



**Department
of Commerce**

Division of Industrial Compliance

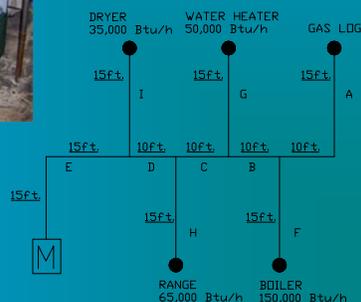
John R. Kasich, Governor
Andre T. Porter, Director

**Ohio Board of Building Standards
Building on the Code Education Series**

**Residential Code of Ohio
Mechanical Requirements
December 20, 2013**

Presentation Handout

2013 Residential Code of Ohio (Mechanical Requirements)



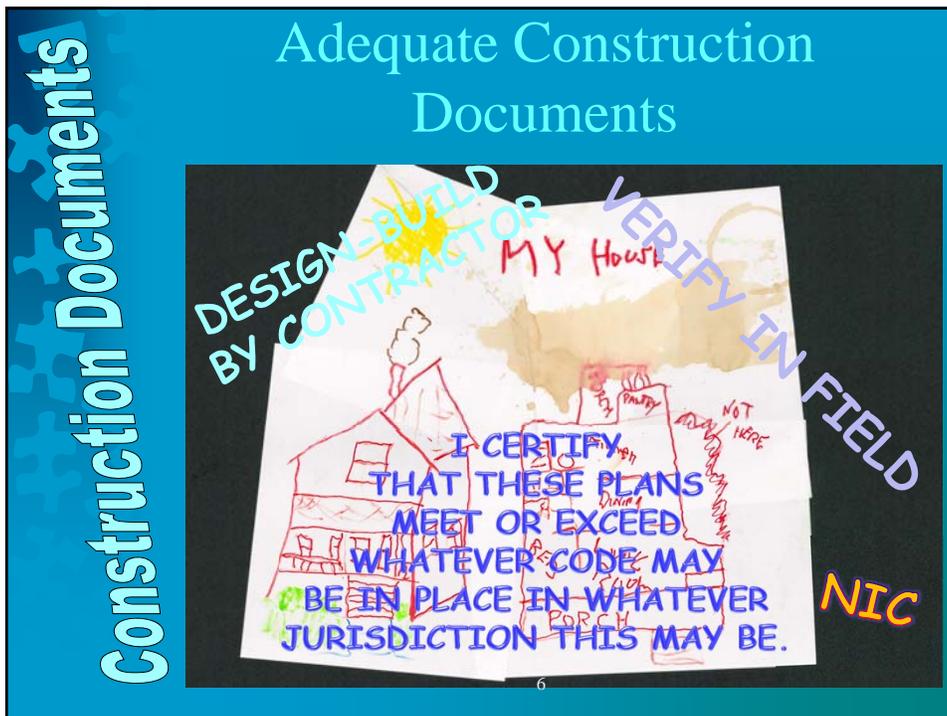
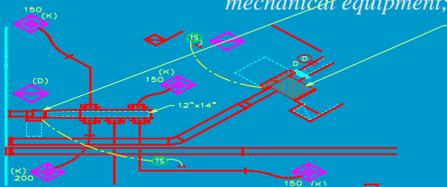
Course Description

- By using the resources and talents of several of its qualified members, OBOA developed a 3-hour course covering mechanical requirements in order to piece together and solidify the intent of specific mechanical areas of the 2013 Residential Code of Ohio.
- This 3-hour course will cover the 2013 Residential Code of Ohio (RCO), selected mechanical requirements and key topics along with their application related in “real world” scenarios. The content will be based upon the Residential Code of Ohio that went into effect on January 1, 2013.
- The content will be appropriate for adult learners with some building code enforcement or residential construction backgrounds; however, the curriculum will not assume any advanced knowledge.

Adequate Construction Documents

- 106.1.3 Submittal documents Information on construction documents. Residential construction documents shall be dimensioned and drawn upon suitable material. Electronic media documents are permitted to be submitted when approved by the residential building official. Construction documents shall be coordinated and of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code. Construction documents, adequate for the scope of the project, shall include information necessary to determine compliance with this code.

Item (8) - System descriptions. Description of the mechanical, plumbing and electrical systems, including: materials; location and type of fixtures and equipment; materials, and sizes of all ductwork; location and type of heating, ventilation, air conditioning and other mechanical equipment; and all lighting and power equipment;



Alternative Products/Materials

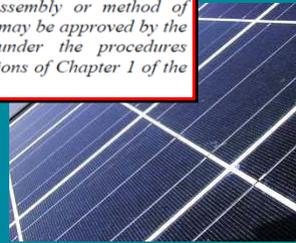
114.2 Alternative materials, products, assemblies and methods of construction.

The provisions of this code are not intended to prevent the installation of any material or to prohibit any material, product, assembly or method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material, product or method of construction shall be approved in accordance with either section 114.2.1 or section 114.2.2.

Exception: Industrialized units constructed in accordance with the "OBC".

114.2.1 Research reports and listings. Any material, product, assembly or method of construction not specifically provided for in this code, shall have a valid research report or listing from an evaluation service listed in "OBC Appendix P" and shall be deemed to be approved provided it complies with the conditions listed in the report and Chapters 3781. and 3791. of the Revised Code.

114.2.2 Board approval. Any material, product, assembly or method of construction not specifically provided for in this code may be approved by the board of building standards upon application under the procedures prescribed by the board and as outlined in the provisions of Chapter 1 of the "OBC"



Listed and Labeled

- 1302.1 Listed and labeled.** Appliances regulated this code shall be listed and labeled for the application in which they are installed and used, unless otherwise approved in accordance with Sections 106.4 and 106.5.

LIMITED TANK A/C SYSTEMS EQUIPMENT

MODEL NO.
D7CG036N07925A

SERIAL (S)NLKM119961

FACTORY CHARGED R22 FOR OUTDOOR INSTALLATION ONLY
TOTAL S LB 8 OZS UNIT SUPPLY 288/230U 50H 60HZ
CONTROL CIRCUIT 75 VA MIN. CKT. AMPACITY 20.0
MAXIMUM FUSE SIZE (TIME DELAY) 30 AMPS
MAXIMUM CIRCUIT BREAKER SIZE 30 AMPS
* USE ONLY HACR TYPE CIRCUIT BREAKER PER UL LISTING.
FACT. TEST PRESS. HIGH SIDE 450 PSIG LOW SIDE 190 PSIG
QTY LOADS HP VOLTS PH HZ
1 COMP. 288/230-3-60 11.4 OLR 90.0 LRR
1 I.D. BLD .5 288/230-1-60 4.4 FLR
1 C.D. FRN .25 288/230-1-60 1.3 FLR
1 COND. VENT .05 288/230-1-60 4 FLR
TYPE GAS-NATURAL MANIFOLD PRESS - 3.5" W.C.
ORIFICE: (42) DRILL SIZE PILOT ORIFICE: (56) DRILL SIZE
THIS APPLIANCE EQUIPPED ONLY FOR ALTITUDES 0-2000 FT
FOR PURPOSES OF INPUT ADJUSTMENTS:
NATURAL GAS SUPPLY @ UNIT " W.C. : 18.5 MAX 4.5 MIN

pliance 11 MFR DATE 12/2004

NO. 2A7A102-3A1000AA VOLTS 200/230
4504K4Y5F PH 1 HZ 60

AM CIRCUIT AMPACITY 13.0 AMPS
CURRENT PROTECTIVE DEVICE USA CANADA
USE / BREAKER (HACR) 20 20
USE / BREAKER (HACR) 20 20
C-22 3 LBS 14 OZ OR 1.76 kg
W-057A REQUIRED INDOORS FOR RATED PERFORMANCE
(Detailed Instructions) Split-Flt Easy-Start

ICAN STANDARD INC. (UL) LISTED BY UL
EX 75707 ASSEMBLED IN USA

COMPR. MOT. 9.0 RLA 200/230V 60 LRA
O.D. MOT. .50 FLA 200/230V 1/6 H
M.E.A. NO. F. ID. A22
DESIGN PSI - HIGH 303 LOW 300

Definitions

- **APPLIANCE**. Any apparatus or device that utilizes gas as a fuel or raw material to produce light, heat, power, refrigeration or air conditioning.



Definitions

- **EQUIPMENT (OR FIXTURE)**. Any plumbing, heating, electrical, ventilating, air conditioning, refrigerating and fire protection devices and components of systems other than appliances, and elevators, dumb waiters, and other mechanical facilities or installations that are related to building services.



Definitions

- **BOILER**. A closed vessel in which water is heated, steam is superheated, or any combination thereof, under pressure to vacuum for use externally to itself by the direct application of heat from the combustion of fuels, or from electricity or nuclear energy. The term boiler includes fired units for heating or vaporizing liquids other than water where these units are separate from processing systems and are complete within themselves.



Layout of the Mechanical Requirements in the 2013 RCO

- The mechanical requirements span between Chapters 12-24.

Chapter 12	Mechanical Administration
Chapter 13	General Mechanical System Requirements
Chapter 14	Heating and Cooling Equipment
Chapter 15	Exhaust Systems
Chapter 16	Duct Systems
Chapter 17	Combustion Air
Chapter 18	Chimneys and Vents
Chapter 19	Special Fuel-Burning Equipment
Chapter 20	Boilers and Water Heaters
Chapter 21	Hydronic Piping
Chapter 22	Special Piping and Storage Systems
Chapter 23	Solar Systems
Chapter 24	Fuel Gas

General Mechanical System Requirements

- **Given:** The Residential Building Official receives construction documents with application for a dust collection/exhaust system to be installed in a residential accessory building (wood working shop).
- **Find:** Use your code book to find the requirements regarding this system in order to review and approve the documents.

1301.1 Scope. The provisions of this chapter shall govern the installation of mechanical systems not specifically covered in other chapters applicable to mechanical systems. Installations of mechanical appliances, equipment and systems not addressed by this code shall comply with the applicable provisions of the mechanical code and the "International Fuel Gas Code"



Mechanical Requirements in RCO Chapter 11

- RCO Chapter 11 is Energy Efficiency.
- Section 1101.2 provides three (3) options for demonstrating energy compliance.
 - 2009 IECC or
 - Sections 1101-1104 or
 - Section 1105 Ohio Home Builder's Association (OHBA) Alternative Energy Code Option

Note: the following slides will focus on key mechanical requirements found in the 2009 IECC (Prescriptive) and Section 1105 OHBA options.

2009 IECC and Section 1105 OHBA

IECC 403.1 & OHBA 1105.3.1.1 – Controls (Mandatory)

- Programmable thermostat.
 - Forced air furnace
 - Minimum of one per dwelling unit
 - Capable of maintaining a daily schedule
 - Setback down to 55°F or up to 85°F
 - Initial programming
 - Heating 70°F maximum.
 - Cooling 78°F minimum.



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2009 IECC and Section 1105 OHBA

IECC 403.2.1 (Prescriptive) & OHBA 1105.3.1.1

Insulation - Supply ducts in attics shall be insulated to a minimum of R-8. All other ducts shall be insulated to a minimum of R-6.

- **Note**: HVAC duct work located outside of the conditioned space must be insulated with insulation of minimum R-values. This includes both supply and return ducts.
- **Exception**: Ducts or portions thereof located completely inside the building thermal envelope.



2009 IECC and Section 1105 OHBA

IECC 403.2.2 (Mandatory) & OHBA 1105.3.2.2 Sealing - All ducts, air handlers, filter boxes and building cavities used as ducts shall be sealed. Joints and seams shall comply with Section M1601.4.1.



Return-air duct work installed in basements or concealed building spaces may conduct chemicals or other products that produce potentially harmful fumes. Because the return air operates under negative pressure, any leaks could draw fumes, moisture, soil gases or odors from the surrounding area and direct them into the house. Therefore, sealing of return air duct work is also a requirement.

OHBA Duct Tightness Post Const. Test

1105.3.2.2 Sealing. Ducts, air handlers, filter boxes and building cavities used as ducts shall be sealed. Joints and seams shall comply with Section M1601.4. Duct tightness shall be verified by either of the following:

1. **Post-construction test:** Post-construction duct tightness shall be verified to meet the values prescribed in Table 1105.3.2.2(a) by testing either the "Leakage to Outdoors" or the "Total Leakage" in accordance with the chosen compliance path. Testing shall be conducted at a pressure differential of 0.1 inch w.g. (25 Pa) across the entire system, including the manufacturer's air handler end closure. All register boots shall be taped or otherwise sealed during the test.

Note: Duct tightness testing will take place on January 1, 2014 (Approvals dated on and after this date).

TABLE 1105.3.2.2(a)
POST-CONSTRUCTION DUCT TIGHTNESS TESTING

	Leakage to Outdoors	Total Leakage
	(per 100 ft ² (9.29 m ²) of conditioned floor area)	(per 100 ft ² (9.29 m ²) of conditioned floor area)
Compliance Path #1	≤ 6 cfm (2.83 L/s)	≤ 9 cfm (4.24 L/s)
Compliance Path #2	≤ 4 cfm (1.89 L/s)	≤ 6 cfm (2.83 L/s)

Exception: Duct tightness test is not required if the air handler and all ducts are located within conditioned space.



OHBA Duct Tightness Rough-in Test

2. **Rough-in test:** Rough-in duct tightness shall be verified to meet the values prescribed in [Table 1105.3.2.2\(b\)](#) by testing the "Total Leakage" in accordance with the chosen compliance path. Testing shall be conducted at a pressure differential of 0.1 inch w.g. (25 Pa) across the roughed in system, including the manufacturer's air handler enclosure, if installed at the time of the test. All register boots shall be taped or otherwise sealed during the test.

TABLE 1105.3.2.2(b)
ROUGH-IN DUCT TIGHTNESS TESTING

	Total Leakage – with air handler installed (per 100 ft ² (9.29 m ²) of conditioned floor area)	Total Leakage – without air handler installed (per 100 ft ² (9.29 m ²) of conditioned floor area)
Compliance Path #1	≤ 6 cfm (2.83 L/s)	≤ 4 cfm (1.89 L/s)
Compliance Path #2	≤ 4 cfm (1.89 L/s)	≤ 3 cfm (1.41 L/s)

Exception: Duct tightness test is not required if the air handler and all ducts are located within conditioned space.



2009 IECC Duct Tightness Testing

403.2.2 Sealing (Mandatory). All ducts, air handlers, filter boxes and building cavities used as ducts shall be sealed. Joints and seams shall comply with Section M1601.4.1 of the *International Residential Code*.

Duct tightness shall be verified by either of the following:

1. Postconstruction test: Leakage to outdoors shall be less than or equal to 8 cfm (226.5 L/min) per 100 ft² (9.29 m²) of conditioned floor area or a total leakage less than or equal to 12 cfm (12 L/min) per 100 ft² (9.29 m²) of conditioned floor area when tested at a pressure differential of 0.1 inches w.g. (25 Pa) across the entire system, including the manufacturer's air handler enclosure. All register boots shall be taped or otherwise sealed during the test.
2. Rough-in test: Total leakage shall be less than or equal to 6 cfm (169.9 L/min) per 100 ft² (9.29 m²) of conditioned floor area when tested at a pressure differential of 0.1 inches w.g. (25 Pa) across the roughed in system, including the manufacturer's air handler enclosure. All register boots shall be taped or otherwise sealed during the test. If the air handler is not installed at the time of the test, total leakage shall be less than or equal to 4 cfm (113.3 L/min) per 100 ft² (9.29 m²) of conditioned floor area.

Note: Duct tightness testing has been in place since January 1, 2013 (Approvals dated on and after this date). Required if the owner/owner's agent has selected the 2009 IECC energy option for the project.

Exception: Duct tightness test is not required if the air handler and all ducts are located within conditioned space.



Appliance Access

1305.1 Appliance access for inspection service, repair and replacement.

Appliances shall be accessible for inspection, service, repair and replacement without removing permanent construction, other appliances, or any other piping or ducts not connected to the appliance being inspected, serviced, repaired or replaced. A level working space at least 30 inches deep and 30 inches wide (762 mm by 762 mm) shall be provided in front of the control side to service an appliance. Installation of room heaters shall be permitted with at least an 18-inch (457 mm) working space. A platform shall not be required for room heaters.

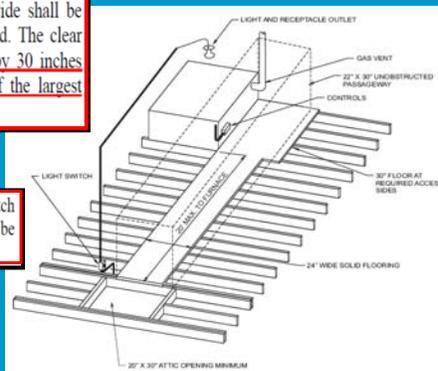
1305.1.2 Appliances in rooms. Appliances installed in a compartment, alcove, basement or similar space shall be accessed by an opening or door and an unobstructed passageway measuring not less than 24 inches (610 mm) wide and large enough to allow removal of the largest appliance in the space, provided there is a level service space of not less than 30 inches (762 mm) deep and the height of the appliance, but not less than 30 inches (762 mm), at the front or service side of the appliance with the door open.



Appliance Access

1305.1.3 Appliances in attics. Attics containing appliances shall be provided with an opening and a clear and unobstructed passageway large enough to allow removal of the largest appliance, but not less than 30 inches (762 mm) high and 22 inches (559 mm) wide and not more than 20 feet (6096 mm) long measured along the centerline of the passageway from the opening to the appliance. The passageway shall have continuous solid flooring in accordance with Chapter 5 not less than 24 inches (610 mm) wide. A level service space at least 30 inches (762 mm) deep and 30 inches (762 mm) wide shall be present along all sides of the appliance where access is required. The clear access opening dimensions shall be a minimum of 20 inches by 30 inches (508 mm by 762 mm), and large enough to allow removal of the largest appliance.

1305.1.3.1 Electrical requirements. A luminaire controlled by a switch located at the required passageway opening and a receptacle outlet shall be installed at or near the appliance location in accordance with *NFPA 70*.



Clearance from Combustible Construction

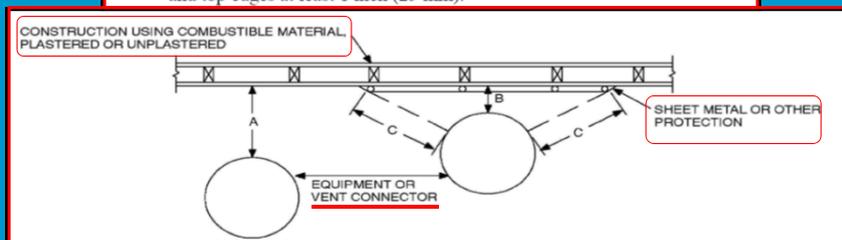
1306.1 Appliance clearance. Appliances shall be installed with the clearances from unprotected combustible materials as indicated on the appliance label and in the manufacturer's installation instructions.



Clearance Reduction

1306.2 Clearance reduction. Reduction of clearances shall be in accordance with the appliance manufacturer's instructions and Table 1306.2. Forms of protection with ventilated air space shall conform to the following requirements:

1. Not less than 1-inch (25 mm) air space shall be provided between the protection and combustible wall surface.
2. Air circulation shall be provided by having edges of the wall protection open at least 1 inch (25 mm).
3. If the wall protection is mounted on a single flat wall away from corners, air circulation shall be provided by having the bottom and top edges, or the side and top edges open at least 1 inch (25 mm).
4. Wall protection covering two walls in a corner shall be open at the bottom and top edges at least 1 inch (25 mm).



Clearance Reduction

Given: A boiler has a minimum 36 inch clearance to vertical combustible assemblies at the rear of the appliance. The Inspector measures 12 inches from the appliance to the combustible wall.

Is there a problem here?

May there be a solution?

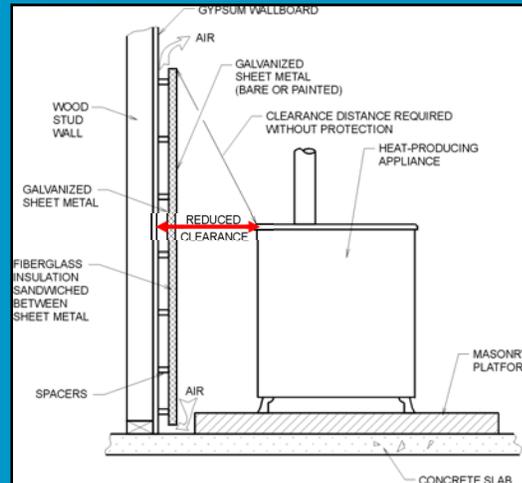
Could a clearance reduction method be installed?

Clearance Reduction Gas (Table 2409.2) and Non-Gas (Table 1306.2)

TYPE OF PROTECTION APPLIED TO AND COVERING ALL SURFACES OF COMBUSTIBLE MATERIAL WITHIN THE DISTANCE SPECIFIED AS THE REQUIRED CLEARANCE WITH NO PROTECTION (See Figures 1306.1 and 1306.2)	REDUCTION OF CLEARANCES WITH SPECIFIED FORMS OF PROTECTION ^{a, c, d, e, f, g, h, i, j, k, l}									
	WHERE THE REQUIRED CLEARANCE WITH NO PROTECTION FROM APPLIANCE, VENT CONNECTOR, OR SINGLE WALL METAL PIPE IS:									
	36 inches	15 inches	12 inches	9 inches	6 inches	36 inches	15 inches	12 inches	9 inches	6 inches
	Allowable clearances with specified protection (inches) ^b									
	Use column 1 for clearances above an appliance or horizontal connector. Use column 2 for clearances from an appliance, vertical connector and single-wall metal pipe.									
	Above column 1	Sides and rear column 2	Above column 1	Sides and rear column 2	Above column 1	Sides and rear column 2	Above column 1	Sides and rear column 2	Above column 1	Sides and rear column 2
3½-inch thick masonry wall without ventilated air space	—	24	—	12	—	9	—	6	—	5
½-in. insulation board over 1-inch glass fiber or mineral wool batts	24	18	12	9	9	6	6	5	4	3
Galvanized sheet steel having a minimum thickness of 0.0236-inch (No. 24 gage) over 1-inch glass fiber or mineral wool batts reinforced with wire or rear face with a ventilated air space	18	12	9	6	6	4	5	3	3	3
3½-inch thick masonry wall with ventilated air space	—	12	—	6	—	6	—	6	—	6
Galvanized sheet steel having a minimum thickness of 0.0236-inch (No. 24 gage) with a ventilated air space 1-inch off the combustible assembly	18	12	9	6	6	4	5	3	3	2
½-inch thick insulation board with ventilated air space	18	12	9	6	6	4	5	3	3	3
Galvanized sheet steel having a minimum thickness of 0.0236-inch (No. 24 gage) with ventilated air space over 24 gage sheet steel with a ventilated space	18	12	9	6	6	4	5	3	3	3
1-inch glass fiber or mineral wool batts sandwiched between two sheets of galvanized sheet steel having a minimum thickness of 0.0236-inch (No. 24 gage) with a ventilated air space	18	12	9	6	6	4	5	3	3	3

Clearance Reduction

Therefore, if the manufacture's instructions allowed reduced clearances, and the assembly was submitted, approved, installed and inspected as indicated below, the 12 inch reduced clearance would be acceptable.



Heating and Cooling

- Six specific areas of Chapter 14
 - Required Heating
 - Sizing of Equipment
 - Types of Equipment
 - Condensate Disposal
 - Locking Access Port Caps
 - Refrigerant Piping Insulation

Heating and Cooling

- Required Heating

303.8 Required heating. When the winter design temperature in [Table 301.2\(1\)](#) is below 60°F (16°C), every dwelling unit shall be provided with heating facilities capable of maintaining a minimum room temperature of 68°F (20°C) at a point 3 feet (914 mm) above the floor and 2 feet (610 mm) from exterior walls in all habitable rooms at the design temperature. The installation of one or more portable space heaters shall not be used to achieve compliance with this section.

STATION	HEATING DEGREE DAYS (Yearly Total)	DESIGN TEMPERATURES	DEGREES NORTH LATITUDE
Akron-Canton	6,037	6°	41°00'
Cincinnati	4,410	6°	39°10'
Cleveland	6,351	5°	41°20'
Columbus	5,660	5°	41°00'
Dayton	5,622	4°	39°50'
Mansfield	6,403	5°	41°50'
Sandusky	5,796	6°	41°30'
Toledo	6,494	1°	41°40'
Youngstown	6,417	4°	41°20'

Heating and Cooling

- Sizing of Equipment

1401.3 Sizing. Heating and cooling equipment shall be sized in accordance with ACCA Manual S based on building loads calculated in accordance with ACCA Manual J or other approved heating and cooling calculation methodologies.



Heating and Cooling

- Types of Equipment

Chapter 14 contains specific information regarding the following equipment:

CENTRAL FURNACES
 HEAT PUMP EQUIPMENT
 REFRIGERATION COOLING EQUIPMENT
 BASEBOARD CONVECTORS
 RADIANT HEATING SYSTEMS
 DUCT HEATERS
 VENTED FLOOR FURNACES
 VENTED WALL FURNACES
 VENTED ROOM HEATERS
HEATING AND COOLING EQUIPMENT
 ABSORPTION COOLING EQUIPMENT
 EVAPORATIVE COOLING EQUIPMENT
 FIREPLACE STOVES
 MASONRY HEATERS



Example:

M1411.2 Refrigeration coils in warm-air furnaces. Where a cooling coil is located in the supply plenum of a warm-air furnace, the furnace blower shall be rated at not less than 0.5-inch water column (124 Pa) static pressure unless the furnace is *listed and labeled* for use with a cooling coil. Cooling coils shall not be located upstream from heat exchangers unless *listed and labeled* for such use.

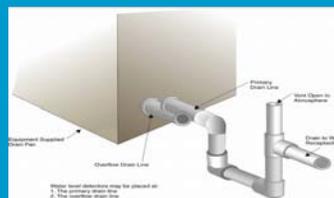
Heating and Cooling

- Condensate Disposal

M1411.3.1 Auxiliary and secondary drain systems. In

addition to the requirements of Section M1411.3, a secondary drain or auxiliary drain pan shall be required for each cooling or evaporator coil where **damage** to any building components will occur as a result of overflow from the *equipment* drain pan or stoppage in the condensate drain piping. Such piping shall maintain a minimum horizontal **slope** in the direction of discharge of **not less than 1/8 unit vertical in 12 units horizontal (1-percent slope)**. Drain piping shall be a minimum of **3/4-inch** (19 mm) nominal pipe size. *One of the methods in this section shall be used. Example Item 2 indicated below:*

2. A separate overflow drain line shall be connected to the drain pan installed with the *equipment*. This overflow drain shall discharge to a conspicuous point of disposal to alert occupants in the event of a stoppage of the primary drain. The overflow drain line shall connect to the drain pan at a higher level than the primary drain connection.



Heating and Cooling

- Locking Access Port Caps

1411.6 Locking access port caps. Refrigerant circuit access ports located outdoors shall be fitted with locking-type tamper-resistant caps.

New requirement due to people huffing refrigerants.



Heating and Cooling

- Refrigerant Piping Insulation

1411.5 Insulation of refrigerant piping. Piping and fittings for refrigerant vapor (suction) lines shall be insulated with insulation having a thermal resistivity of at least R-4 and having external surface permeance not exceeding 0.05 perm [2.87 ng/(s · m² · Pa)] when tested in accordance with ASTM E 96.



Ventilation & Exhaust Systems

- Specific areas of Chapters 3 & 15
 - Natural or Mechanical Ventilation
 - Minimum Exhaust Rates for Kitchens and Bathrooms
 - Clothes Dryer Exhaust (Gas & Non-Gas)

Ventilation & Exhaust Systems

- Natural or Mechanical Ventilation

303.1 Habitable rooms. All habitable rooms shall have an aggregate glazing area of not less than 8 percent of the floor area of such rooms. Natural ventilation shall be through windows, doors, louvers or other approved openings to the outdoor air. Such openings shall be provided with ready access or shall otherwise be readily controllable by the building occupants. The minimum openable area to the outdoors shall be 4 percent of the floor area being ventilated.

Exception 1. The glazed areas need not be openable where the opening is not required by Section 310 and an approved mechanical ventilation system capable of producing 0.35 air change per hour in the room is installed or a whole-house mechanical ventilation system is installed capable of supplying outdoor ventilation air of 15 cubic feet per minute (cfm) (78 L/s) per occupant computed on the basis of two occupants for the first bedroom and one occupant for each additional bedroom.



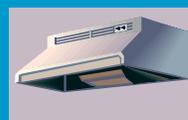
Ventilation & Exhaust Systems

- Minimum Exhaust Rates for Kitchens and Bathrooms

1507.3 Ventilation rate. Ventilation systems shall be designed to have the capacity to exhaust the minimum air flow rate determined in accordance with Table 1507.3.

**TABLE 1507.3
MINIMUM REQUIRED EXHAUST RATES FOR ONE-, TWO-, AND
THREE-FAMILY DWELLINGS**

AREA TO BE VENTILATED	VENTILATION RATES
Kitchens	100 cfm intermittent or 25 cfm continuous
Bathrooms—Toilet Rooms	Mechanical exhaust capacity of 50 cfm intermittent or 20 cfm continuous



Ventilation & Exhaust Systems

- Clothes Dryer Exhaust (Gas & Non-Gas)

Note: Non-gas clothes dryer vent requirements are addressed in RCO Section 1502 (not Section 2439). Although the requirements are basically the same, it should be understood that it would not be appropriate to cite Section 2439 for a non-gas dryer vent code discrepancy. The following information pertains to fuel gas clothes dryer appliances.

2439.5.1 Material and size. Exhaust ducts shall have a smooth interior finish and shall be constructed of metal a minimum 0.016-inch thick (28 ga). The exhaust duct size shall be 4 inches (102 mm) nominal in diameter.

2439.5.6 Length identification. Where the exhaust duct is concealed within the building construction, and only if the equivalent length exceeds 25 feet (7620 mm), the equivalent length of the exhaust duct shall be identified on a permanent label or tag. The label or tag shall be located within 6 feet (1829 mm) of the exhaust duct connection or at the electrical panel.

THE NET EQUIVALENT LENGTH
OF DRYER DUCT FROM THIS
LOCATION IS _____ FEET

The maximum allowable exhaust duct length stated in the clothes dryer's installation instructions shall be equal to or greater than the posted equivalent length indicated on this placard.

2439.5.5 Duct length. The maximum allowable exhaust duct length shall be determined by one of the methods specified in Section 2439.5.5.1 or 2439.5.5.2.

2439.5.5.1 Specified length. The maximum length of the exhaust duct shall be 25 feet (7620 mm) from the connection to the transition duct from the dryer to the outlet terminal. Where fittings are used, the maximum length of the exhaust duct shall be reduced in accordance with Table 2439.5.5.1.

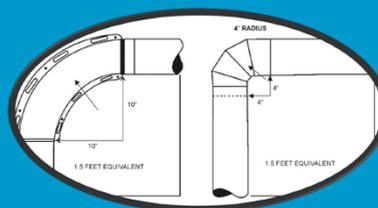
Ventilation & Exhaust Systems

- Clothes Dryer Exhaust (Gas & Non-Gas)

2439.5.5.2 Manufacturer's instructions. The maximum length of the exhaust duct shall be determined by the dryer manufacturer's installation instructions. The *building* official shall be provided with a copy of the installation instructions for the make and model of the dryer. Where the exhaust duct is to be concealed, the installation instructions shall be provided to the *building* official prior to the concealment inspection. **In the absence of fitting equivalent length calculations from the clothes dryer manufacturer, Table 2439.5.5.1 shall be used.**

**TABLE 2439.5.5.1
DRYER EXHAUST DUCT FITTING EQUIVALENT LENGTH**

DRYER EXHAUST DUCT FITTING TYPE	EQUIVALENT LENGTH
4 inch radius mitered 45 degree elbow	2 feet 6 inches
4 inch radius mitered 90 degree elbow	5 feet
6 inch radius smooth 45 degree elbow	1 foot
6 inch radius smooth 90 degree elbow	1 foot 9 inches
8 inch radius smooth 45 degree elbow	1 foot
8 inch radius smooth 90 degree elbow	1 foot 7 inches
10 inch radius smooth 45 degree elbow	9 inches
10 inch radius smooth 90 degree elbow	1 foot 6 inches



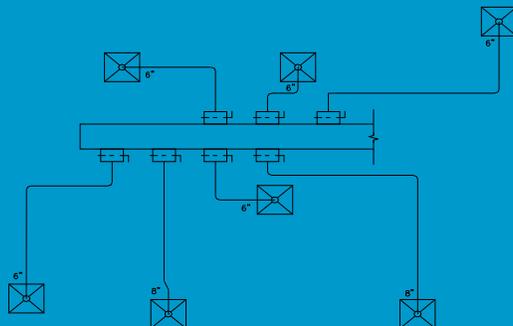
Duct Systems

- Specific areas of Chapters 16
- Duct Design
- Types of ducts
- Duct Insulation
- Sealing Ducts
- Return Air

Duct Systems

- Duct Design

1601.1 Duct design. Duct systems serving heating, cooling and ventilation equipment shall be fabricated in accordance with the provisions of this section and ACCA Manual D or other approved methods.



Duct Systems

- Types of ducts

TABLE 1601.1.1(2)
GAGES OF METAL DUCTS AND PLENUMS USED FOR HEATING OR COOLING

DUCT SIZE	GALVANIZED		ALUMINUM
	MINIMUM THICKNESS (inches)	EQUIVALENT GALVANIZED SHEET NO.	MINIMUM THICKNESS (in.)
Round ducts and enclosed rectangular ducts			
14 inches or less	0.0127	30	0.0175
16 and 18 inches	0.0187	26	0.018
20 inches and over	0.0236	24	0.023
Exposed rectangular ducts			
14 inches or less	0.0157	28	0.0175
Over 14 inches	0.0187	26	0.018

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

DUCT CLASS	MAXIMUM FLAME SPREAD INDEX
0	0
1	25

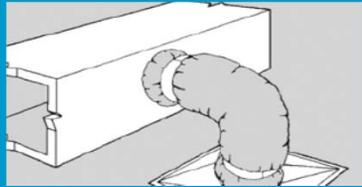
Class 0 indicates flame-spread and smoke-developed indexes of zero; Class 1 indicates a flame spread index not greater than 25 and a smoke-developed index not greater than 50, when tested to ASTM E 84.



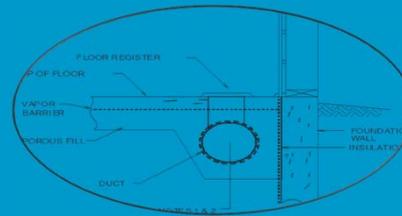
Duct Systems

- Types of ducts

1601.2 Factory-made ducts. Factory-made air ducts or duct material shall be approved for the use intended, and shall be installed in accordance with the manufacturer's installation instructions. Each portion of a factory-made air duct system shall bear a listing and label indicating compliance with UL 181 and UL181A or UL 181B.



1601.1.2 Underground duct systems. Underground duct systems shall be constructed of approved concrete, clay, metal or plastic. The maximum duct temperature for plastic ducts shall not be greater than 150°F (66°C). Metal ducts shall be protected from corrosion in an approved manner or shall be completely encased in concrete not less than 2 inches (51 mm) thick. Nonmetallic ducts shall be installed in accordance with the manufacturer's installation instructions. Plastic pipe and fitting materials shall conform to cell classification 12454-B of ASTM D 1248 or ASTM D 1784 and external loading properties of ASTM D 2412. All ducts shall slope to an accessible point for drainage. Where encased in concrete, ducts shall be sealed and secured prior to any concrete being poured. Metallic ducts having an approved protective coating and nonmetallic ducts shall be installed in accordance with the manufacturer's installation instructions.



Duct Systems

- Duct Insulation

1601.3 Duct insulation materials. Duct coverings and linings, including adhesives where used, shall have a flame spread index not higher than 25, and a smoke-developed index not over 50 when tested in accordance with ASTM E 84 or UL 723, using the specimen preparation and mounting procedures of ASTM E 2231.



Duct Systems

• Sealing Ducts

M1601.4.1 Joints and seams. Joints of *duct systems* shall be made substantially airtight by means of tapes, mastics, liquid sealants, gasketing or other *approved* closure systems.



Duct Systems

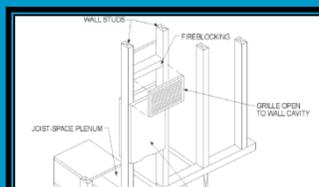
• Return Air

1602.2 Prohibited sources. Outdoor and return air for a forced-air heating or cooling system shall not be taken from the following locations:

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

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

4. A closet, bathroom, toilet room, kitchen, garage, mechanical room, boiler room, furnace room, unconditioned attic or other dwelling unit.
5. A room or space containing a fuel-burning appliance where such room or space serves as the sole source of return air.
6. An unconditioned crawl space by means of direct connection to the return side of a forced air system. Transfer openings in the crawl space enclosure shall not be prohibited.



Combustion Air

- Selected areas of Chapters 17 & 24
- Chapter 17 (Solid fuel and oil)
- Chapter 24 (Fuel gas)

Combustion Air

Combustion air is necessary for complete fuel combustion. Incomplete combustion results in the production of increased carbon monoxide, build-up of soot, and damage to the appliance.

- Chapter 17 (Solid fuel and oil)

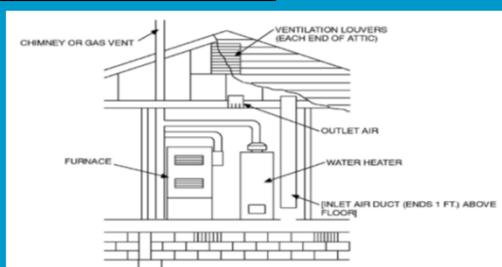
1701.1 Scope. Solid-fuel-burning appliances shall be provided with combustion air in accordance with the appliance manufacturer's installation instructions. Oil fired appliances shall be provided with combustion air in accordance with NFPA 31. The methods of providing combustion air in this chapter do not apply to fireplaces, fireplace stoves and direct-vent appliances. The requirements for combustion and dilution air for gas-fired appliances shall be in accordance with Chapter 24.

Combustion Air

- Chapter 24 (Fuel gas)

SECTION 2407 COMBUSTION, VENTILATION AND DILUTION AIR

2407.1 General. Air for combustion, ventilation and dilution of flue gases for appliances installed in buildings shall be provided by application of one of the methods prescribed in Sections 2407.5 through 2407.9. Where the requirements of Section 2407.5 are not met, outdoor air shall be introduced in accordance with one of the methods prescribed in Sections 2407.6 through 2407.9. Direct-vent appliances, gas appliances of other than natural draft design and vented gas appliances other than Category I shall be provided with combustion, ventilation and dilution air in accordance with the appliance manufacturer's instructions.



Combustion Air

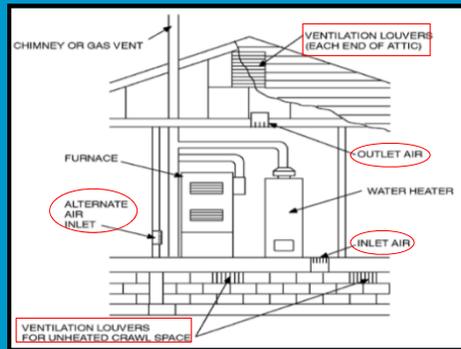
- Chapter 24 (Fuel gas)

Many different methods of providing combustion air are indicated in Section 2407. **Note:** with our modern homes being built tighter and tighter, reliance upon indoor air as the sole means for combustion air is becoming a challenge. However, the following prescriptive methods have been selected to inform the code user of using outdoor air for combustion and dilution.

Combustion Air (Two Opening)

2407.6.1 Two-permanent-openings method. Two permanent openings, one commencing within 12 inches (305 mm) of the top and one commencing within 12 inches (305 mm) of the bottom of the enclosure, shall be provided. The openings shall communicate directly, or by ducts, with the outdoors or spaces that freely communicate with the outdoors.

Where directly communicating with the outdoors, or where communicating with the outdoors through vertical ducts, each opening shall have a minimum free area of 1 square inch per 4,000 Btu/h (550 mm²/kW) of total input rating of all appliances in the enclosure [see Figures 2407.6.1(1) and 2407.6.1(2)].



Combustion Air (One Opening)

2407.6.2 One-permanent-opening method. One permanent opening, commencing within 12 inches (305 mm) of the top of the enclosure, shall be provided. The appliance shall have clearances of at least 1 inch (25 mm) from the sides and back and 6 inches (152 mm) from the front of the appliance. The opening shall directly communicate with the outdoors or through a vertical or horizontal duct to the outdoors, or spaces that freely communicate with the outdoors (see Figure 2407.6.2) and shall have a minimum free area of 1 square inch per 3,000 Btu/h (734 mm²/kW) of the total input rating of all appliances located in the enclosure and not less than the sum of the areas of all vent connectors in the space.

Application:

Furnace 100,000 Btu/h and WH 50,000 Btu/h
Total = 150,000 Btu/h

Min. Area = 150,000/3000 = 50 square inches (free)

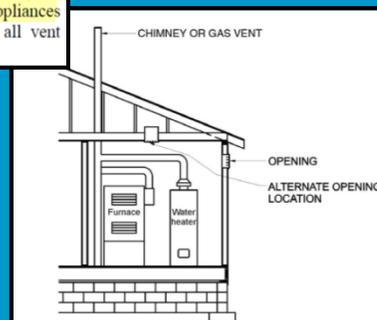


FIGURE 2407.6.2
SINGLE COMBUSTION AIR OPENING,
ALL AIR FROM OUTDOORS
(see Section 2407.6.2)

Combustion Air Louvers & Grilles

Do not forget about the louvers and grilles!

2407.10 Louvers and grilles. The required size of openings for combustion, ventilation and dilution air shall be based on the **net free area** of each opening. Where the free area through a design of louver, grille or screen is known, it shall be used in calculating the size opening required to provide the free area specified. Where the design and free area of louvers and grilles are **not known**, it shall be assumed that wood louvers will have 25-percent free area and metal louvers and grilles will have 75-percent free area.

Chimneys and Vents

- Selected areas of Chapters 18 & 24
- Chapter 18 (Solid fuel and oil)
- Chapter 24 (Fuel gas)

Chimneys and Vents

- Chapter 18 (Solid fuel and oil)

1801.1 Venting required. Fuel-burning appliances shall be vented to the outdoors in accordance with their listing and label and manufacturer's installation instructions except appliances listed and labeled for unvented use. Venting systems shall consist of approved chimneys or vents, or venting assemblies that are integral parts of labeled appliances. Gas-fired appliances shall be vented in accordance with Chapter 24.

Chimneys and Vents

- Chapter 18 (Solid fuel and oil)

SECTION 1803 CHIMNEY AND VENT CONNECTORS

1803.1 General. Connectors shall be used to connect fuel-burning appliances to a vertical chimney or vent except where the chimney or vent is attached directly to the appliance.

1803.2 Connectors for oil and solid fuel appliances. Connectors for oil and solid-fuel-burning appliances shall be constructed of factory-built chimney material, Type L vent material or single-wall metal pipe having resistance to corrosion and heat and thickness not less than that of galvanized steel as specified in Table 1803.2.

**TABLE 1803.2
THICKNESS FOR SINGLE-WALL METAL PIPE CONNECTORS**

DIAMETER OF CONNECTOR (inches)	GALVANIZED SHEET METAL GAGE NUMBER	MINIMUM THICKNESS (inch)
Less than 6	26	0.019
6 to 10	24	0.024
Over 10 through 16	22	0.029

**TABLE 1804.1
VENT SELECTION CHART**

VENT TYPES	APPLIANCE TYPES
Type L oil vents	Oil-burning appliances listed and labeled for venting with Type L vents
Pellet vents	Pellet fuel-burning appliances listed and labeled for use with pellet vents

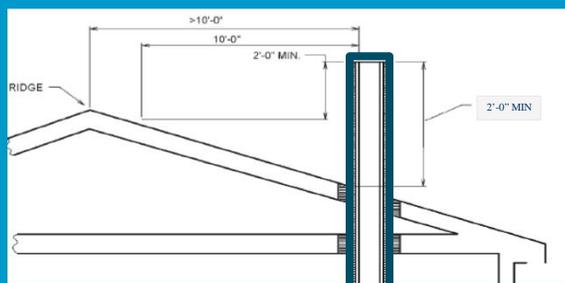


Chimneys and Vents

- Chapter 18 (Solid fuel and oil)

1804.2.4 Type L vent. Type L venting systems shall conform to UL 641 and shall terminate with a listed and labeled cap in accordance with the vent manufacturer's installation instructions not less than 2 feet (610 mm) above the roof and not less than 2 feet (610 mm) above any portion of the building within 10 feet (3048 mm).

Note: The termination requirements are consistent with NFPA 31.



Chimneys and Vents

- Chapter 24 (Fuel gas)

2426.1 General. All vents, except as provided in Section 2427.7, shall be listed and labeled. Type B and BW vents shall be tested in accordance with UL 441. Type L vents shall be tested in accordance with UL 641. Vents for Category II and III appliances shall be tested in accordance with UL 1738. Plastic vents for Category IV appliances shall not be required to be listed and labeled where such vents are as specified by the appliance manufacturer and are installed in accordance with the appliance manufacturer's installation instructions.

Chimneys and Vents

- Chapter 24 (Fuel gas)

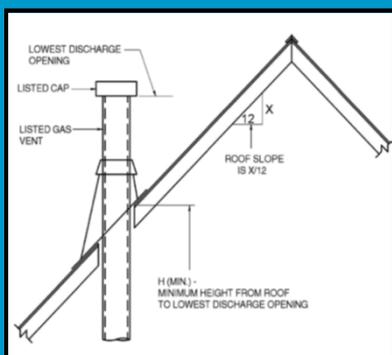
2427.4 Type of venting system to be used. The type of venting system to be used shall be in accordance with Table 2427.4.

**TABLE 2427.4
TYPE OF VENTING SYSTEM TO BE USED**

APPLIANCES	TYPE OF VENTING SYSTEM
Listed Category I appliances Listed appliances equipped with draft hood Appliances listed for use with Type B gas vent	Type B gas vent (Section 2427.6) Chimney (Section 2427.5) Single-wall metal pipe (Section 2427.7) Listed chimney lining system for gas venting (Section 2427.5.2) Special gas vent listed for these appliances (Section 2427.4.2)
Listed vented wall furnaces	Type B-W gas vent (Sections 2427.6, 2436)
Category II appliances	As specified or furnished by manufacturers of listed appliances (Sections 2427.4.1, 2427.4.2)
Category III appliances	As specified or furnished by manufacturers of listed appliances (Sections 2427.4.1, 2427.4.2)
Category IV appliances	As specified or furnished by manufacturers of listed appliances (Sections 2427.4.1, 2427.4.2)
Unlisted appliances	Chimney (Section 2427.5)
Decorative appliances in vented fireplaces	Chimney
Direct-vent appliances	See Section 2427.2.1
Appliances with integral vent	See Section 2427.2.2

Chimneys and Vents

- Chapter 24 (Fuel gas)



2427.6.3 Gas vent termination. A gas vent shall terminate in accordance with one of the following:

- Gas vents that are 12 inches (305 mm) or less in size and located not less than 8 feet (2438 mm) from a vertical wall or similar obstruction shall terminate above the roof in accordance with [Figure 2427.6.3](#).
- Gas vents that are over 12 inches (305 mm) in size or are located less than 8 feet (2438 mm) from a vertical wall or similar obstruction shall terminate not less than 2 feet (610 mm) above the highest point where they pass through the roof and not less than 2 feet (610 mm) above any portion of a building within 10 feet (3048 mm) horizontally.

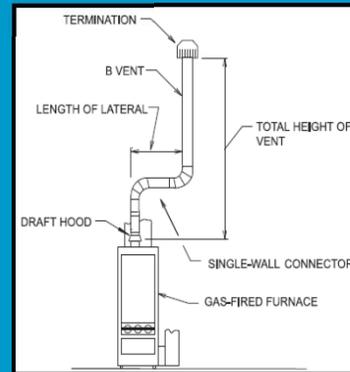
ROOF SLOPE	H (minimum) ft
Flat to 6/12	1.0
Over 6/12 to 7/12	1.25
Over 7/12 to 8/12	1.5
Over 8/12 to 9/12	2.0
Over 9/12 to 10/12	2.5
Over 10/12 to 11/12	3.25
Over 11/12 to 12/12	4.0
Over 12/12 to 14/12	5.0
Over 14/12 to 16/12	6.0
Over 16/12 to 18/12	7.0
Over 18/12 to 20/12	7.5
Over 20/12 to 21/12	8.0

Chimneys and Vents

- Chapter 24 (Fuel gas)

2427.6.8 Size of gas vents. Venting systems shall be sized and constructed in accordance with Section 2428 or other approved engineering methods and the gas vent and appliance manufacturer's installation instructions.

Components for a single Category I appliance venting system.



Chimneys and Vents

- Chapter 24 (Fuel gas)

TABLE 2427.10.5²
CLEARANCES FOR CONNECTORS

APPLIANCE	MINIMUM DISTANCE FROM COMBUSTIBLE MATERIAL			
	Listed Type B gas vent material	Listed Type L vent material	Single-wall metal pipe	Factory-built chimney sections
Listed appliances with draft hoods and appliances listed for use with Type B gas vents	As listed	As listed	6 inches	As listed
Residential boilers and furnaces with listed gas conversion burner and with draft hood	6 inches	6 inches	9 inches	As listed
Residential appliances listed for use with Type L vents	Not permitted	As listed	9 inches	As listed
Listed gas-fired toilets	Not permitted	As listed	As listed	As listed
Unlisted residential appliances with draft hood	Not permitted	6 inches	9 inches	As listed
Residential and low-heat appliances other than above	Not permitted	9 inches	18 inches	As listed
Medium-heat appliances	Not permitted	Not permitted	36 inches	As listed



Chimneys and Vents

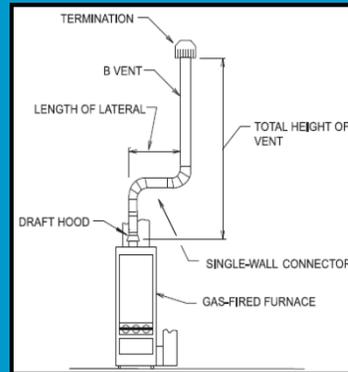
- Chapter 24 (Fuel gas)

2427.6.8 Size of gas vents. Venting systems shall be sized and constructed in accordance with Section 2428 or other approved engineering methods and the gas vent and appliance manufacturer's installation instructions.

2427.10.8 Slope. A vent connector shall be installed without dips or sags and shall slope upward toward the vent or chimney at least 1/4 inch per foot (21 mm/m).



Components of a single Category I appliance venting system.

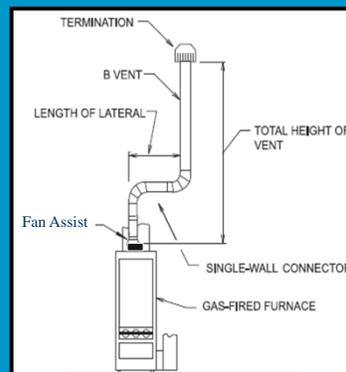


Chimneys and Vents

- Chapter 24 (Fuel gas)

Example: Using Table 2428.2(2) size the B-vent based upon the following information:

- Furnace Input-100,000 Btu/h (Category I)
- Total Vent height is 15 feet
- Lateral length is 2 feet



Chimneys and Vents

TABLE 2428.2(2)
TYPE B DOUBLE-WALL GAS VENT

		Number of Appliances		Appliance Type		Appliance Vent Connection		Single		Category I		Single-wall metal connector																	
HEIGHT (ft)	LAT. ERA (ft)	VENT DIAMETER—(D) inches																											
		3			4			5			6			7			8			9			10			12			
		APPLIANCE INPUT RATING IN THOUSANDS OF BTU/H						FAN						NAT						FAN						NAT			
		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
6	0	38	77	45	59	151	85	85	249	140	126	373	204	165	522	284	211	495	369	267	894	469	371	1,118	569	537	1,639	849	
	2	39	51	36	60	96	66	85	156	104	123	231	156	159	320	213	201	423	284	251	541	368	347	673	453	498	979	648	
	4	NA	NA	33	74	92	63	103	152	102	146	235	152	187	313	208	237	416	277	295	533	360	409	664	443	584	971	638	
8	0	NA	NA	31	83	89	60	114	147	99	165	220	148	207	307	203	263	409	271	327	526	352	449	656	433	638	962	627	
	2	37	83	50	58	164	93	83	273	154	123	412	234	161	580	319	206	777	414	258	1,002	536	360	1,257	658	521	1,852	967	
	4	39	56	39	59	108	75	83	178	119	121	261	179	155	363	246	197	482	321	246	617	417	339	768	513	486	1,120	743	
10	0	NA	NA	37	77	102	69	107	168	114	151	252	171	193	352	235	245	470	311	305	604	404	418	754	500	598	1,104	730	
	2	NA	NA	33	90	95	64	123	161	107	175	243	163	223	342	225	289	458	300	344	591	392	470	740	486	665	1,089	715	
	4	37	87	53	57	174	99	82	293	165	120	444	254	158	628	344	202	844	449	253	1,093	584	351	1,373	718	507	2,031	1,057	
15	0	36	62	57	56	190	111	80	235	186	116	409	283	153	713	388	195	966	523	244	1,259	681	336	1,591	828	488	2,374	1,137	
	2	38	69	47	57	126	83	80	235	149	115	337	224	148	473	314	187	631	413	332	812	543	319	1,015	673	457	1,491	983	
	4	51	63	44	75	128	86	102	216	140	144	326	217	182	459	298	231	616	400	287	795	526	302	897	657	562	1,460	963	
15	10	NA	NA	39	95	116	79	128	201	131	182	308	203	238	438	284	284	592	381	349	768	501	470	966	628	664	1,433	928	
	15	NA	NA	NA	NA	72	158	186	124	220	290	192	272	418	269	334	568	367	404	742	484	540	937	601	750	1,399	894		

Boilers and Water Heaters

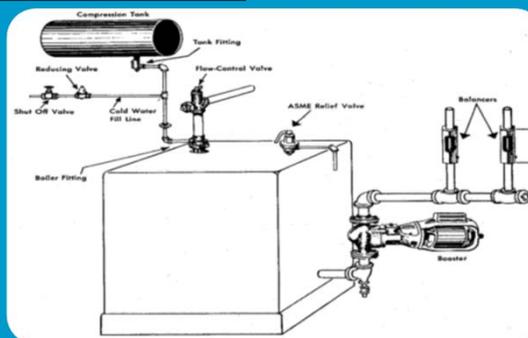
- Selected areas of Chapter 20
- Boiler Standards
- Boiler Operating and Safety Controls
- Expansion Tanks
- Water Heaters

Boilers and Water Heaters

- Boiler Standards

2001.1.1 Standards. Oil-fired boilers and their control systems shall be listed and labeled in accordance with UL 726. Electric boilers and their control systems shall be listed in accordance with UL 834. Boilers shall be designed and constructed in accordance with the requirements of ASME CSD-1 and as applicable, the ASME Boiler and Pressure Vessel Code, Sections I and IV. Gas-fired boilers shall conform to the requirements listed in Chapter 24.

Components of a hot water boiler



Boilers and Water Heaters

- Boiler Operating and Safety Controls

SECTION 2002 OPERATING AND SAFETY CONTROLS

2002.1 Safety controls. Electrical and mechanical operating and safety controls for boilers shall be listed and labeled.

2002.2 Hot water boiler gauges. Every hot water boiler shall have a pressure gauge and a temperature gauge, or combination pressure and temperature gauge. The gauges shall indicate the temperature and pressure within the normal range of the system's operation.

2002.3 Steam boiler gauges. Every steam boiler shall have a water-gauge glass and a pressure gauge. The pressure gauge shall indicate the pressure within the normal range of the system's operation. The gauge glass shall be installed so that the midpoint is at the normal water level.

2002.4 Pressure-relief valve. Boilers shall be equipped with pressure-relief valves with minimum rated capacities for the equipment served. Pressure-relief valves shall be set at the maximum rating of the boiler. Discharge shall be piped to drains by gravity to within 18 inches (457 mm) of the floor or to an open receptor.

2002.5 Boiler low-water cutoff. All steam and hot water boilers shall be protected with a low-water cutoff control. The low-water cutoff shall automatically stop the combustion operation of the appliance when the water level drops below the lowest safe water level as established by the manufacturer.



Boilers and Water Heaters

• Expansion Tanks

Note: When the temperature is raised in a closed hot water system a volume and pressure increase is the result. If there was no equipment (cushion) connected to the system to account for the expansion, then the relief valve would always open. Therefore, an expansion tank is required for hot water boilers to take the expansion relative to pressure changes in the system, thus ensuring normal steady state operation.

2003.2 Minimum capacity. The minimum capacity of expansion tanks shall be determined from [Table 2003.2](#).

SYSTEM VOLUME ¹ (gallons)	PRESSURIZED DIAPHRAGM TYPE	NONPRESSURIZED TYPE
10	1.0	1.5
20	1.5	3.0
30	2.5	4.5
40	3.0	6.0
50	4.0	7.5
60	5.0	9.0
70	6.0	10.5
80	6.5	12.0
90	7.5	13.5
100	8.0	15.0



Boilers and Water Heaters

• Water Heaters

2005.1 General. Water heaters shall be installed in accordance with the manufacturer's installation instructions and the requirements of this code. Water heaters installed in an attic shall conform to the requirements of Section 1305.1.3. Gas-fired water heaters shall conform to the requirements in Chapter 24. Domestic electric water heaters shall conform to UL 174 or UL 1453. Commercial electric water heaters shall conform to UL 1453. Oil-fired water heaters shall conform to UL 732.

2005.2 Prohibited locations. Fuel-fired water heaters shall not be installed in a room used as a storage closet. Water heaters located in a bedroom or bathroom shall be installed in a sealed enclosure so that combustion air will not be taken from the living space. Installation of direct-vent water heaters within an enclosure is not required.

Water heaters used to supply both potable hot water and hot water for space heating shall be installed in accordance with this chapter, Chapter 24, Chapter 28 and the manufacturer's installation instructions according to 2004.1.



What is Hydronic Heating

APPLICATIONS OF CHANGES IN SENSIBLE HEAT

Mechanical systems such as heating, cooling, and refrigeration installations commonly transfer heat from one place to another by circulating a medium such as water in pipes or air through ducts. In the process, the medium is either heated or cooled, the changes in heat content occurring as changes in sensible heat of the medium without change of state. The quantities of heat involved can be calculated by the use of appropriate equations which take into account the rate of flow of the medium.

Hydronic heating or cooling with water:

$$\text{Btu/h} = 500 \times \text{gpm} \times \text{TD}$$

Where:

Btu/h = rate of heat transfer in Btu per hour

gpm = flow rate of water in gallons per minute

TD = temperature difference, degrees F, between entering and leaving water temperatures

APPLICATIONS OF CHANGES IN SENSIBLE HEAT Cont'd

Heating or cooling with water:

$$\text{Btu/h} = 500 \times \text{gpm} \times \text{TD}$$

Where:

Btu/h = Rate of heat transfer in Btu per hour

gpm = Flow rate of water in gallons per minute

TD = temperature difference, degrees F, between entering and leaving water temperatures

NOTE: the number 500 is derived from the product of 60 x 8.3, where 60 is the number of minutes in an hour (noting that heat transfer rate is in Btu per hour while water flow rate is in gallons per minute); the factor 8.3 is the weight of a gallon of water, in pounds.

EXAMPLE: In a hydronic heating system, water flowing at a rate of 5 gpm enters the boiler at 178°F and leaves the boiler at 200°F. How much heat is the boiler putting into the system?

$$\text{Btu/h} = 500 \times \text{gpm} \times \text{TD}$$

$$\text{Btu/h} = 500 \times 5 \times (200 - 178)$$

$$= 500 \times 5 \times 22$$

$$\text{Btu/h} = 55,000$$

Thus, heat transfer from the boiler to the system is 55,000 Btu/h.

Hydronic Piping

- Selected areas of Chapter 21
 - System Drain Down & Protection of potable water
 - Floor Heating Systems

2101.1 General. Hydronic piping shall conform to Table 2101.1. Approved piping, valves, fittings and connections shall be installed in accordance with the manufacturer's installation instructions. Pipe and fittings shall be rated for use at the operating temperature and pressure of the hydronic system. Used pipe, fittings, valves or other materials shall be free of foreign materials.

Hydronic Piping

- System Drain Down & Protection of potable water

2101.2 System drain down. Hydronic piping systems shall be installed to permit draining of the system. Where the system drains to the plumbing drainage system, the installation shall conform to the requirements of *the plumbing code*.

Exception: The buried portions of systems embedded underground or under floors.

2101.3 Protection of potable water. The potable water system shall be protected from backflow in accordance with the provisions listed in *the plumbing code*.



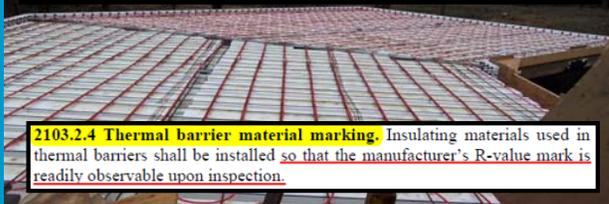
Hydronic Piping

- Floor Heating Systems

2103.1 Piping materials. Piping for embedment in concrete or gypsum materials shall be standard-weight steel pipe, copper tubing, cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX) pressure pipe, chlorinated polyvinyl chloride (CPVC), polybutylene, cross-linked polyethylene (PEX) tubing or polypropylene (PP) with a minimum rating of 100 psi at 180°F (690 kPa at 82°C).

Minimum insulation R-value and marking required

2103.2.1 Slab on grade installation. Radiant piping used in slab-on-grade applications shall have insulating materials having a minimum R-value of 5 installed beneath the piping.



2103.2.4 Thermal barrier material marking. Insulating materials used in thermal barriers shall be installed so that the manufacturer's R-value mark is readily observable upon inspection.

Fuel Gas

- Selected areas of Chapter 24

- Elevation of ignition source
- Electrical
- Prohibited Locations
- Underground Penetrations Prohibited
- Gas Piping in Solid Floors & Beneath Buildings
- Sediment Trap
- Testing Piping

Fuel Gas

- Elevation of ignition source

2408.2 Elevation of ignition source. Equipment and appliances having an ignition source shall be elevated such that the source of ignition is not less than 18 inches (457 mm) above the floor in hazardous locations and public garages, private garages, repair garages, motor fuel-dispensing facilities and parking garages. For the purpose of this section, rooms or spaces that are not part of the living space of a dwelling unit and that communicate directly with a private garage through openings shall be considered to be part of the private garage.

Exception: Elevation of the ignition source is not required for appliances that are listed as flammable vapor ignition resistant.

Typical hazardous locations are in residential private garages



Fuel Gas Piping

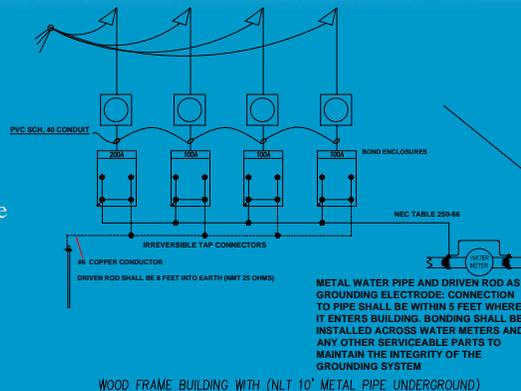
- Electrical

2410.1 Grounding. Gas piping shall not be used as a grounding electrode.

2410.2 Connections. Electrical connections between appliances and the building wiring, including the grounding of the appliances, shall conform to NFPA 70.

Explain grounding (earthing)

The intent of 2410.1 is to not intentionally connect buried metallic piping in earth via a wire (GEC) to the grounded service conductor.



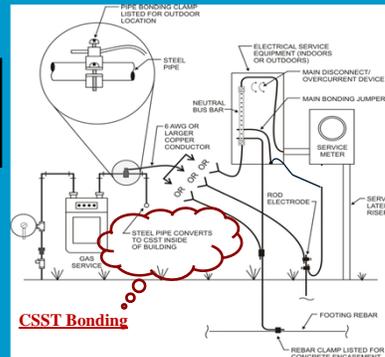
Fuel Gas Piping

• Electrical Bonding

2411.1 Pipe and tubing other than CSST. Each above-ground portion of a gas piping system other than corrugated stainless steel tubing (CSST), that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping, other than CSST, shall be considered to be bonded where it is connected to appliances that are connected to the equipment grounding conductor of the circuit supplying that appliance.

Note: Similar language in 2011 NEC 250.104,B

2411.1.1 CSST. Corrugated stainless steel tubing (CSST) gas piping systems shall be bonded to the electrical service grounding electrode system at the point where the gas service enters the building. The bonding jumper shall be not smaller than 6 AWG copper wire or equivalent.

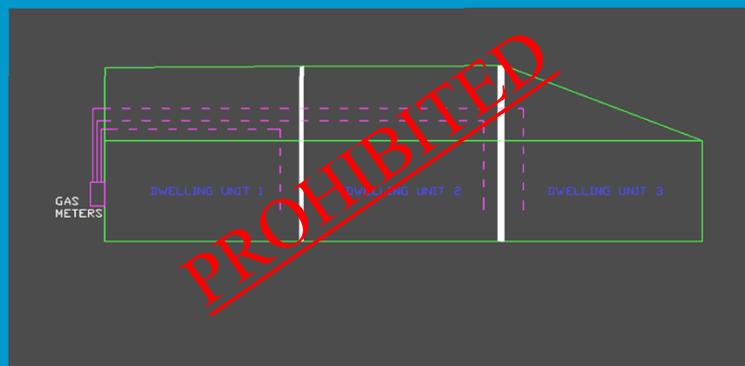


Fuel Gas Piping

• Prohibited Locations

2415.1 Prohibited locations. Piping shall not be installed in or through a ducted supply, return or exhaust, or a clothes chute, chimney or gas vent, dumbwaiter or elevator shaft. Piping installed downstream of the point of delivery shall not extend through any townhouse unit other than the unit served by such piping.

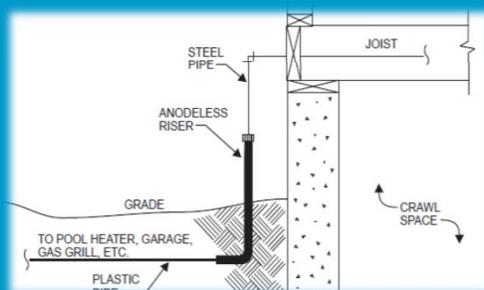
New requirement for 2013!



Fuel Gas Piping

- Underground Penetrations Prohibited

2415.4 Underground penetrations prohibited. Gas piping shall not penetrate building foundation walls at any point below grade. Gas piping shall enter and exit a building at a point above grade and the annular space between the pipe and the wall shall be sealed.



A gas pipe is not permitted to enter or exit a building below grade because any gas leakage in the underground piping will be channeled into the building through the surrounding soil and the wall penetration.

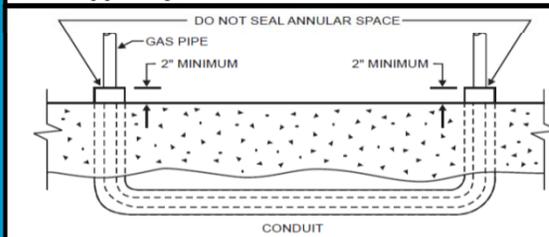
Fuel Gas Piping

- Gas Piping in Solid Floors & Beneath Buildings

2415.6 Piping in solid floors. Piping in solid floors shall be laid in channels in the floor and covered in a manner that will allow access to the piping with a minimum amount of damage to the building. Where such piping is subject to exposure to excessive moisture or corrosive substances, the piping shall be protected in an approved manner. As an alternative to installation in channels, the piping shall be installed in a conduit of Schedule 40 steel, wrought iron, PVC or ABS pipe in accordance with Section 2415.6.1 or 2415.6.2.

2415.6.2 Conduit with both ends terminating indoors. Where the conduit originates and terminates within the same building, the conduit shall originate and terminate in an accessible portion of the building and shall not be sealed. The conduit shall extend not less than 2 inches (51 mm) beyond the point where the pipe emerges from the floor.

Note: 2415.12 allows gas piping in conduit to be run under ground beneath the building.



Fuel Gas Piping

• Testing Piping

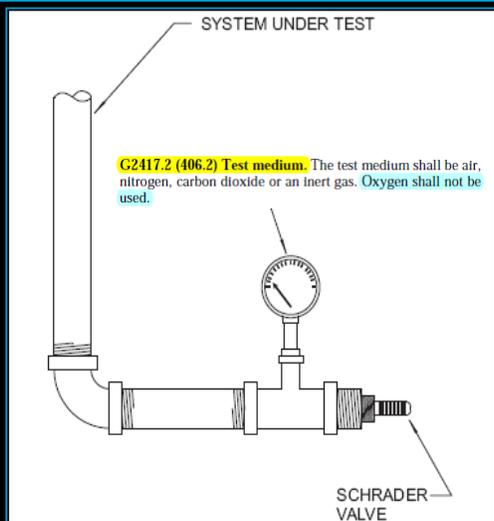
G2417.4 (406.4) Test pressure measurement. Test pressure shall be measured with a manometer or with a pressure-measuring device designed and calibrated to read, record, or indicate a pressure loss caused by leakage during the *pressure test* period. The source of pressure shall be isolated before the *pressure tests* are made. Mechanical gauges used to measure test pressures shall have a range such that the highest end of the scale is not greater than five times the test pressure.

G2417.4.1 (406.4.1) Test pressure. The test pressure to be used shall be not less than one and one-half times the proposed maximum working pressure, but not less than 3 psig (20 kPa gauge), irrespective of design pressure. Where the test pressure exceeds 125 psig (862 kPa gauge), the test pressure shall not exceed a value that produces a hoop stress in the *pipng* greater than 50 percent of the specified minimum yield strength of the *pipe*.

G2417.4.2 (406.4.2) Test duration. The test duration shall be not less than 10 minutes.

G2417.5 (406.5) Detection of leaks and defects. The *pipng system* shall withstand the test pressure specified without showing any evidence of leakage or other defects. Any reduction of test pressures as indicated by pressure gauges shall be deemed to indicate the presence of a leak unless such reduction can be readily attributed to some other cause.

G2417.5.1 (406.5.1) Detection methods. The leakage shall be located by means of an *approved* combustible gas detector, a noncorrosive leak detection fluid or an equivalent nonflammable solution. Matches, candles, open flames or other methods that could provide a source of ignition shall not be used.



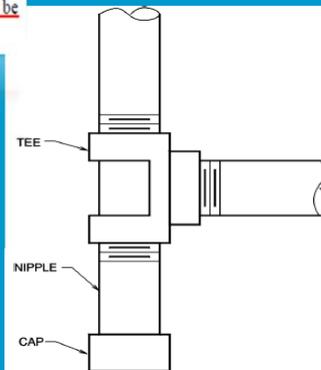
G2417.2 (406.2) Test medium. The test medium shall be air, nitrogen, carbon dioxide or an inert gas. Oxygen shall not be used.

Fuel Gas Piping

• Sediment Trap

2419.4 Sediment trap. Where a sediment trap is not incorporated as part of the appliance, a sediment trap shall be installed downstream of the appliance shutoff valve as close to the inlet of the appliance as practical. The sediment trap shall be either a tee fitting having a capped nipple of any length installed vertically in the bottom-most opening of the tee or other device approved as an effective sediment trap. Illuminating appliances, ranges, clothes dryers and outdoor grills need not be so equipped.

Many times the sediment traps are constructed wrong in the field...allowing particles of dirt and metal to flow into regulators and gas valves.



Fuel Gas Piping

• Appliance Shutoff Valves

2420.5 Appliance shutoff valve. Each appliance shall be provided with a shutoff valve in accordance with Section 2420.5.1, 2420.5.2 or 2420.5.3.

2420.5.1 Located within same room. The shutoff valve shall be located in the same room as the appliance. The shutoff valve shall be within 6 feet (1829 mm) of the appliance, and shall be installed upstream of the union, connector or quick disconnect device it serves. Such shutoff valves shall be provided with access. Appliance shutoff valves located in the firebox of a fireplace shall be installed in accordance with the appliance manufacturer's instructions.

2420.5.2 Vented decorative appliances and room heaters. Shutoff valves for vented decorative appliances, room heaters and decorative appliances for installation in vented fireplaces shall be permitted to be installed in an area remote from the appliances where such valves are provided with ready access. Such valves shall be permanently identified and shall serve no other appliance. The piping from the shutoff valve to within 6 feet (1829 mm) of the appliance shall be designed, sized and installed in accordance with Sections 2412 through 2419.

2420.5.3 Located at manifold. Where the appliance shutoff valve is installed at a manifold, such shutoff valve shall be located within 50 feet (15 240 mm) of the appliance served and shall be readily accessible and permanently identified. The piping from the manifold to within 6 feet (1829 mm) of the appliance shall be designed, sized and installed in accordance with Sections 2412 through 2419.

Note: For valves allowed to be remote from appliances according to 2420.5.2 and 2420.5.3...the last 6 feet of piping must be designed, sized, and installed as piping (2412-2419). This is stating that not all appliance connectors listed in 2422 can be used regarding these locations.



Forced Air Furnaces

2442.1 General. Forced-air warm-air furnaces shall be tested in accordance with ANSI Z21.47 or UL 795 and shall be installed in accordance with the manufacturer's installation instructions.

2442.2 Forced-air furnaces. The minimum unobstructed total area of the outside and return air ducts or openings to a forced-air warm-air furnace shall be not less than 2 square inches for each 1,000 Btu/h (4402 mm²/W) output rating capacity of the furnace and not less than that specified in the furnace manufacturer's installation instructions. The minimum unobstructed total area of supply ducts from a forced-air warm-air furnace shall be not less than 2 square inches for each 1,000 Btu/h (4402 mm²/W) output rating capacity of the furnace and not less than that specified in the furnace manufacturer's installation instructions.

Exception: The total area of the supply air ducts and outside and return air ducts shall not be required to be larger than the minimum size required by the furnace manufacturer's installation instructions.



Note: A furnace that is "starved" for return air or is restricted by an inadequate supply air duct size will produce an abnormal temperature rise across the heat exchanger, which is both a fire hazard and detrimental to the furnace.

Forced Air Furnaces

2442.5 Prohibited sources. Outside or return air for a forced-air heating system shall not be taken from the following locations:

1. Closer than 10 feet (3048 mm) from an appliance vent outlet, a vent opening from a plumbing drainage system or the discharge outlet of an exhaust fan, unless the outlet is 3 feet (914 mm) above the outside air inlet.
2. Where objectionable odors, fumes or flammable vapors are present; or where located less than 10 feet (3048 mm) above the surface of any abutting public way or driveway; or where located at grade level by a sidewalk, street, alley or driveway.
3. A hazardous or insanitary location or a refrigeration machinery room as defined in the *Ohio Mechanical Code*.
4. A room or space, the volume of which is less than 25 percent of the entire volume served by such system. Where connected by a permanent opening having an area sized in accordance with Section 2442.2, adjoining rooms or spaces shall be considered as a single room or space for the purpose of determining the volume of such rooms or spaces.
5. A room or space containing an appliance where such a room or space serves as the sole source of return air.
6. A closet, bathroom, toilet room, kitchen, garage, mechanical room, boiler room, furnace room or attic.
7. A crawl space by means of direct connection to the return side of a forced air system. Transfer openings in the crawl space enclosure shall not be prohibited.



Note: There are several exceptions regarding the items above.

END OF PRESENTATION
ANY QUESTIONS ?

