

9-15-76

CHAPTER VI DUCT SYSTEMS

600—Warm Air Heating, Air Conditioning, Air Cooling and Ventilating Systems (For Comfort Cooling See Chapter XVII)

601.0—Application.

- A. This chapter applies to air duct systems employing mechanical means for the movement of air and used for heating and ventilating including warm air heating systems, plain ventilating systems, combination heating and ventilating systems, air cooling systems, air conditioning systems, and exhaust systems except that it does not apply to systems for removal of flammable vapors and residues nor to systems for conveying dust, stock or refuse by means of air currents.

602.0—Construction of Ducts.

(Sections 602, 603, and 604 do not apply to systems serving one or two family dwellings or serving spaces having a volume of 25,000 cubic feet and less.)

- A. Ducts shall be constructed of iron, steel, aluminum, or other approved metal or non-combustible materials such as clay or asbestos cement. [For ducts used in a rated assembly see section 604(M)].
Exception: Ducts constructed of Class 1 materials tested in accordance with Standards for Air Ducts UL-181 may be used for air duct systems when they comply with the following:
1. They are not used for vertical risers serving more than two stories.
 2. They are not used in systems which operate with a normal air temperature higher than 250°F.
 3. They are installed in accordance with the manufacturer's installation instructions.
- B. The materials, thickness and construction and installation of all ducts shall provide structural strength and durability so as to be safe to persons or property. Ducts shall be deemed as meeting these requirements if constructed, braced and reinforced in accordance with the requirements of the Sheet Metal and Air Conditioning Contractors National Associations Fibrous Glass Construction Duct Manual, Low Velocity Duct Construction Standard or High Velocity Duct Construction Standard or ASHRAE Guide and Data Book, whichever is applicable.
- C. Ducts may be of independent construction or a part of the building construction provided they are in accordance with the requirements of this code.
- D. Flexible connectors and ducts for use between ducts and air outlets, air inlets or air terminal units and which do not pass through floors of buildings, need not conform to the requirements for ducts, Section 602(a), if they conform to the following provisions and are approved for this use:
1. Connectors and ducts shall conform to the requirements for Class 1 materials when tested in accordance with Standard for Ducts UL-181.
 2. They shall not exceed 14 feet in length.
 3. They shall not pass through any fire wall or partition required to have a fire resistant rating of two hours or more.
 4. They shall not be used in concealed spaces of a rated assembly unless they have been tested for this service. (This does not prohibit the use of these connectors and ducts above lay-in type ceilings.)

- E. Flexible connectors and ducts which are for use between ducts and air terminal units may pass through one floor only provided they conform for their full length to the following provisions:
1. They shall be of material having a melting point of not less than 1700°F, classed as non-combustible as defined in Test for Noncombustibility of Elementary Materials (ASTM E-136) and conforms with the requirements for Class 1 air duct materials of Standard for Air Ducts UL-181.
 2. They shall not exceed 20 square inches in cross-sectional area.
 3. They shall not exceed 14 feet in length.
 4. They shall not pass through a wall or partition required to have a fire resistance rating of two hours or more. [See Section 1107 (e)]
 5. The penetration shall be firestopped in accordance with Section 604(c) of this code.
- F. Vibration isolation connectors in duct systems shall be made of woven asbestos or of an approved flame retarded fabric or shall consist of sleeve joints with packing of approved material having a flame spread rating of not over 25 and a smoke development rating of not over 50. Vibration isolation connectors of fabric shall not exceed 10 inches in length.
- G. A vibration isolation connector at the joint between duct and fan where the inlets to the fan, if of exhaust type, or the outlets from the fan are in the same room or enclosure as the joint shall be exempt from Section 602.0(f) if not over 10 inches in length.
- H. Duct coverings, linings, insulations including vapor barriers and core materials in panels used in duct systems shall have a flame-spread rating not over 25 without evidence of continued progressive combustion and with a smoke developed rating not higher than 50. If the coverings and linings are to be applied with adhesives, they shall be tested as applied with such adhesives, or the adhesives used shall have a flame-spread rating not over 25 and a smoke developed rating not higher than 50.
Exception: Coverings need not meet these requirements where they are entirely located outside of a building and do not penetrate a wall or roof, and do not create an exposure hazard.
Evidence shall also be offered that the duct coverings and linings will not flame, glow, smolder, or smoke when tested in accordance with *Test for Hot-Surface Performance of High-Temperature Thermal Insulation* (ASTM C411—1961) at a temperature to which it is exposed in service. In no case shall the test temperature be below 250°F.
- I. Equipment, such as fan coil units, self-contained air conditioning units, furnaces, etc., shall be considered to meet the requirements of 602(h) if they are listed.
- J. Work involving the use of torches shall not be undertaken on ducts until the system has been shut down, the duct cleaned and all combustible lining and covering material has been removed from the portion of the duct being repaired.
- K. Ducts shall be made reasonably tight throughout and shall have no openings other than those required for proper operation and maintenance of the system. Approved wire glass may be used for inspection

windows in ducts. Tape may be used for sealing joints but where exposed to the air in the duct, it shall be not more combustible than approved flameproof fabric.

603.0—Clean-out openings in ducts.

- A. Return ducts, other than vertical, shall be so constructed that the interior is accessible for cleaning, except that accessibility is not required when the occupancy is not productive of combustible material, such as lint, dust or greasy vapors. Such occupancies include banks, offices, churches, hotels and institutions, but not kitchens, service rooms and manufacturing portions.
- B. Clean-out openings at approximately 20-foot intervals shall be provided where accessibility to facilitate cleaning is required and where the ducts are smaller than 18 x 24-inch. Removable grilles of adequate size and accessibility may be accepted as cleanout openings. Inspection windows if required shall be of approved wired glass.
- C. Supply ducts, other than vertical, shall conform to section 603(a) and 603(b) unless all of the supply air passes through either water spray or filters.

604.0—Installation of ducts.

- A. Ducts shall not be built into a building in such a way as to impair the effectiveness of the fireproofing around steel or iron structural members such as placing ducts between the fireproofing and the members protected, except in the case of structural members protected by a fire-resisting ceiling.
- B. The clearance from metal ducts to combustible construction including plaster on wood lath shall be not less than $\frac{1}{2}$ inch. These clearances apply only to heating systems of the fuel burning type and those using electric resistance heaters.
- C. Where ducts pass through walls, floors or partitions the opening in the construction around the duct shall not exceed $\frac{1}{2}$ -inch average clearance on all sides and shall be firestopped by packing with mineral fiber or other approved material to prevent the passage of flame and smoke.
Exception No. 1: This requirement may be disregarded where ducts are installed and enclosed as required under 604(e).
Exception No. 2: Where fire dampers are installed their proper clearance to building construction shall be maintained.
- D. Where ducts pass through concealed spaces within a floor/ceiling assembly or a roof/ceiling assembly constructed of combustible materials or through partitions or walls constructed of combustible materials, either the ducts or the interior surfaces of such concealed ceiling space, partition, or walls shall be protected with $\frac{1}{4}$ -inch asbestos or other approved insulating material, or a clearance of $\frac{1}{2}$ -inch (as specified in 604(b)) shall be maintained between ducts and all combustible materials. The integrity of fire-stopping shall be maintained. The spaces between the ducts and the fire-stopping shall be maintained. The spaces between the ducts and the fire-stopping shall be filled solidly with brick, mineral fiber, or other approved noncombustible material.

- E. Ducts which pass through floors of buildings requiring the protection of vertical openings shall be enclosed with partitions or walls constructed of noncombustible materials having fire resistance rating (based on possible fire exposure from either side of the partition or wall) of not less than 1 hour when such ducts are located in a building less than 4 stories in height, and not less than 2 hours when such ducts are located in a building 4 stories or more in height. A fire resistive shaft used as a duct which conforms both with the above and with the requirements for ducts need not be additionally enclosed.
1. The enclosure of ducts shall not be required for branches which are cut off from the main portion of the duct by approved fire dampers.
 2. Ducts which are located in one story and have all duct openings extending through a floor to the story next above or below may in lieu of such fire resistive enclosure be provided with approved fire dampers at each such point where the floor is pierced.
 3. Two or more ducts serving separate floors shall not be located within the same fire resistive enclosure unless approved fire dampers are installed where each branch is taken from such enclosure.
 4. The portion of a duct system below a floor which has a branch serving connectors which pierce the floor at more than one point is not required to be enclosed when all of the following are complied with:
 - (a) Each connector has a cross sectional area less than 20 square inches.
 - (b) The connectors pierce only one floor.
 - (c) Each connector serves an air handling terminal enclosed with material having a melting point of not less than 1700°F, classed as noncombustible as defined in *Test for Noncombustibility of Elementary Materials* (ASTM E136—1965) located on the floor above, and protected by the above mentioned enclosure.
 - (d) The above mentioned duct system is of material having a melting point of not less than 1700°F, classed as noncombustible as defined in *Test for Noncombustibility of Elementary Materials* (ASTM E136—1965) and conforms with requirements for Class 1 air duct materials for Standard of Air Ducts (UL181—1972).
 5. Where a branch which does not meet the requirements of 604(e) serves connectors which pierce the floor at more than one point, that portion of the duct system below the floor shall be enclosed with construction having a symmetrical fire resistance rating of not less than 1 hour.
- F. Duct coverings shall not extend through walls or floors required to be firestopped or required to have a fire resistance rating. Duct linings shall be interrupted at fire dampers and fire doors so as not interfere with their operation. Duct coverings and linings shall also be interrupted at the immediate area of operation of heat sources in a duct system involving electric resistance or fuel burning heaters.
- G. Stairways and required exit corridors shall not be used as plenums in the following occupancies:
1. Group C (Schools) and Group E (assembly) occupancies where the corridor serves more than 100 people.

2. Group A (Multiple Dwellings, Hotels, Motels, etc.) occupancies when the corridor exceeds 75 feet in length.

3. Group D (Institutions, Hospitals, Nursing Homes) occupancies where the corridor serves more than 15 people.

Exception No. 1: This does not prohibit the use of the corridor as a source of makeup air for toilet rooms, bathrooms, shower rooms, sink closets and similar auxiliary spaces opening directly on the corridor.

Exception No. 2: This requirements shall not prohibit the use of mechanical ventilation for the corrdior or incidental exfiltration because of pressure differential in special institutional occupancies. *corridor*

Exception No. 3: In apartment houses, this requirement shall not prohibit the use of a corridor as a source of makeup air through normal leakage around doors for interior exhaust fans in kitchens, appliances, bathrooms and toilets.

H. No attic, basement, room or concealed space in a building shall be used as an integral part of a duct system, unless it conforms to all the requirements for ducts. Plenums which conform to all the requirements for ducts may be located in any such portion of the building; such plenums shall not be used for storage.

Exception No. 1: The space between the ceiling and floor (or roof) of a floor and ceiling assembly or roof and ceiling assembly which has been tested in accordance with Standard Methods of Fire Tests of Building Construction and Materials (NFPA 251—1972) and obtained not less than a one-hour fire resistance rating may be used as part of a duct system provided it conforms to the following:

1. No combustible materials shall be incorporated in the floor/ceiling or roof/ceiling assembly construction. No combustibles shall be installed in the plenum unless it is properly protected or has been tested and obtained a flame spread rating of 25 or less and a smoke developed rating of 50 or less. Electrical wiring including control and communication wiring is considered properly protected when installed in accordance with Section 300-21 and 300-22 of the National Electrical Code.
2. Openings in such ceilings shall be protected in accordance with Section 1107(e)(2).
3. The integrity of fire stopping shall be maintained.
4. Such spaces may be used as a supply air plenum if tested for this use.
5. Such spaces may be used for return air plenums in all occupancies except assembly and institutional if the following provisions are met:
 - (a) Sheet metal elbow shall be attached to each return air opening penetrating the ceiling with the horizontal leg of the elbow extending a minimum of 18 inches from the edge of the ceiling penetration.
 - (b) A listed ceiling radiation damper shall be installed in the vertical section of the elbow attached to return grille.
 - (c) Elbow and damper shall be supported from structure with hanger assemblies equal to those shown in Underwriter's Laboratories Fire Resistance Index.
 - (d) Install ionization type smoke detector at inlet of air handling equipment to stop flow in case of fire. Smoke detectors shall be installed at each relief air opening to the exterior.

6. Electric heating equipment installed in drop ceiling area used as supply or return plenums shall be in accordance with the following:
 - (a) No electric resistance heating equipment not utilizing positive forced air movement across the heating element shall be installed.
 - (b) A minimum of three feet of duct shall be installed on the discharge end of any electric furnace or heater with the ductwork terminated in a bullhead tee.
 - (c) The heating unit must be provided with necessary controls to prevent operation of the heating element without air flow through the unit.
 - (d) A filter must be provided on the inlet side of the unit and the unit must be provided with a high limit control.
 - (e) Equipment shall be accessible for inspection, service and maintenance.

7. Fuel fired equipment shall not be installed.

Exception No. 2: The space between the ceiling and floor (or roof) of non-rated assemblies may be used as part of the duct system in all occupancies except assembly and institutional provided the space complies with the following:

- (1) No combustible materials shall be incorporated in the floor/ceiling or roof/ceiling assembly construction. No combustibles shall be installed in the plenum unless it is properly protected or has been tested and obtained a flame spread rating of 25 or less and a smoke developed rating of 50 or less. Electrical wiring including control and communication wiring is considered properly protected when installed in accordance with Section 300-21 and 300-22 of the National Electrical Code.
- (2) The ceiling is constructed to resist deformation or collapse during installation and use.
- (3) The ceiling material shall be made from a base material of metal or mineral and shall not be subject to deterioration or deformation on long exposure to temperatures of 250°F or conditions of high humidity, excessive moisture or mildew.
- (4) The ceiling material shall be supported by non-combustible material having a melting point above 1400°F.
- (5) The concealed space shall not be used on systems which operate with an air temperature higher than 250°F.
- (6) Electric heating equipment installed in drop ceiling area used as supply or return plenums shall be in accordance with the following:
 - (a) No electric resistance heating equipment not utilizing positive forced air movement across the heating element shall be installed.
 - (b) A minimum of three feet of duct shall be installed on the discharge end of any electric furnace or heater with the ductwork terminated in a bullhead tee.
 - (c) The heating unit must be provided with necessary controls to prevent operation of the heating element without air flow through the unit.
 - (d) A filter must be provided on the inlet side of the unit and the unit must be provided with a high limit control.
 - (e) Equipment shall be accessible for inspection, service and maintenance.

(7) Fuel fire equipment shall not be installed.

- I. Where access doors or panels are necessary in the ceiling of a floor and ceiling assembly or roof and ceiling assembly, which has been tested in accordance with the *Standard Methods of Fire Tests of Building Construction and Materials* (NFPA—1972), the door or panel shall be designed and installed to not reduce the fire resistance rating of the assembly.
- J. Where the installation of the hangers for the components of an air duct system penetrates an existing ceiling of a fire resistive floor and ceiling assembly or roof and ceiling assembly and requires removal of a portion of that ceiling, materials used to repair the ceiling shall provide a construction equivalent of the existing ceiling.
Exception: In lieu of repair of the existing ceiling, another ceiling of the same construction may be installed below the duct system.
- K. Ducts shall not be located where they will be subject to damage or rupture. Where so located they shall be suitably protected.
- L. Ducts shall be substantially supported. Hangers and brackets for supporting ducts shall be of metal.
- M. Where ducts and openings are employed in a fire resistive floor and ceiling assembly or roof and ceiling assembly, the duct materials tested shall be used and such openings shall be limited in size and adequately protected to preserve the required fire resistance.

605—Residential and Small Commercial Systems

Section 606 through 609 apply only to central warm air heating and cooling systems including separate air cooling systems, combination heating and air conditioning systems, and to heat pump systems:

- A. Serving one or two family dwellings; or
- B. Serving spaces not exceeding 25,000 cu. ft. in volume in any occupancy.
Exception: For buildings of combustible construction exceeding three stories in height. Sections 602, 603 and 604 shall apply.

606—Duct Materials

- A. Except as permitted in paragraphs 606 B, C and D supply and return ducts shall be constructed of sheet metal having a nominal thickness as shown in the following table, Class 0, Class I or other non-combustible materials.

Round Ducts and enclosed rectangular ducts

Diameter or Width (in.)	Nominal Thickness (inches)	Equiv. Galvanized Sheet Gage Number	Approximate Aluminum B & S Gage
14 or less	0.016	30	26
over 14	0.019	28	24
Exposed Rectangular			
14 or less	0.019	28	24
over 14	0.022	26	23

- B. Class 2 duct materials may be used for supply and return ducts in single family dwelling only, except for ducts located within three feet of the bonnet or plenum and ducts located directly above the heating surface of the unit.
- C. Return ducts except those directly above the heating surface or within two feet of the outer jacket may be one inch nominal wood boards

(Flame spread classification of 200) or other suitable material which is not flammable than one inch boards.

- D. Ducts installed in or below concrete floors or slabs shall be of metal completely enclosed in two inches of concrete or other materials specifically designed for this purpose and installed in accordance with the manufacturer's installation instructions. Materials other than metal shall not be installed within two feet of a furnace plenum or within two feet of a vertical connection to a riser or register.
- E. Vibration isolation connectors in duct systems shall be made of approved flame retarded fabric or shall consist of sleeve joints with packing of approved noncombustible material. Vibration isolation connectors of fabric shall not exceed 10 inches in length.

607—Construction and Installation of Ducts—Duct systems shall be constructed and installed in accordance with Section 602(b) and the following:

- A. Radius elbows or turning vanes shall be required in supply duct and shall not diminish the cross sectional area or throat.
- B. Balancing dampers shall be installed in each branch supply duct. A register or diffuser damper shall not be used as a balancing damper.

607 C—6-14-77—Ductwork used as a part of a heating system and/or mechanical cooling systems shall be insulated to provide the thermal resistance ratings listed below:

1. External insulation 2 inches thick, $\frac{3}{4}$ pounds density (Minimum R-6.5) shall be provided in the following locations:

- (a) Supply and return ductwork in attic.
- (b) Supply and return ductwork in ventilated crawl space.
- (c) Supply and return ductwork in non-conditioned areas not covered in the above.
- (d) Supply ductwork, used for mechanical cooled air, located in non-ventilated insulated crawl space, basement or cellar.

2. Duct liner 1" thick, $1\frac{1}{2}$ pounds density conforming to the fire hazard classification of UL-181 may be used in lieu of the external insulation specified above. Duct liner may be combined with external insulation to obtain the minimum "R" values listed above.

3. Factory preformed sleeve-type insulation shall have a maximum conductance value (c) of 0.23 (minimum R-4.3) at 75° F.

4. External insulation, including sleeve-type insulation shall comply with the flame spread classification of UL-181 and shall have a vapor barrier facing having a permeance rating of 0.05 perms or less. Joints and seams shall be sealed with tape having a permeance rating of 0.05 perms or less or by other equivalent methods approved by the manufacturer.

5. Factory pre-fabricated insulated flexible air duct shall conform to the requirements of UL-181 for Class I air duct and shall have a maximum conductance value (c) of 0.23 (minimum R-4.3).

6. Fibrous glass duct systems constructed of non-metallic, preformed material shall have a maximum conductance value (c) of 0.23 at 75° F (minimum R-4.3) and a facing having a perm rating of 0.05 or less.

7. The thickness and density or R value, vapor barrier permeance, where applicable, flame spread rating and smoke developed rating shall be identified on the exposed face of insulating materials by January 1, 1978.

- D. All ductwork shall be sized in accordance with the ASHRAE Guide, SMACNA Standards and/or other acceptable warm air and air conditioning manuals. Joints and seams shall be securely fastened and made substantially air tight. Slip joints shall have a lap of at least one inch and shall be individually fastened.
- E. When installing round pipe for air distribution systems and/or for furnace venting systems and/or for exhaust systems, any change of direction from a straight line run shall be made with a factory-made fitting or equal approved by the inspector.
- F. Ducts and plenums shall not be installed within four inches of the ground. Ducts installed in and/or under slab floors shall be waterproofed and/or have an acceptable method of drainage.
- G. Cutting a hole in a plenum or duct system and inserting the pipe in the opening or field dovetailing is prohibited. Take off fittings shall be used. All plenums shall be constructed of approved materials.
- H. Joints in all round pipe shall be secured with three or more sheet metal screws.
- I. Tape shall be used for sealing joints but where exposed to the air in the system, it shall not be more combustible than flameproofed fabric complying with STANDARD METHODS OF FIRE TESTS FOR FLAME-RESISTANT TEXTILES AND FILMS, NFPA 701 (1969).
- J. Ducts shall be securely supported by minimum 1" wide metal hangers, straps, lugs or brackets. No nails shall be driven through the ducts walls and no unnecessary holes shall be cut therein. Galvanized wire may be used for hangers when approved by the inspection official having jurisdiction.
- K. Where the installation of supply ducts in walls, floors, or partitions requires the removal of any firestopping, the spaces around the duct at such points where firestoppings was removed shall be sealed with noncombustible insulating material.
- L. Covering of exposed vertical supply ducts. Where vertical heating supply ducts are exposed in closets or rooms, they shall be covered or lined at least ¼-inch approved fire resistant insulation or other approved methods.
- M. Except where listed for specific clearances, ductwork shall have the following minimum clearances from construction of combustible materials:
 - 1. Horizontal supply ducts within three feet of the furnace plenum shall have a minimum clearance of two inches.
 - 2. A vertical duct, riser, boot or box connecting to a supply duct within three feet of the furnace plenum shall have a minimum clearance of two inches or the duct shall change directions equivalent to two 90 degree turns before entering the combustible construction.
 - 3. No clearance is required for ducts beyond the distances noted in 1 and 2 above.
 - 4. No clearance is required for ducts used solely for air conditioning, environmental exhaust and ventilating systems.
- N. Where a main supply duct enters the floor of the first story above that in which the furnace is located, the space around the duct at such points shall be sealed with asbestos cement or other noncombustible material.

608—Use of Concealed Ceiling Spaces as Supply or Return Plenums

When concealed ceiling spaces are to be used for air chambers or plenums, the following shall apply:

- A. No concealed ceiling space plenum shall serve more than one story of such building. This shall not preclude separate installations on each floor.
- B. The concealed space plenum shall be separated from any other concealed spaces and shall be completely enclosed with construction not more flammable than one inch (nominal) wood boards. (Flamespread classification not exceeding 200).
- C. Such spaces shall not be used for storage.
- D. No exhaust systems shall discharge into such spaces.
- E. Units supplying such spaces shall be designed to limit the temperature of the air discharged into the supply plenum or chamber to 165 degrees F.
- F. Where units incorporate heating elements, heated surfaces, or combustion chambers, developing temperatures higher than 165 degrees F., such components shall be shielded so as to prevent direct radiation onto combustible material when the unit is installed.
- G. Any duct used to convey heated air to or from the air changer or plenum to distant rooms shall conform to Sections 606 and 607.
- H. The installation of the unit supplying such spaces shall not produce negative pressure in the attic when the attic is the source of air for combustion for fuel fired equipment.

609—Use of Under Floor Space as Supply Plenum—When heated air is discharged downward into an air chamber which forms a plenum of an under floor space, the following shall apply:

- A. Use of such spaces shall be restricted to one story portions of single family dwellings.
- B. Such spaces shall be not more than 24 inches in height to the bottom of floor joists, shall be cleaned of all combustible material and shall be tightly and substantially enclosed.
- C. The enclosing material of the under floor space including the side wall insulation shall be not more flammable than one-inch (nominal) wood boards (Flame spread classification of 200). Combustible ground cover shall be covered over with at least two inches of sand or other noncombustible material.
- D. Access, if provided to such spaces, shall be through an opening in the floor and shall not be less than 24 by 24 inches.
- E. The furnace supplying warm air to such space 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. Such control shall be one that cannot be set higher than 150°F.
- F. The furnace supplying warm air to such space shall be equipped with an approved temperature limit control that will limit outlet air temperature to 200°F.
- G. Floor registers shall be designed for easy removal.
- H. Exterior walls and interior stud partitions shall be firestopped at the floor.

- I. Each wall register shall be connected to the air chamber with a duct or boot complying with Sections 606 and 607.
- J. Supply ducts to the air chamber shall comply with the provisions of Sections 606 and 607 and shall terminate approximately under the center of a room above, at a distance of not less than six feet from the plenum chamber.
- K. Furnaces, boiler's or other heat-producing appliances shall not be installed in such a supply plenum.
- L. The "U" value of the insulated foundation walls shall not exceed 0.17. A vapor barrier shall be provided within the foundation perimeter with joints lapped two inches. The vapor barrier shall be equal to or greater than polyethylene film of 4 mil thickness.

610—Return-Air Intakes for Residences (NON-ENGINEERED SYSTEMS)

- A. If only one central return air grille is installed, it shall be of proper size. The size shall be sufficient to return a volume of air compatible with the CFM requirements and temperature rise limitations specified by the equipment manufacturer. The face velocity of return air grilles shall not exceed 450 feet per minute. At least one separate return shall be installed on each level of a multilevel structure. For split-level and split-foyer structures one return may serve more than one level if located near the levels served and the total area of the levels does not exceed 1600 square feet. Return air grilles shall not be located in bathrooms or kitchens. This does not prohibit the installation of a return grille in a combination kitchen-dining room or kitchen-living room if the grille is not located within 10 feet of the cooking appliance.
- B. In buildings with 1600 square feet or less of conditioned area, a central return is permitted. When the building contains more than 1600 square feet of conditioned area, additional returns shall be provided. Each return shall not serve more than 1600 square feet of area and shall be located in the area it serves. Return air may travel through the living space to the return air intake if there are no restrictions, such as solid doors, to the air movement. When panned joists are used for return air, the structural integrity shall be maintained. Air capacity for joists 16" on center shall be a maximum of 375 CFM for 8" joists and 525 CFM for 10" joists. Wiring shall not be located in joist spaces used for return air ducts.

611—Air Filters

- A. Air filters are required and shall be of an approved type that will not burn freely or emit large volumes of smoke or other objectionable products of combustion when exposed to flames. Filters qualifying as Class I and Class II shall be accepted as meeting these requirements. An evaporative cooler containing a combustible filter or water evaporation medium such as excelsior shall not be used.
- B. Liquid adhesive coatings used on filters shall have a flash point of 325° F, Cleveland Open Cup test or higher.

612—Registers

- A. Floor registers shall be of metal or other approved material designed to resist without structural failure a 200 pound concentrated load on a two-inch diameter disc applied at the most critical area of the exposed face of the register when the temperature of the register is a minimum of 165° F. The material for non-metallic registers shall meet

equivalent requirements of Class 2 duct materials.

- B. Wall and ceiling registers shall meet the requirements of above except the structural failure test is not required.
- C. Registers of combustible material shall not be used in buildings of residential, institutional, schools and assembly occupancies and shall be approved in other occupancies by the authority having jurisdiction.

(6-11-74) Page 8-2—In Section 803.3(a)(1) change Section 2708.3(a) to "803.3(a)."

(3-13-73) Page 9-1—Section 901—In Sixth line of paragraph add "schools" between "institutional" and "and."

(3-13-73) Page 9-2—Section 903.4(b)(1)—Delete the "Exception" in this section.

(6-11-74) Page 9-2—Section 903.4(b)(2)—Add new paragraph "(ee)" under sub-paragraph III to read as follows: "The shaft or enclosure shall be used exclusively to enclose a single grease exhaust system."

(6-11-74) Page 9-2—Section 903.4(f)—At the end of the sentence delete "unless fire dampers are used."

(6-11-74) Page 9-3—Section 903.4(h)(3)—In first and second sentence delete "Aluminum or fiber glass."

(6-11-74) Page 9-3—Section 903.4(i)(1)—Revise to read as follows: "With at least forty (40) inches clearance from the outlet to the nearest roof surface."

(6-11-74) Page 9-4—Section 905(b)(1)—Revise to read as follows: "(1) Materials. Grease filters, including frames or other grease removal devices shall be UL listed."

Page 9-5—Change the paragraph designation "I" to "909."

Page 9-8—Section 918.0—In paragraph (g) change "908.0" to "918.0."

(6-11-74) Page 11-2—Section 1107(c)—Delete first paragraph beginning with "Fire dampers shall be—" and ending with "—Building Official is granted."

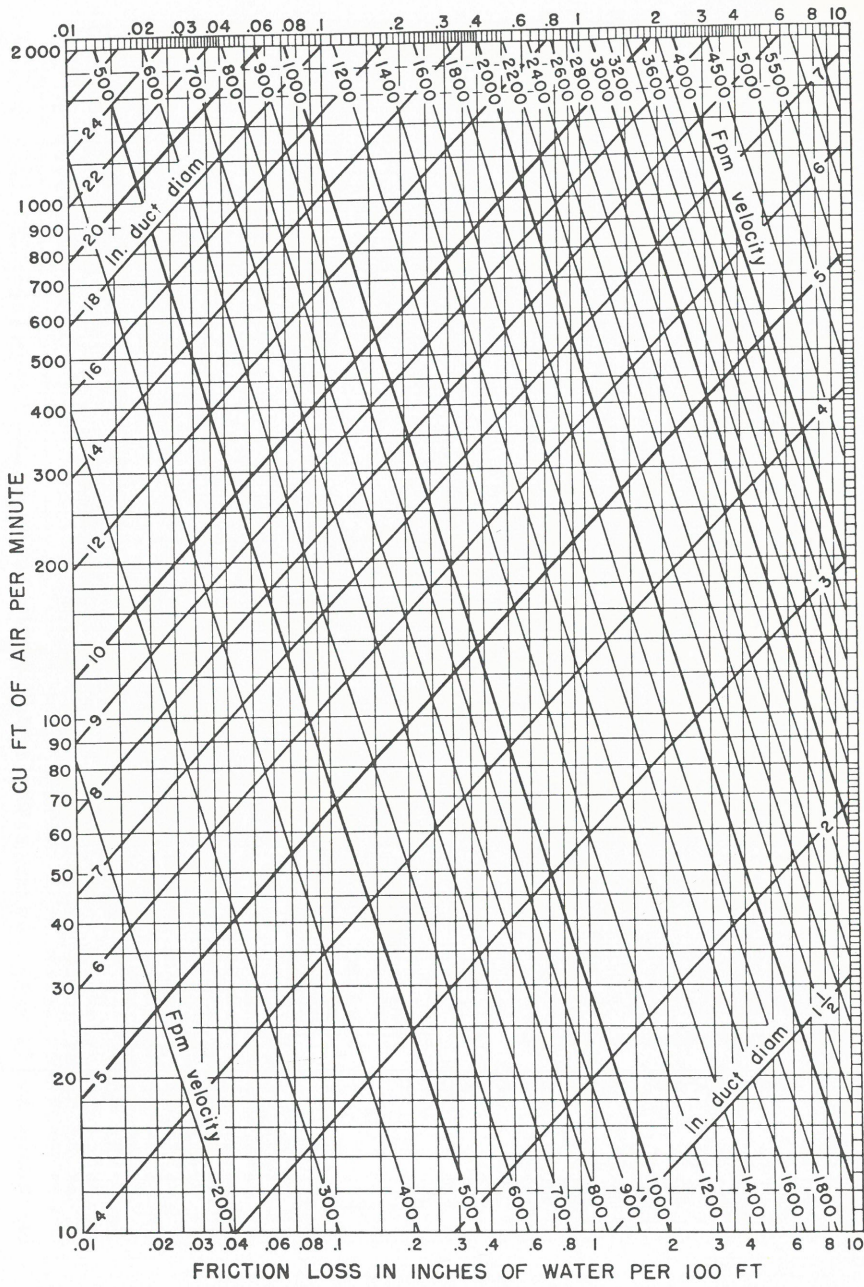
(6-11-74) Page 11-3—Section 1107(e)—Revise paragraphs 1107(e)(1) through (3) to read as follows:

(e) INSTALLATION OF APPROVED FIRE DAMPERS

Approved fire dampers shall be installed in the following locations:

- (1) OCCUPANCY SEPARATIONS—In ducts or openings piercing occupancy separations of 2 hours or more as required by Vol. I, N. C. State Building Code, Sec. 412.
- (2) CEILING PROTECTION—When dampers are selected as the means of protecting the opening. (See specific designs in U.L. Fire Resistance Index, and alternate methods approved for use.)
- (3) WALLS AND PARTITIONS, INCLUDING SHAFT WALLS—Penetrations of enclosures required by this Code or Volume I of N. C. State Building Code to have fire resistance ratings as follows:
 - A. 2-hours or more (not fire walls). All such penetrations.

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(Based on Standard Air of 0.075 lb per cu ft density flowing through average, clean, round, galvanized metal ducts having approximately 40 joints per 100 ft.) Caution: Do not extrapolate below chart.

Friction of Air in Straight Ducts for Volumes of 10 to 2000 Cfm

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Table 2 Circular Equivalents of Rectangular Ducts for Equal Friction and Capacity

Dimensions in Inches

Side Rectangular Duct	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0
3.0	3.8	4.0	4.2	4.4	4.6	4.8	4.9	5.1	5.2	5.5	5.7	6.0	6.2	6.4	6.6	6.8	7.0
3.5	4.1	4.3	4.6	4.8	5.0	5.2	5.3	5.5	5.7	6.0	6.3	6.5	6.8	7.0	7.2	7.4	7.6
4.0	4.4	4.6	4.9	5.1	5.3	5.5	5.7	5.9	6.1	6.4	6.8	7.1	7.3	7.6	7.8	8.1	8.3
4.5	4.6	4.9	5.2	5.4	5.6	5.9	6.1	6.3	6.5	6.9	7.2	7.5	7.8	8.1	8.4	8.6	8.9
5.0	4.9	5.2	5.5	5.7	6.0	6.2	6.4	6.7	6.9	7.3	7.6	8.0	8.3	8.6	8.9	9.1	9.4
5.5	5.1	5.4	5.7	6.0	6.3	6.5	6.8	7.0	7.2	7.6	8.0	8.4	8.7	9.0	9.4	9.6	9.8

Side Rectangular Duct	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22	24	26	28	30	Side Rectangular Duct	
6	6.6																				6	
7	7.1	7.7																			7	
8	7.5	8.2	8.8																		8	
9	8.0	8.6	9.3	9.9																	9	
10	8.4	9.1	9.8	10.4	10.9																10	
11	8.8	9.5	10.2	10.8	11.4	12.0															11	
12	9.1	9.9	10.7	11.3	11.9	12.5	13.1														12	
13	9.5	10.3	11.1	11.8	12.4	13.0	13.6	14.2													13	
14	9.8	10.7	11.5	12.2	12.9	13.5	14.2	14.7	15.3												14	
15	10.1	11.0	11.8	12.6	13.3	14.0	14.6	15.3	15.8	16.4											15	
16	10.4	11.4	12.2	13.0	13.7	14.4	15.1	15.7	16.3	16.9	17.5										16	
17	10.7	11.7	12.5	13.4	14.1	14.9	15.5	16.1	16.8	17.4	18.0	18.6									17	
18	11.0	11.9	12.9	13.7	14.5	15.3	16.0	16.6	17.3	17.9	18.5	19.1	19.7								18	
19	11.2	12.2	13.2	14.1	14.9	15.6	16.4	17.1	17.8	18.4	19.0	19.6	20.2	20.8							19	
20	11.5	12.5	13.5	14.4	15.2	15.9	16.8	17.5	18.2	18.8	19.5	20.1	20.7	21.3	21.9						20	
22	12.0	13.1	14.1	15.0	15.9	16.7	17.6	18.3	19.1	19.7	20.4	21.0	21.7	22.3	22.9	24.1					22	
24	12.4	13.6	14.6	15.6	16.6	17.5	18.3	19.1	19.8	20.6	21.3	21.9	22.6	23.2	23.9	25.1	26.2				24	
26	12.8	14.1	15.2	16.2	17.2	18.1	19.0	19.8	20.6	21.4	22.1	22.8	23.5	24.1	24.8	26.1	27.2	28.4			26	
28	13.2	14.5	15.6	16.7	17.7	18.7	19.6	20.5	21.3	22.1	22.9	23.6	24.4	25.0	25.7	27.1	28.2	29.5	30.6		28	
30	13.6	14.9	16.1	17.2	18.3	19.3	20.2	21.1	22.0	22.9	23.7	24.4	25.2	25.9	26.7	28.0	29.3	30.5	31.6	32.8	30	
32	14.0	15.3	16.5	17.7	18.8	19.8	20.8	21.8	22.7	23.6	24.4	25.2	26.0	26.7	27.5	28.9	30.1	31.4	32.6	33.8	32	
34	14.4	15.7	17.0	18.2	19.3	20.4	21.4	22.4	23.3	24.2	25.1	25.9	26.7	27.5	28.3	29.7	31.0	32.3	33.6	34.8	34	
36	14.7	16.1	17.4	18.6	19.8	20.9	21.9	23.0	23.9	24.8	25.8	26.6	27.4	28.3	29.0	30.5	32.0	33.0	34.6	35.8	36	
38	15.0	16.4	17.8	19.0	20.3	21.4	22.5	23.5	24.5	25.4	26.4	27.3	28.1	29.0	29.8	31.4	32.8	34.2	35.5	36.7	38	
40	15.3	16.8	18.2	19.4	20.7	21.9	23.0	24.0	25.1	26.0	27.0	27.9	28.8	29.7	30.5	32.1	33.6	35.1	36.4	37.6	40	
42	15.6	17.1	18.5	19.8	21.1	22.3	23.4	24.5	25.6	26.6	27.6	28.5	29.4	30.4	31.2	32.8	34.4	35.9	37.3	38.6	42	
44	15.9	17.5	18.9	20.2	21.5	22.7	23.9	25.0	26.1	27.2	28.2	29.1	30.0	31.0	31.9	33.5	35.2	36.7	38.1	39.5	44	
46	16.2	17.8	19.2	20.6	21.9	23.2	24.3	25.5	26.7	27.7	28.7	29.7	30.6	31.6	32.5	34.2	35.9	37.4	38.9	40.3	46	
48	16.5	18.1	19.6	20.9	22.3	23.6	24.8	26.0	27.2	28.2	29.2	30.2	31.2	32.2	33.1	34.9	36.6	38.2	39.7	41.2	48	
50	16.8	18.4	19.9	21.3	22.7	24.0	25.2	26.4	27.6	28.7	29.8	30.8	31.8	32.8	33.7	35.5	37.3	38.9	40.4	42.0	50	
52	17.0	18.7	20.2	21.6	23.1	24.4	25.6	26.8	28.1	29.2	30.3	31.4	32.4	33.4	34.3	36.2	38.0	39.6	41.2	42.8	52	
54	17.3	19.0	20.5	22.0	23.4	24.8	26.1	27.3	28.5	29.7	30.8	31.9	32.9	33.9	34.9	36.8	38.7	40.3	42.0	43.6	54	
56	17.6	19.3	20.9	22.4	23.8	25.2	26.5	27.7	28.9	30.1	31.2	32.4	33.4	34.5	35.5	37.4	39.3	41.0	42.7	44.3	56	
58	17.8	19.5	21.1	22.7	24.2	25.5	26.9	28.2	29.3	30.5	31.7	32.9	33.9	35.0	36.0	38.0	39.8	41.7	43.4	45.0	58	
60	18.1	19.8	21.4	23.0	24.5	25.8	27.3	28.7	29.8	31.0	32.2	33.4	34.5	35.5	36.5	38.6	40.4	42.3	44.0	45.8	60	
62	18.3	20.1	21.7	23.3	24.8	26.2	27.6	29.0	30.2	31.4	32.6	33.8	35.0	36.0	37.1	39.2	41.0	42.9	44.7	46.5	62	
64	18.6	20.3	22.0	23.6	25.2	26.5	27.9	29.3	30.6	31.8	33.1	34.2	35.5	36.5	37.6	39.7	41.6	43.5	45.4	47.2	64	
66	18.8	20.6	22.3	23.9	25.5	26.9	28.3	29.7	31.0	32.2	33.5	34.7	35.9	37.0	38.1	40.2	42.2	44.1	46.0	47.8	66	
68	19.0	20.8	22.5	24.2	25.8	27.3	28.7	30.1	31.4	32.6	33.9	35.1	36.3	37.5	38.6	40.7	42.8	44.7	46.6	48.4	68	
70	19.2	21.1	22.8	24.5	26.1	27.6	29.1	30.4	31.8	33.1	34.3	35.6	36.8	37.9	39.1	41.3	43.3	45.3	47.2	49.0	70	
72	Equation for Circular Equivalent of a Rectangular Duct ^a															39.6	41.8	43.8	45.9	47.8	49.7	72
74																40.0	42.3	44.4	46.4	48.4	50.3	74
76																40.5	42.8	44.9	47.0	49.0	50.8	76
78																40.9	43.3	45.5	47.5	49.5	51.5	78
80																41.3	43.8	46.0	48.0	50.1	52.0	80
82																41.8	44.2	46.4	48.6	50.6	52.6	82
84																42.2	44.6	46.9	49.2	51.1	53.2	84
86																42.6	45.0	47.4	49.6	51.6	53.7	86
88																43.0	45.4	47.9	50.1	52.2	54.3	88
90																43.4	45.9	48.3	50.6	52.8	54.8	90
92																43.8	46.3	48.7	51.1	53.4	55.4	92
96																44.6	47.2	49.5	52.0	54.4	56.3	96

where
 a = length of one side of rectangular duct, inches.
 b = length of adjacent side of rectangular duct, inches.
 d_c = circular equivalent of a rectangular duct for equal friction and capacity, inches.

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Table 2 . . . Circular Equivalents of Rectangular Ducts for Equal Friction and Capacity (Concluded)
Dimensions in Inches

Side Rectangular Duct	32	34	36	38	40	42	44	46	48	50	52	56	60	64	68	72	76	80	84	88	Side Rectangular Duct	
32	35.0																					32
34	36.0	37.2																				34
36	37.0	38.2	39.4																			36
38	38.0	39.2	40.4	41.6																		38
40	39.0	40.2	41.4	42.6	43.8																	40
42	39.9	41.1	42.4	43.6	44.8	45.9																42
44	40.8	42.0	43.4	44.6	45.8	46.9	48.1															44
46	41.7	43.0	44.3	45.6	46.8	47.9	49.1	50.3														46
48	42.6	43.9	45.2	46.5	47.8	48.9	50.2	51.3	52.6													48
50	43.5	44.8	46.1	47.4	48.8	49.8	51.2	52.3	53.6	54.7												50
52	44.3	45.7	47.1	48.3	49.7	50.8	52.2	53.3	54.6	55.8	56.9											52
54	45.0	46.5	48.0	49.2	50.6	51.8	53.2	54.3	55.6	56.8	57.9	61.3										54
56	45.8	47.3	48.8	50.1	51.5	52.7	54.1	55.3	56.5	57.8	58.9	61.3										56
58	46.6	48.1	49.6	51.0	52.4	53.7	55.0	56.2	57.5	58.8	60.0	62.3										58
60	47.3	48.9	50.4	51.8	53.3	54.6	55.9	57.1	58.5	59.8	61.0	63.3	65.7									60
62	48.0	49.7	51.2	52.6	54.2	55.5	56.8	58.0	59.4	60.7	62.0	64.3	66.7									62
64	48.7	50.4	52.0	53.4	55.0	56.4	57.7	59.0	60.3	61.6	62.9	65.3	67.7	70.0								64
66	49.5	51.1	52.8	54.2	55.8	57.2	58.6	59.9	61.2	62.5	63.9	66.3	68.7	71.1								66
68	50.2	51.8	53.5	55.0	56.6	58.0	59.5	60.8	62.1	63.4	64.8	67.3	69.7	72.1	74.4							68
70	50.9	52.5	54.2	55.8	57.3	58.8	60.3	61.7	63.0	64.3	65.7	68.3	70.7	73.1	75.4							70
72	51.5	53.2	54.9	56.5	58.0	59.6	61.1	62.6	63.9	65.2	66.6	69.2	71.7	74.1	76.4	78.8						72
74	52.1	53.9	55.6	57.2	58.8	60.4	61.9	63.3	64.8	66.1	67.5	70.1	72.7	75.1	77.4	79.9						74
76	52.7	54.6	56.3	57.9	59.5	61.2	62.7	64.1	65.6	67.0	68.4	71.0	73.6	76.1	78.4	80.9	83.2					76
78	53.3	55.2	57.0	58.6	60.3	62.0	63.4	64.9	66.4	67.9	69.3	71.8	74.5	77.1	79.4	81.8	84.2					78
80	53.9	55.8	57.6	59.3	61.0	62.7	64.1	65.7	67.2	68.7	70.1	72.7	75.4	78.1	80.4	82.8	85.2	87.5				80
82	54.5	56.4	58.2	60.0	61.7	63.4	64.9	66.5	68.0	69.5	71.0	73.6	76.3	79.0	81.4	83.8	86.2	88.6				82
84	55.1	57.0	58.9	60.7	62.4	64.1	65.7	67.3	68.8	70.3	71.8	74.5	77.2	79.9	82.4	84.8	87.2	89.6	91.9			84
86	55.7	57.6	59.5	61.3	63.0	64.8	66.4	68.0	69.5	71.1	72.6	75.4	78.1	80.8	83.3	85.8	88.2	90.6	92.9			86
88	56.3	58.2	60.1	62.0	63.7	65.4	67.0	68.7	70.3	71.8	73.4	76.3	79.0	81.6	84.2	86.8	89.2	91.6	93.9	96.3		88
90	56.9	58.8	60.7	62.6	64.4	66.0	67.8	69.4	71.1	72.6	74.2	77.1	79.9	82.6	85.1	87.8	90.2	92.6	94.9	97.3		90
92	57.4	59.4	61.3	63.2	65.0	66.8	68.5	70.1	71.8	73.3	74.9	77.9	80.8	83.4	86.0	88.7	91.2	93.6	95.9	98.3		92
94	57.9	60.0	61.9	63.8	65.6	67.5	69.2	70.8	72.5	74.1	75.6	78.7	81.7	84.3	86.9	89.6	92.1	94.6	96.9	99.3		94
96	58.4	60.5	62.4	64.4	66.2	68.2	69.8	71.5	73.2	74.3	76.3	79.4	82.6	85.2	87.8	90.5	93.0	95.6	97.9	100.3		96

