prevent water from entering or accumulating within the ducts during floods up to the design flood elevation. If the ducts are located below the design flood elevation, the ducts shall be capable of resisting hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the design flood elevation.

**603.14 Location.** Ducts shall not be installed in or within 4 inches (102 mm) of the earth, except where such ducts comply with Section 603.8.

**603.15 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.

**603.16 Weather protection.** All ducts including linings, coverings and vibration isolation connectors installed on the exterior of the building shall be protected against the elements.

**603.17 Registers, grilles and diffusers.** Duct registers, grilles and diffusers shall be installed in accordance with the manufacturer's installation instructions. Volume dampers or other means of supply air adjustment shall be provided in the branch ducts or at each individual duct register, grille or diffuser. Each volume damper or other means of supply air adjustment used in balancing shall be provided with access.

**603.17.1 Floor registers.** Floor registers shall resist, without structural failure, a 200-pound (90.8 kg) concentrated load on a 2-inch-diameter (51 mm) disc applied to the most critical area of the exposed face.

**603.17.2 Prohibited locations.** Diffusers, registers and grilles shall be prohibited in the floor or its upward extension within toilet and bathing rooms required by the *building code* to have smooth, hard, nonabsorbent surfaces.

**Exception:** Dwelling units.

## **SECTION 604** **INSULATION**

**604.1 General.** Duct insulation shall conform to the requirements of Sections 604.2 through 604.13 and the *the applicable energy conservation code referenced from Chapter 13 of the building code*.

**604.2 Surface temperature.** Ducts that operate at temperatures exceeding 120°F (49°C) shall have sufficient thermal insulation to limit the exposed surface temperature to 120°F (49°C).

**604.3 Coverings and linings.** Coverings and linings, including adhesives when used, shall have a flame spread index not more than 25 and a smoke-developed index not more than 50, when tested in accordance with ASTM E 84 or UL 723, using the specimen preparation and mounting procedures of ASTM E 2231. 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).

**604.4 Foam plastic insulation.** Foam plastic used as duct coverings and linings shall conform to the requirements of Section 604.

**604.5 Appliance insulation.** Listed and labeled appliances that are internally insulated shall be considered as conforming to the requirements of Section 604.

**604.6 Penetration of assemblies.** Duct coverings shall not penetrate a wall or floor required to have a fire-resistance rating or required to be fireblocked.

**604.7 Identification.** External duct insulation, except spray polyurethane foam, and factory-insulated flexible duct shall be legibly printed or identified at intervals not greater 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. 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:

1. For duct board, duct liner and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.
2. For duct wrap, the installed thickness shall be assumed to be 75 percent (25 percent compression) of nominal thickness.
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. 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.

**604.8 Lining installation.** Linings shall be interrupted at the area of operation of a fire damper and at a minimum of 6 inches (152 mm) upstream of and 6 inches (152 mm) downstream of electric-resistance and fuel-burning heaters in a duct system. Metal nosings or sleeves shall be installed over exposed duct liner edges that face opposite the direction of airflow.

**604.9 Thermal continuity.** Where a duct liner has been interrupted, a duct covering of equal thermal performance shall be installed.

**604.10 Service openings.** Service openings shall not be concealed by duct coverings unless the exact location of the opening is properly identified.

**604.11 Vapor retarders.** Where ducts used for cooling are externally insulated, the insulation shall be covered with a vapor retarder having a maximum permeance of 0.05 perm [2.87 ng/(Pa • s • m<sup>2</sup>)] or aluminum foil having a minimum thickness of 2 mils (0.051 mm). Insulations having a permeance of 0.05 perm [2.87 ng/(Pa • s • m<sup>2</sup>)] or less shall not be required to be covered. All joints and seams shall be sealed to maintain the continuity of the vapor retarder.

**604.12 Weatherproof barriers.** Insulated exterior ducts shall be protected with an approved weatherproof barrier.

**604.13 Internal insulation.** Materials used as internal insulation and exposed to the airstream in ducts shall be shown to be durable when tested in accordance with UL 181. Exposed internal insulation that is not impermeable to water shall not be used to line ducts or plenums from the exit of a cooling coil to the downstream end of the drain pan.

## **SECTION 605** **AIR FILTERS**

**605.1 General.** Heating and air-conditioning systems of the central type shall be provided with approved air filters. Filters shall be installed in the return air system, upstream from any heat exchanger or coil, in an approved convenient location. Liquid adhesive coatings used on filters shall have a flash point not lower than 325°F (163°C).

**605.2 Approval.** Media-type and electrostatic-type air filters shall be listed and labeled. Media-type air filters shall comply with UL 900. High efficiency particulate air filters shall comply with UL 586. Electrostatic-type air filters shall comply with UL 867. Air filters utilized within dwelling units shall be designed for the intended application and shall not be required to be listed and labeled.

**605.3 Airflow over the filter.** Ducts shall be constructed to allow an even distribution of air over the entire filter.

## **SECTION 606** **SMOKE DETECTION SYSTEMS CONTROL**

**606.1 Controls required.** Air distribution systems shall be equipped with smoke detectors listed and labeled for installation in air distribution systems, as required

by this section. Duct smoke detectors shall comply with UL 268A. Other smoke detectors shall comply with UL 268.

**606.2 Where required.** Smoke detectors shall be installed where indicated in Sections 606.2.1 through 606.2.3.

**Exception:** Smoke detectors shall not be required where air distribution systems are incapable of spreading smoke beyond the enclosing walls, floors and ceilings of the room or space in which the smoke is generated.

**606.2.1 Return air systems.** Smoke detectors shall be installed in return air systems with a design capacity greater than 2,000 cfm ( $0.9 \text{ m}^3/\text{s}$ ), in the return air duct or plenum upstream of any filters, exhaust air connections, outdoor air connections, or decontamination equipment and appliances.

**Exception:** Smoke detectors are not required in the return air system where all portions of the building served by the air distribution system are protected by area smoke detectors connected to a fire alarm system in accordance with the *building code*. The area smoke detection system shall comply with Section 606.4.

**606.2.2 Common supply and return air systems.** Where multiple air-handling systems share common supply or return air ducts or plenums with a combined design capacity greater than 2,000 cfm ( $0.9 \text{ m}^3/\text{s}$ ), the return air system shall be provided with smoke detectors in accordance with Section 606.2.1.

**Exception:** Individual smoke detectors shall not be required for each fan-powered terminal unit, provided that such units do not have an individual design capacity greater than 2,000 cfm ( $0.9 \text{ m}^3/\text{s}$ ) and will be shut down by activation of one of the following:

1. Smoke detectors required by Sections 606.2.1 and 606.2.3.
2. An approved area smoke detector system located in the return air plenum serving such units.
3. An area smoke detector system as prescribed in the exception to Section 606.2.1.

In all cases, the smoke detectors shall comply with Sections 606.4 and 606.4.1.

**606.2.3 Return air risers.** Where return air risers serve two or more stories and serve any portion of a return air system having a design capacity greater than 15,000 cfm ( $7.1 \text{ m}^3/\text{s}$ ), smoke detectors shall be installed at each story. Such smoke detectors shall be located upstream of the connection between the return air riser and any air ducts or plenums.

**606.3 Installation.** Smoke detectors required by this section shall be installed in

accordance with NFPA 72. The required smoke detectors shall be installed to monitor the entire airflow conveyed by the system including return air and exhaust or relief air. Access shall be provided to smoke detectors for inspection and maintenance.

**606.4 Controls operation.** Upon activation, the smoke detectors shall shut down all operational capabilities of the air distribution system in accordance with the listing and labeling of appliances used in the system. Air distribution systems that are part of a smoke control system shall switch to the smoke control mode upon activation of a detector.

**606.4.1 Supervision.** The duct smoke detectors shall be connected to a fire alarm system where a fire alarm system is required by Section 907.2 of the *building code*. The actuation of a duct smoke detector shall activate a visible and audible supervisory signal at a constantly attended location.

**Exceptions:**

1. The supervisory signal at a constantly attended location is not required where the duct smoke detector activates the building's alarm-indicating appliances.
2. In occupancies not required to be equipped with a fire alarm system, actuation of a smoke detector shall activate a visible and audible signal in an approved location. Duct smoke detector trouble conditions shall activate a visible or audible signal in an approved location and shall be identified as air duct detector trouble.

## **SECTION 607**

### **DUCT AND TRANSFER OPENINGS**

**607.1 General.** The provisions of this section shall govern the protection of duct penetrations and air transfer openings in assemblies required to be protected.

**607.1.1 Ducts that penetrate fire-resistance-rated assemblies without dampers.** Ducts that penetrate fire-resistance-rated assemblies and are not required by this section to have dampers shall comply with the requirements of Sections 713.2 through 713.3.3 of the *building code*. Ducts that penetrate horizontal assemblies not required to be contained within a shaft and not required by this section to have dampers shall comply with the requirements of Sections 713.4 through 713.4.2.2 of the *building code*.

**607.1.1.1 Ducts that penetrate nonfire-resistance-rated assemblies.** The space around a duct penetrating a nonfire-resistance-rated floor assembly shall comply with Section 716.6.3 of the *building code*.

**607.2 Installation.** Fire dampers, smoke dampers, combination fire/smoke dampers and ceiling radiation dampers located within air distribution and smoke control systems shall be installed in accordance with the requirements of this section, and the manufacturer's installation instructions and listing.

**607.2.1 Smoke control system.** Where the installation of a fire damper will interfere with the operation of a required smoke control system in accordance with Section 909 of the *building code*, *approved* alternative protection shall be used. Where mechanical systems including ducts and dampers used for normal building ventilation serve as part of the smoke control system, the expected performance of these systems in smoke control mode shall be addressed in the rational analysis required by Section 909.4 of the *building code*.

**607.2.2 Hazardous exhaust ducts.** Fire dampers for hazardous exhaust duct systems shall comply with Section 510.

**607.3 Damper testing, ratings and actuation.** Damper testing, ratings and actuation shall be in accordance with Sections 607.3.1 through 607.3.3.

**607.3.1 Damper testing.** Dampers shall be listed and bear the label of an approved testing agency indicating compliance with the standards in this section. Fire dampers shall comply with the requirements of UL 555. Only fire dampers labeled for use in dynamic systems shall be installed in heating, ventilation and air-conditioning systems designed to operate with fans on during a fire. Smoke dampers shall comply with the requirements of UL 555S. Combination fire/smoke dampers shall comply with the requirements of both UL 555 and UL 555S. Ceiling radiation dampers shall comply with the requirements of UL 555C.

**607.3.2 Damper rating.** Damper ratings shall be in accordance with Sections 607.3.2.1 through 607.3.2.3.

**607.3.2.1 Fire damper ratings.** Fire dampers shall have the minimum fire protection rating specified in Table 607.3.2.1 for the type of penetration.

**TABLE 607.3.2.1**  
**FIRE DAMPER RATING**

<b><u>TYPE OF PENETRATION</u></b>	<b><u>MINIMUM DAMPER RATING (hour)</u></b>
<u>Less than 3-hour fire-resistance-rated assemblies</u>	<u>1 ½</u>
<u>3-hour or greater fire-resistance-rated assemblies</u>	<u>3</u>

**607.3.2.2 Smoke damper ratings.** Smoke damper leakage ratings shall not be less than Class II. Elevated temperature ratings shall not be less than 250°F (121°C).

**607.3.2.3 Combination fire/smoke damper ratings.** Combination fire/smoke dampers shall have the minimum fire protection rating specified for fire dampers in Table 607.3.2.1 for the type of penetration and shall also have a minimum Class II leakage rating and a minimum elevated temperature rating of 250°F (121°C).

**607.3.3 Damper actuation.** Damper actuation shall be in accordance with Sections 607.3.3.1 through 607.3.3.4 as applicable.

**607.3.3.1 Fire damper actuation device.** The fire damper actuation device shall meet one of the following requirements:

1. The operating temperature shall be approximately 50°F (28°C) above the normal temperature within the duct system, but not less than 160°F (71°C).
2. The operating temperature shall be not more than 350°F (177°C) where located in a smoke control system complying with Section 909 of the *building code*.

**607.3.3.2 Smoke damper actuation.** The smoke damper shall close upon actuation of a *listed* smoke detector or detectors installed in accordance with Section 907.3 of the *building code* and one of the following methods, as applicable:

1. Where a smoke damper is installed within a duct, a smoke detector shall be installed in the duct within 5 feet (1524 mm) of the damper with no air outlets or inlets between the detector and the damper. The detector shall be listed for the air velocity, temperature and humidity anticipated at the point where it is installed. Other than in mechanical smoke control systems, dampers shall be closed upon fan shutdown where local smoke detectors require a minimum velocity to operate.
2. Where a smoke damper is installed above smoke barrier doors in a smoke barrier, a spot-type detector listed for releasing service shall be installed on either side of the smoke barrier door opening.
3. Where a smoke damper is installed within an unducted opening in a wall, a spot-type detector listed for releasing service shall be installed within 5 feet (1524 mm) horizontally of the damper.
4. Where a smoke damper is installed in a corridor wall or ceiling, the damper shall be permitted to be controlled by a smoke detection system installed in the corridor.
5. Where a total-coverage smoke detector system is provided within areas served by a heating, ventilation and air-conditioning (HVAC) system,

smoke dampers shall be permitted to be controlled by the smoke detection system.

**607.3.3.3 Combination fire/smoke damper actuation.** Combination fire/smoke damper actuation shall be in accordance with Sections 607.3.3.1 and 607.3.3.2. Combination fire/smoke dampers installed in smoke control system shaft penetrations shall not be activated by local area smoke detection unless it is secondary to the smoke management system controls.

**607.3.3.4 Ceiling radiation damper actuation.** The operating temperature of a ceiling radiation damper actuation device shall be 50°F (28°C) above the normal temperature within the duct system, but not less than 160°F (71°C).

**607.4 Access and identification.** Fire and smoke dampers shall be provided with an approved means of access, large enough to permit inspection and maintenance of the damper and its operating parts. The access shall not affect the integrity of fire-resistance-rated assemblies. The access openings shall not reduce the fire-resistance rating of the assembly. Access points shall be permanently identified on the exterior by a label having letters not less than 0.5 inch (12.7 mm) in height reading: FIRE/SMOKE DAMPER, SMOKE DAMPER or FIRE DAMPER. Access doors in ducts shall be tight fitting and suitable for the required duct construction.

**607.5 Where required.** Fire dampers, smoke dampers and combination fire/smoke dampers shall be provided at the locations prescribed in Sections 607.5.1 through 607.5.7. Where an assembly is required to have both fire dampers and smoke dampers, combination fire/smoke dampers or a fire damper and smoke damper shall be required.

**607.5.1 Fire walls.** Ducts and air transfer openings permitted in fire walls in accordance with Section 705.11 of the *building code* shall be protected with listed fire dampers installed in accordance with their listing.

**607.5.1.1 Horizontal exits.** A listed smoke damper designed to resist the passage of smoke shall be provided at each point that a duct or air transfer opening penetrates a fire wall that serves as a horizontal exit.

**607.5.2 Fire barriers.** Ducts and air transfer openings that penetrate fire barriers shall be protected with listed fire dampers installed in accordance with their listing. Ducts and air transfer openings shall not penetrate exit enclosures and exit passageways except as permitted by Sections 1022.4 and 1023.6, respectively, of the *building code*.

**Exception:** Fire dampers are not required at penetrations of fire barriers where any of the following apply:

1. Penetrations are tested in accordance with ASTM E 119 or UL 263 as part of the fire-resistance-rated assembly.



2. Ducts are used as part of an approved smoke control system in accordance with Section 513 and where the fire damper would interfere with the operation of the smoke control system.
3. Such walls are penetrated by ducted HVAC systems, have a required fire-resistance rating of 1 hour or less, are in areas of other than Group H and are in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2 of the *building code*. For the purposes of this exception, a ducted HVAC system shall be a duct system for the structure's HVAC system. Such a duct system shall be constructed of sheet steel not less than 26 gage [0.0217 inch (0.55 mm)] thickness and shall be continuous from the air-handling appliance or equipment to the air outlet and inlet terminals.

**607.5.2.1 Horizontal exits.** A listed smoke damper designed to resist the passage of smoke shall be provided at each point that a duct or air transfer opening penetrates a fire barrier that serves as a horizontal exit.

**607.5.3 Fire partitions.** Ducts and air transfer openings that penetrate fire partitions shall be protected with listed fire dampers installed in accordance with their listing.

**Exception:** In occupancies other than Group H, fire dampers are not required where any of the following apply:

1. Corridor walls in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2 of the *building code* and the duct is protected as a through penetration in accordance with Section 713 of the *building code*.
2. The partitions are tenant partitions in covered mall buildings where the walls are not required by provisions elsewhere in the *building code* to extend to the underside of the floor or roof sheathing, slab or deck above.
3. The duct system is constructed of approved materials in accordance with Section 603 and the duct penetrating the wall complies with all of the following requirements:
  - 3.1. The duct shall not exceed 100 square inches (0.06 m<sup>2</sup>).
  - 3.2. The duct shall be constructed of steel a minimum of 0.0217 inch (0.55 mm) in thickness.
  - 3.3. The duct shall not have openings that communicate the corridor with adjacent spaces or rooms.
  - 3.4. The duct shall be installed above a ceiling.
  - 3.5. The duct shall not terminate at a wall register in the fire-resistance-rated wall.

3.6. A minimum 12-inch-long (305 mm) by 0.060-inch-thick (1.52 mm) steel sleeve shall be centered in each duct opening. The sleeve shall be secured to both sides of the wall and all four sides of the sleeve with minimum 1 1/2-inch by 1 1/2-inch by 0.060-inch (38 mm by 38 mm by 1.52 mm) steel retaining angles. The retaining angles shall be secured to the sleeve and the wall with No. 10 (M5) screws. The annular space between the steel sleeve and the wall opening shall be filled with rock (mineral) wool batting on all sides.

**607.5.4 Corridors/smoke barriers.** A listed smoke damper designed to resist the passage of smoke shall be provided at each point a duct or air transfer opening penetrates a smoke barrier wall or a corridor enclosure required to have smoke and draft control doors in accordance with the *building code*. Smoke dampers and smoke damper actuation methods shall comply with Section 607.5.4.1.

**Exceptions:**

1. Smoke dampers are not required in corridor penetrations where the building is equipped throughout with an approved smoke control system in accordance with Section 513 and smoke dampers are not necessary for the operation and control of the system.
2. Smoke dampers are not required in smoke barrier penetrations where the openings in ducts are limited to a single smoke compartment and the ducts are constructed of steel.
3. Smoke dampers are not required in corridor penetrations where the duct is constructed of steel not less than 0.019 inch (0.48 mm) in thickness and there are no openings serving the corridor.

**607.5.4.1 Smoke damper.** The smoke damper shall close upon actuation of a listed smoke detector or detectors installed in accordance with the *building code* and one of the following methods, as applicable:

1. Where a damper is installed within a duct, a smoke detector shall be installed in the duct within 5 feet (1524 mm) of the damper with no air outlets or inlets between the detector and the damper. The detector shall be listed for the air velocity, temperature and humidity anticipated at the point where it is installed.
2. Where a damper is installed above smoke barrier doors in a smoke barrier, a spot-type detector listed for releasing service shall be installed on either side of the smoke barrier door opening.
3. Where a damper is installed within an unducted opening in a wall, a spot-type detector listed for releasing service shall be installed within 5 feet (1524 mm) horizontally of the damper.
4. Where a damper is installed in a corridor wall, the damper shall be permitted to be controlled by a smoke detection system installed in the corridor.

5. Where a total-coverage smoke detector system is provided within all areas served by an HVAC system, dampers shall be permitted to be controlled by the smoke detection system.

**607.5.5 Shaft enclosures.** Shaft enclosures that are permitted to be penetrated by ducts and air transfer openings shall be protected with approved fire and smoke dampers installed in accordance with their listing.

**Exceptions:**

1. Fire dampers are not required at penetrations of shafts where:
  - 1.1. Steel exhaust subducts extend at least 22 inches (559 mm) vertically in exhaust shafts provided that there is a continuous airflow upward to the outdoors; or
  - 1.2. Penetrations are tested in accordance with ASTM E 119 or UL 263 as part of the fire-resistance-rated assembly; or
  - 1.3. Ducts are used as part of an approved smoke control system in accordance with Section 909 of the *building code*, and where the fire damper will interfere with the operation of the smoke control system; or
  - 1.4. The penetrations are in parking garage exhaust or supply shafts that are separated from other building shafts by not less than 2-hour fire-resistance-rated construction.
2. In Group B and R occupancies equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 of the *building code*, smoke dampers are not required at penetrations of shafts where kitchen, clothes dryer, bathroom and toilet room exhaust openings with steel exhaust subducts, having a minimum thickness of 0.0187 inch (0.4712 mm) (No. 26 gage), extend at least 22 inches (559 mm) vertically and the exhaust fan at the upper terminus is powered continuously in accordance with the provisions of Section 909.11 of the *building code*, and maintains airflow upward to the outdoors.
3. Smoke dampers are not required at penetrations of exhaust or supply shafts in parking garages that are separated from other building shafts by not less than 2-hour fire-resistance-rated construction.
4. Smoke dampers are not required at penetrations of shafts where ducts are used as part of an approved mechanical smoke control system designed in accordance with Section 909 of the *building code* and where the smoke damper will interfere with the operation of the smoke control system.
5. Fire dampers and combination fire/smoke dampers are not required in kitchen and clothes dryer exhaust systems installed in accordance with this code.

**607.5.5.1 Enclosure at the bottom.** Shaft enclosures that do not extend to the bottom of the building or structure shall be protected in accordance with

Section 708.11 of the *building code*.

**607.5.6 Exterior walls.** Ducts and air transfer openings in fire-resistance-rated exterior walls required to have protected openings in accordance with Section 705.10 of the *building code* shall be protected with listed fire dampers installed in accordance with their listing.

**607.5.7 Smoke partitions.** A listed smoke damper designed to resist the passage of smoke shall be provided at each point where an air transfer opening penetrates a smoke partition. Smoke dampers and smoke damper actuation methods shall comply with Section 607.3.3.2.

**Exception:** Where the installation of a smoke damper will interfere with the operation of a required smoke control system in accordance with Section 513, approved alternate protection shall be used.

**607.6 Horizontal assemblies.** Penetrations by air ducts of a floor, floor/ceiling assembly or the ceiling membrane of a roof/ceiling assembly shall be protected by a shaft enclosure that complies with Section 708 and Sections 716.6.1 through 716.6.3 of the *building code* or shall comply with Sections 607.6.1 through 607.6.3.

**607.6.1 Through penetrations.** In occupancies other than Groups I-2 and I-3, a duct constructed of approved materials in accordance with Section 603 that penetrates a fire-resistance-rated floor/ceiling assembly that connects not more than two stories is permitted without shaft enclosure protection provided that a *listed* fire damper is installed at the floor line or the duct is protected in accordance with Section 713.4 of the *building code*. For air transfer openings, see Exception 7, Section 708.2 of the *building code*.

**Exception:** A duct is permitted to penetrate three floors or less without a fire damper at each floor provided it meets all of the following requirements.

1. The duct shall be contained and located within the cavity of a wall and shall be constructed of steel having a minimum thickness of 0.0187 inch (0.4712 mm) (No. 26 gage).
2. The duct shall open into only one dwelling unit or sleeping unit and the duct system shall be continuous from the unit to the exterior of the building.
3. The duct shall not exceed 4-inch (102 mm) nominal diameter and the total area of such ducts shall not exceed 100 square inches for any 100 square feet (64 516 mm<sup>2</sup> per 9.3 m<sup>2</sup>) of the floor area.
4. The annular space around the duct is protected with materials that prevent the passage of flame and hot gases sufficient to ignite cotton waste when subjected to ASTM E 119 or UL 263 time-temperature conditions under a minimum positive pressure differential of 0.01 inch

(2.49 Pa) of water at the location of the penetration for the time period equivalent to the fire-resistance rating of the construction penetrated.

5. Grille openings located in a ceiling of a fire-resistance-rated floor/ceiling or roof/ceiling assembly shall be protected with a listed ceiling radiation damper installed in accordance with Section 607.6.2.1.

**607.6.2 Membrane penetrations.** Ducts and air transfer openings constructed of approved materials, in accordance with Section 603, that penetrate the ceiling membrane of a fire-resistance-rated floor/ceiling or roof/ceiling assembly shall be protected with one of the following:

1. A shaft enclosure in accordance with Section 708 of the *building code*.
2. A listed ceiling radiation damper installed at the ceiling line where a duct penetrates the ceiling of a fire-resistance-rated floor/ceiling or roof/ceiling assembly.
3. A listed ceiling radiation damper installed at the ceiling line where a diffuser with no duct attached penetrates the ceiling of a fire-resistance-rated floor/ceiling or roof/ceiling assembly.

**607.6.2.1 Ceiling radiation dampers.** Ceiling radiation dampers shall be tested as part of a fire-resistance-rated floor/ceiling or roof/ceiling assembly in accordance with ASTM E 119 or UL 263. Ceiling radiation dampers shall be installed in accordance with the details listed in the fire-resistance-rated assembly and the manufacturer's installation instructions and the listing. Ceiling radiation dampers are not required where either of the following applies:

1. Tests in accordance with ASTM E 119 or UL 263 have shown that ceiling radiation dampers are not necessary to maintain the fire-resistance rating of the assembly.
2. Where exhaust duct penetrations are protected in accordance with Section 713.4.1.2 of the *building code*, are located within the cavity of a wall and do not pass through another dwelling unit or tenant space.

**607.6.3 Nonfire-resistance-rated floor assemblies.** Duct systems constructed of approved materials in accordance with Section 603 that penetrate nonfire-resistance-rated floor assemblies shall be protected by any of the following methods:

1. A shaft enclosure in accordance with Section 708 of the *building code*.
2. The duct connects not more than two stories, and the annular space around the penetrating duct is protected with an approved noncombustible material that resists the free passage of flame and the products of combustion.
3. The duct connects not more than three stories, and the annular space around the penetrating duct is protected with an approved noncombustible material that resists the free passage of flame and the products of combustion, and a

listed fire damper is installed at each floor line.

**Exception:** Fire dampers are not required in ducts within individual residential dwelling units.

**607.7 Flexible ducts and air connectors.** Flexible ducts and air connectors shall not pass through any fire-resistance-rated assembly.

Replaces: 4101:2-6-01

Effective:

R.C. 119.032 review dates:

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Certification

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Date

Promulgated Under: 119.03  
Statutory Authority: 3781.10(A)  
Rule Amplifies: 3781.10, 3781.11, 3791.04  
Prior Effective Dates: 1/1/02, 3/1/05, 3/1/06, 7/1/07