
2021 IMC® UMC® Essentials
Based on the 2021 International Mechanical Code, 2021 International Fuel Gas Code, and 2021 International Residential Code and the 201
PMG

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ICC PMG
Plumbing, Mechanical, Fuel Gas, and Swimming Pool & Spa

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INSTRUCTOR
Jim Cika
International Code Council
Director, PMG Technical Resources
Provide code related resources and education to AHJs, Engineers, and Contractors on the various editions of I-codes related to PMG:
IPC, IMC, IFGC, ISPSC, and IPSDC
Responsible for state specific PMG technical support in the states of:
AL, AR, FL, GA, KS, LA, MS, NC, OK, SC, PR and USVI
Director, Engineering and Product Management at HTP Comfort Solutions, the chief technical expert for regulatory, product standards, building code, and product engineering matters.
Manager, Solar Products at VELUX America, Inc., managed solar thermal business unit that included marketing, sales, engineering and technical services.
Specialty Water Heating Manager at Rheem Manufacturing Company, managed the specialty business unit consisting of tankless water heater, solar, and aftermarket parts product lines.
Engineering Services Manager at Rinnai America Corp., chief technical expert for regulatory, product standards, building code, and product engineering matters.

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INSTRUCTOR

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Director, PMG Technical Resources

I serve as a subject matter expert for ICC's plumbing, mechanical, fuel gas, swimming pool & spa, and private sewage disposal codes (PMG).

ICC PMG
Plumbing, Mechanical, Fuel Gas, and Swimming Pool & Spa

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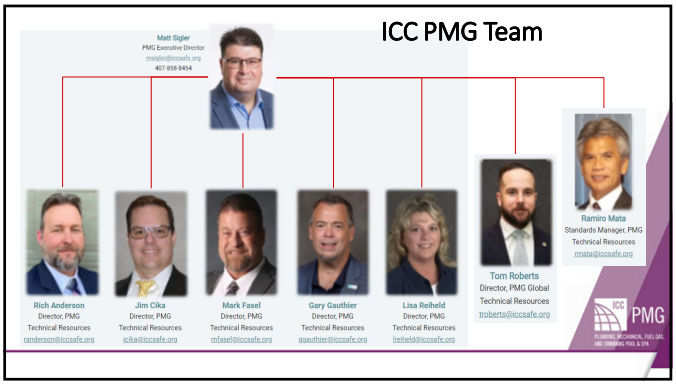
ICC PMG Team



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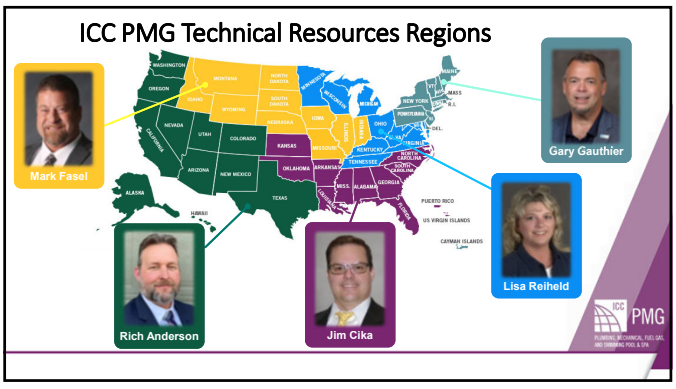
ICC PMG Technical Resources Regions



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ICC Family of Solutions

ICC INTERNATIONAL CODE COUNCIL®

ES ICC EVALUATION SERVICE® | IAS INTERNATIONAL ACCREDITATION SERVICE® | GENERAL CODE | ICC SKGA S. K. GHOSH ASSOCIATES®

NIA | Alliance for National & Community Resilience | ICC COMMUNITY DEVELOPMENT SOLUTIONS | ICC Pti

ICC PMG

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ICC Evaluation Service (ICC-ES)

ES ICC EVALUATION SERVICE®

- International Code Council subsidiary
- Evaluates products using codes and standards for the built environment
- Accredited by:
  - American National Standard Institute (ANSI) to ISO/IEC 17065
  - Standards Council of Canada (SCC)
  - American Association for Laboratory Accreditation (A2LA)
  - EMA to conduct Plumbing Product listing to the Mexican NOMs
- Expert in developing and interpreting ICC-ES Acceptance Criteria (ACs) for innovative products

ICC ES | ICC ES PMG

Standards Council of Canada Conseil canadien des normes | ema | ANSI | ACCREDITED CERTIFICATE #1530.02

ICC PMG

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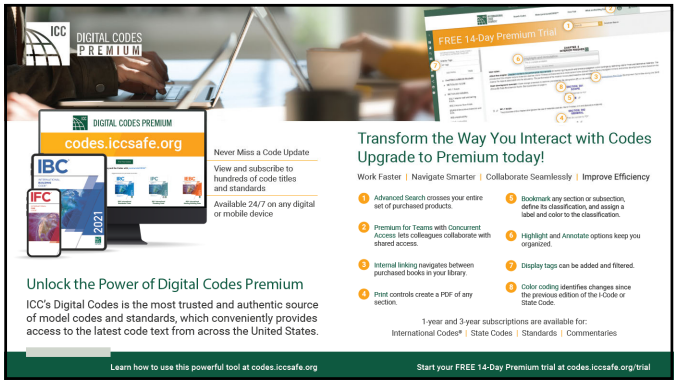

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READ IAPMO CODES ONLINE:

The codes of practice attempt to minimize public risk by specifying technical standards of design, materials, workmanship and maintenance for various systems.

The main aims of the Uniform codes are:

- To ensure that planners, administrators and plumbers develop the required competency to ensure that the codes are applied and upheld;
- That standards are set to ensure that plumbing assemblies, ,materials and technologies are safe and effective;

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IAPMO and ASSE Offer Access to Library of Standards

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Goal

- The goal of this seminar is to provide key information on the design, installation and inspection principles based on the 2021 IMC®, 2021 IFGC®, 2021 IRC® and the 2021 UMC®
- Gain an understanding of the frequently used provisions of the 2021 IMC®, 2021 IFGC®, 2021 IRC® and the 2021 UMC®as they apply to design, plan submittals and/or inspection

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Objectives

Upon completion, participants will be better able to:

- Identify code enforcement issues and key code sections.
- Determine appropriate code provisions to apply to mechanical.
- Describe the application of the code to inspection, plan review and code enforcement.
- Apply the provisions of the 2021 IMC®, 2021 IFGC®, 2021 IRC® and the 2021 UMC® to design, installation and inspection phases of construction.

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Part I

Code Administration

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International Code Council Model Codes (I-Codes)

- Nationally recognized construction regulations that serve as models for local ordinances.
- Revised and updated through an open process that invites participation by experts, stakeholders and all affected parties.
- Updated on three-year cycles to recognize new and developing technology, materials and methods of construction.
- Changes are often in response to natural or human-made disasters involving the loss of lives or the destruction of property.

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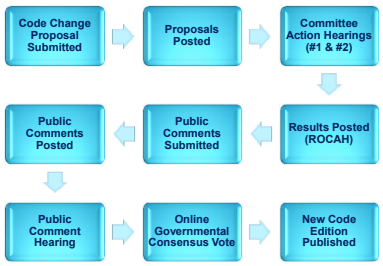
Code Development Cycle



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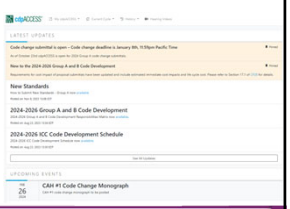
cdpACCESS™

- ICC's cloud-based system for the code development process (cdp).
- Developed to increase participation in the code development process.
- Users can create, collaborate, review, submit and vote (if eligible) on code change proposals and public comments.
- ICC members can view and vote on motions for code changes that receive an assembly motion.
- ICC posts the Online Governmental Consensus Vote.



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International Mechanical Code (IMC)

- The IMC includes minimum requirements for mechanical systems using prescriptive- and performance related provisions.
- The IMC regulates the design, installation, maintenance, alteration and inspection of mechanical systems that are permanently installed and utilized to provide control of environmental conditions and related processes within buildings.

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Combustion Air Requirements (Fuel Gas Code)

- The IFGC includes minimum requirements for fuel gas systems and gas-fired appliances using prescriptive- and performance related provisions.
- The IFGC regulates the design and installation of fuel gas distribution piping and systems, appliances, appliance venting systems, combustion air provisions, gaseous hydrogen systems and motor vehicle gaseous-fuel-dispensing stations.

UMC ® Chapter 13

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International Residential Code (IRC)

- Regulates construction of detached 1- and 2-family dwellings and townhouses.
- Combines all regulations for building, energy, mechanical, fuel gas, plumbing and electrical into one document.

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Uniform Mechanical Code

- The UMC® applies to all occupancy Classifications and includes Fuel Gas piping and Venting provisions.

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Code Development

Step 1: Proposal Stage (first year)

•Step 2: Comment Stage (second year). At the Assembly Consideration Session, IAPMO membership may submit public comments for the Technical Committee consideration.

Source: HTTPs://www.iapmo.org/media/30772/iapmo-codes-development-process-website-jan-2023.pdf

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Code Development

- Step 3: Association Meeting (second year year) followed by a final Technical Committee vote. At the Association Technical meeting, IAPMO membership votes to adopt the Report on Proposal (ROP) and Report on comments (ROC). Any approved amendments to the ROP and ROC by IAPMO membership are forwarded to the Technical Committee for a final vote.
- Step 4: Appeals Stage and Publication (third year)

Source: HTTPs://www.iapmo.org/media/30772/iapmo-codes-development-process-website-jan-2023.pdf

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Part I – Administration

1. T F Only code officials, contractors, builders, architects, engineers, industry professionals and other experts can *submit a proposal* to add, revise or delete a code provision.

False
Any member of the public can submit a proposal to add, revise or delete a code provision.

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Part I – Administration

2. T F Only code officials, contractors, builders, architects, engineers, industry professionals and other experts can *vote on a proposal*.

False
Only the ICC Governmental Member Voting Representatives and the ICC Honorary Members are permitted to cast votes.

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Part I – Administration

3. Where do you find the mechanical provisions for the construction of detached one- and two-family dwellings and townhouses?

The International Residential Code® (IRC®)
&
The Uniform Mechanical Code® (UMC®)

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Part I – Administration

4. Where do you find the commercial mechanical requirements that regulate the design, installation, maintenance, alteration and inspection of mechanical systems?

The International Mechanical Code® (IMC®)
&
The Uniform Mechanical Code® (UMC®)

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Adoption of a Mechanical Code

- Becomes an enforceable regulation through legal proceedings of the governmental jurisdiction.
- Adopting ordinance references IMC® or UMC® edition and title and provides ordinance purpose, scope and effective date.
- Government authority must provide local information for insertion into the code text.

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Amending the Mechanical Codes

- Jurisdiction can modify the model code through amendments placed in the adopting ordinance.
- Amendments influenced by:
  - Unique characteristics and conditions, such as geographic location, weather, topography, flooding, soil properties and water tables.
  - Considerations of political influences, local traditions or customs, compatibility issues with other state or local laws, or the existence of unique housing stock, such as in historic districts.

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Local and State Laws

- The IMC is not meant to nullify any local, state or federal law, and in many cases, such other laws supersede provisions found in the model code.
- State law often determines circumstances under which a licensed engineer or architect is required and sets the licensing regulations for these design professionals.

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Code Official

Duties

- Enforce the code.
- Review plans, diagrams and calculations.
- Issue permits.
- Issue notices & orders.
- Conduct inspections.
- Maintain records.

Authorities

- Make interpretations.
- Adopt policies and procedures.
- Approve modifications and alternatives.

Limits on authority

- Cannot waive code requirements.
- Cannot require more than the code.

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Prescriptive vs Performance

- *Prescriptive code provisions* form a specific set of rules (a recipe) to follow to gain compliance with the code.
- *Performance code provisions* require systems or components to function in a certain way to meet the desired level of safety and performance but do not specify the method of construction.

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Alternative Methods/Materials and Evaluation Service Reports

- The code official approves alternative methods and materials that comply with the intent of the code.
- ICC Evaluation Service (ES) Reports are valuable tools for verifying that alternative methods and materials perform satisfactorily and are equivalent to those prescribed by the code.

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Uniform Mechanical Code

- The AHJ approves alternative methods and materials that comply with the intent of the code.

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Permits

- A permit is essentially an authorization to erect, install, enlarge, alter, repair, remove, convert or replace a mechanical system the installation of which is regulated by the International Mechanical Code.
- The owner, owner's authorized agent or contractor must first make application to the code official for the proposed work and obtain the required permit.
- The permit causes the work to be inspected to determine compliance with the intent of the code.


Notice
HVAC Permit

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Plans and Specifications

- Design drawings, calculations and other submittal documents must accompany the permit application to verify compliance with the code.
- The extent of required documents varies with the complexity and scope of the project. The code official is authorized to waive submittal documents for work of a minor nature, provided that code compliance can be verified by other means.
- Local or state laws may determine requirements for a registered design professional to prepare the construction documents.

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Fees

- The jurisdiction establishes a schedule of fees.
- Permit fees are often based on the number of plumbing fixtures and may also be included as part of the overall building permit.

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Permit Issuance

- The code official must review the application and construction documents within a reasonable time and, when approved, issue the permit.
- A copy of the permit and the approved construction documents must be kept on the jobsite until completion of the project.


Notice
HVAC Permit

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Inspections

It is the responsibility of the permit holder or agent to call for the required inspections before work is concealed and to provide access to such work.

Inspection approval tag


Department of Building Safety
Phone (###) 555-4567
INSPECTION APPROVED
☐ Building ☐ Plumbing
☐ Electrical ☐ Mechanical
Description:
Comments:
Date:
Inspector:

Jobsite inspection record card


Inspection Record

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Required Inspections

INSPECTION	CONDUCTED WHEN	INSPECT
Mechanical underground	Underground work is completed and before any backfill is put in place.	• Materials, fittings and methods • Work properly supported and protected • Pressure testing of piping systems
Mechanical rough-in	Rough framing complete, ducting and all other components to be concealed are complete. Prior to sheetrock.	• Mechanical appliances and equipment • Gas appliance fuel supply system and venting • Air ducts
Mechanical final	After building complete, ready for occupancy. All mechanical systems complete.	• Mechanical appliances and equipment • Clothes dryer exhaust ducts • Appliance clearances to combustibles

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Board of Appeals

- IMC basis for appeal pertains to code requirements:
  - Appellant claims the code official erred in interpreting the code or wrongly applied a code section.
  - Appellant considers a proposed alternative to be equal to the code requirements.
- Appeals not permitted for seeking a variance or a waiver.
- Board has no authority to waive code requirements.


Department of Building Safety
Application for Appeal
Board of Appeals

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Part I – Administration

5. T F The IMC® or the UMC® overrides any local, state or federal law.

False
Both codes are meant to nullify any local, state, or federal law, and in many cases, such other laws supersede provisions found in the model code.

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Part I – Administration

6. Who applies for a permit?
   A. Code Official
   B. Owner/Authorized Agent
   C. Jurisdiction

B
The owner or authorized agent applies for a permit

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Part I – Administration

7. Who issues the permit?
   A. Code Official
   B. Owner/Authorized Agent
   C. Jurisdiction

A
The code official must review the application and construction documents and, when approved, issue the permit as soon as is practical.

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Discussion

- Why is it important for Codes to be updated on three-year cycles?
- What are the duties and authorities of the code official?
- How do prescriptive and performance code provisions help a code official to determine compliance?

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Break

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Part II

General Mechanical Requirements

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Installation of Equipment and Appliances

- Equipment such as piping, tubing, and fittings are required to comply with the applicable referenced standards, specifications, and performance criteria of the mechanical code.
- The mechanical code contains requirements for oil, electric, and solid fuel-type appliances and equipment.
- The International Fuel Gas Code references fuel-gas piping systems, appliances, and equipment.

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Installation of Equipment and Appliances

- The mechanical code requires listing and labeling for appliances, such as boilers, furnaces, condensing units, factory-built fireplaces, direct-fired heaters, cooking appliances and rooftop HVAC units to name a few.
- When equipment, materials or products are listed, this indicates that they have been tested and found suitable for a specified purpose or provides conformance by meeting an applicable standard.

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Installation of Equipment and Appliances

- The label informs the installer, mechanical inspector and the end user that the installed appliance has been tested and evaluated by an approved agency and has been deter-mined to perform safely and efficiently when installed and operated in compliance with its listing.

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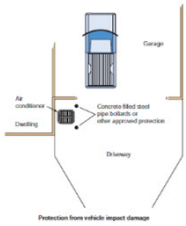
Installation of Equipment and Appliances

- Mechanical systems and their components must be located as indicated by the manufacturer's installation instructions for the listed equipment or appliances.
- Appliances are prohibited from being installed in locations where they may be subject to mechanical damage from vehicle impact.



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Installation of Equipment and Appliances

- Appliances such as furnaces, boilers, space heaters, clothes dryers and water heaters are prohibited from being installed directly on the floor when located in hazardous locations and public garages, private garages, repair garages, automotive motor fuel-dispensing facilities and parking garages.
- The ignition source must be at least 18 inches above the floor surface where the equipment or appliance is installed.

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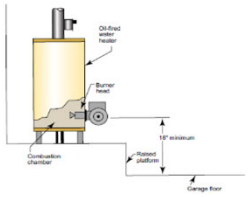
Installation of Equipment and Appliances

- The ignition source must be at least 18 inches above the floor surface where the equipment is installed.



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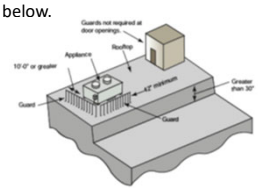
Installation of Equipment and Appliances

- Guards are required to provide protection for personnel working on or servicing equipment, appliances, components and roof hatch openings that are within 10 feet of a roof edge or open side that is more than 30 inches above the surface below.



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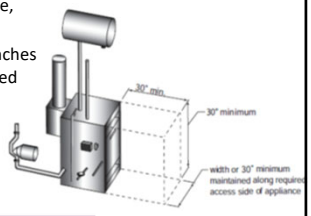
Equipment and Appliance Access

- Equipment and appliances, such as air-conditioning condensers, air handlers, controls devices, heat exchangers and other system components, must be accessible for inspection, service, repair and replacement.
- A level working space not less than 30 inches deep and 30 inches wide shall be provided in front of the control side to service an appliance.



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Equipment and Appliance Access

- When appliances are installed in attic spaces, there is typically an access opening and not much room to approach the appliance to repair, replace or provide maintenance.
- A clear access opening dimensions must be not less than 30 inches by 20 inches, and large enough to allow removal of the largest appliance.
- The passageway cannot be less than 30 inches high and 22 inches wide and not more than 20 feet in length measured along the centerline of the passageway from the opening to the appliance.

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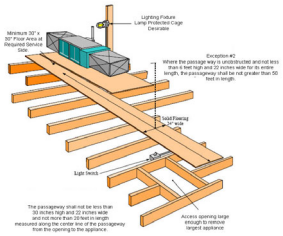
Equipment and Appliance Access

- For example, consider accessing an appliance in an attic as indicated.



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Equipment and Appliance Access

- It is very common that HVAC equipment and appliances will be designed and installed on flat building rooftops. Access to these appliances can usually be provided by means of a portable extension ladder where building heights are low.

Condensing unit on rooftop.

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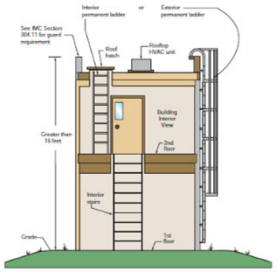
Equipment and Appliance Access

- A permanent means of access must be provided to equipment and appliances located on an elevated structure or the roof of a building that cause a person to climb higher than 16 feet above grade to access equipment or appliances.
- Options for compliance are to design and install interior stairs to an upper floor room with a permanent ladder to a roof hatch or to install an exterior permanent ladder.



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Equipment and Appliance Access

- Appliances and equipment may also be installed on sloped roofs. When installing appliances, fans and other equipment that require service on roofs having a slope of 3 units vertical in 12 units horizontal (25-percent slope) or greater and having an edge more than 30 inches above grade, a platform must be installed level and not less than 30 inches in any dimension at each side of the appliance or equipment for repairs, maintenance and service.

Platform and guards providing access to rooftop appliance.

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Piping

- Piping systems, including hydronic, refrigerant and fuel oil, must be supported adequately for the weight of the pipe material and the fluid within the pipe.
- Designers must also take into consideration these loads imposed on building elements while specifying hangar systems.
- Pipe hanger construction must be specified not only to carry the loads, but also to be attached to the building construction in an approved manner and using materials that are compatible with the piping to prevent any corrosive action. Inadequate support can cause piping to fail under its own weight, resulting in fluid leaks, fire, explosion or property damage.

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Piping Support

- Piping shall be supported at distances not exceeding the spacing specified in Table 305.4.

TABLE 305.4
PIPING SUPPORT SPACING[a]

PIPING MATERIAL	MAXIMUM HORIZONTAL SPACING (feet)	MAXIMUM VERTICAL SPACING (feet)
ABS pipe	4	10[c]
Aluminum pipe and tubing	10	15
Cast-iron pipe[b]	5	15
Copper or copper alloy pipe	12	10
Copper or copper alloy tubing	8	10
CPVC pipe or tubing, 1 inch and smaller	3	10[c]
CPVC pipe or tubing, 1¼ inches and larger	4	10[c]
Lead pipe	Continuous	4
PB pipe or tubing	2⅔ (32 inches)	4
PE-RT 1 inch and smaller	2⅔ (32 inches)	10[c]
PE-RT 1¼ inches and larger	4	10[c]
PEX tubing 1 inch and smaller	2⅔ (32 inches)	10[c]
PEX tubing 1¼ inches and larger	4	10[c]
Polypropylene (PP) pipe or tubing, 1 inch and smaller	2⅔ (32 inches)	10[c]
Polypropylene (PP) pipe or tubing, 1¼ inches and larger	4	10[c]
PVC pipe	4	10[c]
Steel pipe	12	15
Steel tubing	8	10

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.
a. See Section 301.18.
b. The maximum horizontal spacing of cast-iron pipe hangers shall be increased to 10 feet where 10-foot lengths of pipe are installed.
c. Mid-story guide.

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Part II – General Mechanical Requirements

1. Appliances located in attics shall have clear access opening dimensions a minimum of:
   - A. 18 by 24 inches (457 mm by 610 mm).
   - B. 24 by 24 inches (610 mm by 610 mm).
   - C. 30 by 30 inches (762 mm by 762 mm).
   - D. 20 by 30 inches (508 mm by 762 mm).

D
20 by 30 inches

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Part II – General Mechanical Requirements

2. Two ten-foot lengths of 2-inch cast-iron piping are to be installed horizontally to convey condensate to the sanitary sewer. What is the maximum spacing permissible for the piping hangers?
   - A. 10 feet
   - B. 8 feet
   - C. 6 feet
   - D. 5 feet

A
10 feet

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Part III

Ventilation and Exhaust Systems

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Ventilation Systems

- Ventilation in simple terms can be understood as introducing fresh air into a single-story office building by opening several exterior wall windows in order to dilute and possibly remove certain contaminants. However, the natural airflow through openable windows is not precisely controllable due to variables such as wind speed, wind direction, indoor and outdoor pressure differences to name a few.
- Chapter 4 of the International Mechanical Code (IMC) provides general and specific ventilation requirements for buildings intended to be occupied when the space or room in the building is occupied.

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Required Ventilation

- Every occupied space is required to be ventilated by utilizing natural means or mechanical means. The required ventilation must always be provided continuously when the spaces are occupied and is permitted to be discontinued when spaces are unoccupied.
- Dwelling units complying with the air leakage requirements of the International Energy Conservation Code (IECC) or ASHRAE 90.1 are required to be ventilated by mechanical means. The requirement for mechanical ventilation in R-2 dwelling units is not tied to a residential blower door test.

Group R-2 apartment building.

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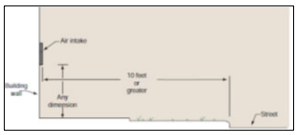
Required Ventilation

- Intake opening locations must comply with the requirements of IMC Section 401.4 as well as IMC Section 501.3.1 which addresses exhaust opening locations.
- Both sections must be applied in harmony because they both can affect the separation between intakes and exhaust openings.
- Section 401.4 Item 1 requires a minimum separation of 10 feet between outdoor air intake openings and any streets, alleys, parking lots, lot lines or buildings on the same lot in order to prevent contaminants from directly being drawn into the ventilation air inlet openings of a building.



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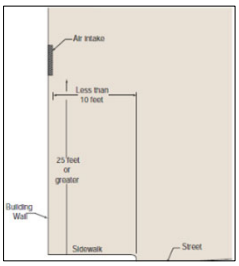
Required Ventilation

- Another arrangement for outdoor air intake openings is permitted to be located less than 10 feet horizontally from streets, alleys, parking lots and loading docks pro-vided that the openings are located not less than 25 feet vertically above such locations.
- Where openings face a street or public way, the distance shall be measured from the closest edge of the street or public way .



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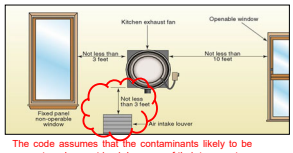
Required Ventilation

- In areas where the required 10 feet separation cannot be met, the intake opening could be located at least 3 feet below a contaminant source, such as a kitchen exhaust fan indicated in the figure below.
- It is assumed that the contaminants likely to be present are buoyant in air because of their temperature or specific gravity, and they will rise above and away from the intake opening.



The code assumes that the contaminants likely to be present are buoyant in air because of their temperature or specific gravity, and they will rise above and away from the intake opening.

Intake opening separation below a contamination source.

75

Intake Opening and Exhaust Outlet Locations

Intake openings shall be located not less than 3 feet (914 mm) below contaminant sources where such sources are located within 10 feet (3048 mm) of the opening. Separation is not required between intake air openings and living space exhaust air openings of an individual dwelling unit or sleeping unit where an approved factory-built intake/exhaust combination termination fitting is used to separate the air streams in accordance with the manufacturer's instructions.

IMC 2021

76

Natural Ventilation

- In order to qualify for natural ventilation, the minimum open-able area to the outdoors must be 4 percent of the floor area being ventilated. Based on the minimum required area calculated for openings, the locations of windows should be placed to allow air to flow through spaces. Windows only installed on one side of a building may not produce the function of natural ventilation.
- In order to provide natural ventilation, openings must communicate with the outdoor air. Openings to the outdoor air, such as doors, windows or louvers provide natural ventilation.

IMC 2021

ICC PMG

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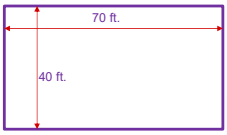
Example

Given: A new office building with a proposed floor area of 2,800 sq. ft. will be naturally ventilated. Calculate the required minimum openable area to the outdoors to be installed?



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Questions and Answers

Calculate building floor area to be ventilated: 70 ft × 40 ft = 2,800 sq. ft

Calculate minimum openable area required (4%): 2,800 sq. ft × 0.04 = 112 sq. ft (Min. required area)

Recall: Natural ventilation openings must be 4 percent of the floor area being ventilated.

IMC Section 402.2

79

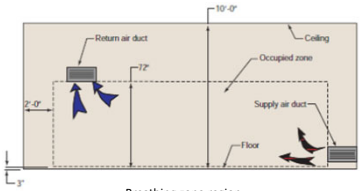
Mechanical Ventilation

- Mechanical ventilation is the alternative to providing natural ventilation. This method is much more predictable than natural ventilation, as it may be controlled and directed deep into occupied spaces within buildings.
- The duct system to convey ventilation air must be designed and installed in accordance with IMC Chapter 6.
- The minimum outdoor airflow rate for mechanical ventilation is determined using IMC Section 403.3.
- In each occupiable space, the ventilation system shall be designed to deliver the required rate of outdoor airflow to the breathing zone.

80

Mechanical Ventilation

- The breathing zone, by definition, has defined boundaries based on where people occupy spaces.



Breathing zone region.

81

Mechanical Ventilation

- The occupant load utilized for design of the ventilation system shall be not less than the number determined from the estimated maximum occupant load rate indicated in Table 403.3.1.1.

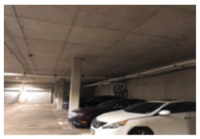
OCCUPANCY CLASSIFICATION	OCCUPANT DENSITY #/1000 ft²	PEOPLE OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_p cfm/person	AREA OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_a cfm/ft²	EXHAUST AIRFLOW RATE cfm/ft²
Education				
Locker/dressing rooms	—	—	—	0.25
Media center	25	10	0.12	—
Multiuse assembly	100	7.5	0.06	—
Music/theater/dance	35	10	0.06	—
Science laboratories	25	10	0.18	1.0
Smoking lounges	70	60	—	—
Sports locker rooms	—	—	—	0.5
Wood/metal shops	20	10	0.18	0.5

Partial Table 403.3.1.1

82

Enclosed Parking Garage Ventilation

- Mechanical ventilation for enclosed parking garages applies to parking garages and not to repair garages.
- The intent of the code is that the exhaust system can operate continuously or intermittently.

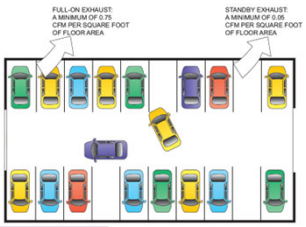



Exterior entrance and interior view of an enclosed parking garage for a multiple-story office building.

83

Enclosed Parking Garage Ventilation

- The required ventilation rate for enclosed public parking garages is 0.75 cfm per square foot of area for continuous operation of the exhaust system. This method can consume a significant amount of energy and quite costly to operate.
- As a means of conserving energy, ventilation systems for enclosed public parking garages are allowed to alternate or modulate between full capacity and the minimum capacity.



84

Enclosed Parking Garage Ventilation

- By providing a gas sensing system consisting of carbon monoxide (CO) detectors applied in conjunction with nitrogen dioxide (NO2) detectors, intermittent operation is permitted when designed to operate at a lower limit of not less than 0.05 cfm per square foot of exhaust running continuously and when the system is capable of producing a maximum ventilation airflow rate of 0.75 cfm per square foot of floor area as determined by the CO and NO2 detection system.

CO and NO2 sensing devices that are installed to transmit gas concentration signals to a control panel that controls automatic louvers and fans.

85

Ambulatory Care Facilities and Group I-2 Occupancies

- Mechanical ventilation for ambulatory care facilities and Group I-2 occupancies are required to be designed and installed in accordance with the International Mechanical Code, ASHRAE 170 and NFPA 99.
- The standards contain specific requirements used for ventilation and exhaust systems for patient-care areas, gas storage areas and emergency power system rooms to name a few.

86

Break

87

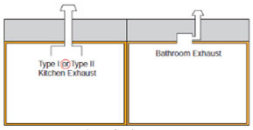
Exhaust Systems

- Chapter 5 of the International Mechanical Code (IMC) provides exhaust system requirements regarding clothes dryers and cooking appliances; hazardous exhaust systems; dust, stock and refuse conveyor systems; sub-slab soil exhaust systems; smoke control systems; energy recovery ventilation systems and other systems.
- Specific sections regulate the materials and methods used for construction and installation of detailed exhaust equipment, system controls, fire protection and related components.

88

Types of Exhaust Systems (Required Exhaust)

- The primary intent is to provide requirements for connections and discharge locations of exhaust systems.
- The air removed by every mechanical exhaust system is required to be discharged outdoors at a point where it will not cause a public nuisance.
- Single or combined mechanical exhaust systems for environmental air must be independent of all other exhaust systems.



Separation of exhaust systems

89

Types of Exhaust Systems (Required Exhaust)

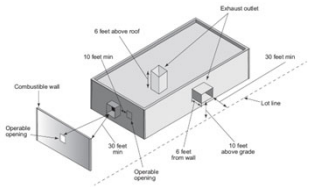
- All environmental air must exhaust a minimum of 10 feet from property lines, 3 feet from operable openings into buildings for all occupancies other than Group U and 10 feet from mechanical air intakes.
- Air cannot be exhausted into an attic or crawl space or be directed onto walkways. Such exhaust is not to be considered hazardous or noxious.
- The air shall be discharged to a location from which it cannot again be readily drawn in by a ventilating system.

Louvered exhaust discharge termination for environmental air from a compressor room complying with IMC Section 501.3, Item 3.

90

Types of Exhaust Systems (Required Exhaust)

- For ducts conveying explosive or flammable vapors, fumes or dusts, IMC Section 501.3, Item 1 requires the following minimum separation distances:

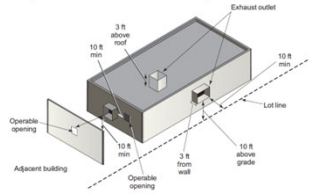


Locations of exhaust duct terminations that are exhausting explosive or flammable vapors, fumes or dusts.

91

Types of Exhaust Systems (Required Exhaust)

- For ducts NOT conveying explosive or flammable vapors, fumes or dusts, the following minimum separation distances are required:



Locations of exhaust duct terminations that are NOT exhausting explosive or flammable vapors, fumes or dusts.

92

Types of Exhaust Systems (Clothes Dryer Exhaust Systems)

- Clothes dryer exhaust systems must convey the moisture and any products of combustion directly to the exterior of the building and must pass completely through the building envelope to the outdoors.
- The IMC contains specific testing standards for electric dryers and specific exhaust systems requirements for electric clothes dryers.
- Similar to electric dryers, fuel-gas-type clothes dryers are covered in the International Fuel Gas Code (IFGC). Installation of clothes dryer exhaust ducts must comply with the dryer manufacturer's installation instructions and all the requirements of IMC Section 504.

93

Types of Exhaust Systems (Clothes Dryer Exhaust Systems)

- Clothes dryer ducts of rigid metal are used to convey the moisture and product of combustion from the dryer appliance to the outdoors. However, the penetrations must be properly protected to help pre-vent a fire that is associated with a dryer from spreading into the wall or ceiling cavity.
- This can be achieved by sealing with noncombustible material, approved fire caulking or a noncombustible dryer exhaust duct wall receptacle.

Example of a noncombustible wall receptacle

94

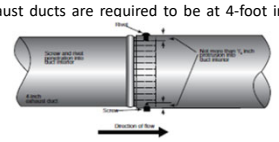
Types of Exhaust Systems (Clothes Dryer Exhaust Systems)

- Dryers exhausting more than 200 cfm are required to be provided with makeup air.
- Where a closet is designed for the installation of a clothes dryer, an opening having an area of not less than 100 square inches shall be provided in the closet enclosure or makeup air can be provided by other approved means.
- Exhaust duct material must have a smooth interior finish and be constructed of metal not less than 0.016-inch thick. Exhaust duct diameter is required to be 4 inches nominal in diameter.

95

Types of Exhaust Systems (Clothes Dryer Exhaust Systems)

- The insert end of the duct shall extend into the adjoining duct or fitting in the direction of airflow.
- Ducts are not allowed to be joined with screws or similar fasteners that protrude more than 1/8 inch into the inside of the duct.
- Supporting of exhaust ducts are required to be at 4-foot intervals and secured in place.



Example showing duct installation in the direction of flow. Fasteners such as screws and rivets may be used if they do not penetrate more than 1/8 inch.

96

Types of Exhaust Systems (Clothes Dryer Exhaust Systems)

- Transition ducts for clothes dryers allow for a flexible connection from the dryer exhaust duct system to the clothes dryer appliance.
- A transition duct must be listed and labeled in accordance with UL 2158A, installed in a single length and have a total length of not more than 8 feet.
- Transition ducts are not permitted to be concealed within construction.

Transition duct.

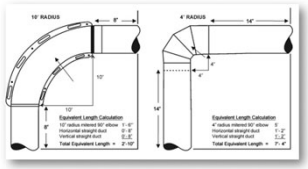
97

Types of Exhaust Systems (Clothes Dryer Exhaust Systems)

- The maximum allowable duct length for dryers is either 35 feet or determined by the manufacturer's installation instructions unless a power ventilator is used. When dryer fittings are used, the maximum length must be reduced according to Table 504.9.4.1.

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
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

Partial Table 504.9.4.1



98

Types of Exhaust Systems (Commercial Kitchen Exhaust Systems)

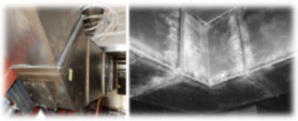
- Type I kitchen hoods are designed for collecting and removing grease vapors and smoke at the locations of cooking appliances.
- Ducts are connected to Type I hoods conveying grease and smoke to the outdoors through exhaust fans. These hoods are required to be equipped with fire suppression systems.

Type I hood designed for capturing grease-laden vapor and smoke.

99

Types of Exhaust Systems (Commercial Kitchen Exhaust Systems)

- Type I grease duct materials are required to be thicker than those specified for hoods because the ducts are usually concealed in the building structure and because the possibility of a fire occurring in a duct is greater than in the hood.
- Grease ducts serving Type I hoods are permitted to be constructed of steel with a minimum thickness of not less than 0.0575 inch (No. 16 gage) or stainless steel with a minimum thickness of not less than 0.0450 inch (No. 18 gage).



Type I steel grease duct system constructed of No. 16 gage welded sheet steel.

100

Types of Exhaust Systems (Commercial Kitchen Exhaust Systems)

- An exception allows for commercial factory-built grease ducts that are listed and labeled in accordance with UL 1978 and must be installed according to the manufacturer's installation instructions.
- Makeup air ducts connecting to or within 18 inches of a Type I hood must be noncombustible or listed for the intended application.

Factory-built grease ducts listed and labeled in accordance with UL 1978 for zero clearance to combustibles.

101

Types of Exhaust Systems (Commercial Kitchen Exhaust Systems)

- Type II kitchen hoods are designed for collecting and removing steam, vapor, heat, odors and products of combustion. Other examples may include Type II hoods installed over steamers, kettles, pasta cookers, cheese melters and ovens.
- Below is an example of a Type II hood installed to capture steam from a commercial dish washing appliance.

102

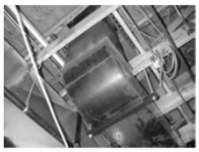
Types of Exhaust Systems (Commercial Kitchen Exhaust Systems)

- Duct materials serving Type II hoods are to be constructed of rigid metallic material. Chapter 6 references duct construction, installation, bracing and supports. Additionally, ducts subject to positive pressure and ducts conveying moisture-laden or waste-heat-laden air must be constructed, joined and sealed in an approved manner.

103

Types of Exhaust Systems (Commercial Kitchen Exhaust Systems)

- Type I kitchen hoods and duct systems are designed for collecting and removing grease vapors and smoke at the locations of cooking appliances. *Consider the potential of abnormally high temperatures within ducts caused by grease fires possibly igniting surrounding combustible materials.*
- Clearances to combustible construction of not less than 18 inches must be maintained for grease in these duct systems and exhaust equipment serving a Type I hood when enclosures are not required. [Ref. IMC 506.3.6]



Prohibited installation of grease duct less than 18 inches from combustible construction.

104

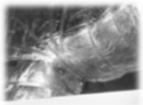
Types of Exhaust Systems (Commercial Kitchen Exhaust Systems)

- Reference to UL 1978 for factory-built commercial kitchen grease ducts. Reduced clearance to combustibles for commercial kitchen grease ducts that are covered with a field-applied grease duct enclosure system listed in accordance with ASTM E 2336.

506.3.6 Grease duct clearances. Where enclosures are not required, grease duct systems and exhaust *equipment* serving a Type I hood shall have a *clearance* to combustible construction of not less than 18 inches (457 mm), and shall have a *clearance* to noncombustible construction and gypsum wallboard attached to noncombustible structures of not less than 3 inches (76 mm).

Exceptions:

1. Factory-built commercial kitchen grease ducts *listed* and *labeled* in accordance with UL 1978.
2. *Listed* and *labeled* exhaust *equipment* installed in accordance with Section 304.1.
3. Where commercial kitchen grease ducts are continuously covered on all sides with a *listed* and *labeled* field-applied grease duct enclosure material, system, product or method of construction specifically evaluated for such purpose in accordance with ASTM E 2336, the required *clearance* shall be in accordance with the listing of such material, system, product or method.

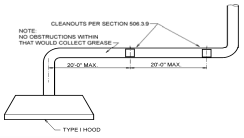


105

Types of Exhaust Systems (Commercial Kitchen Exhaust Systems)

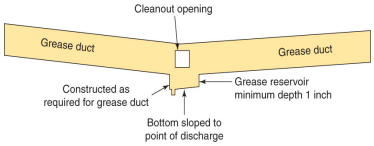
- Ducts serving Type I hoods must be constructed with the code-prescribed slopes and installed without forming any dips, pockets or low points that are capable of collecting grease or residue.
- These grease duct systems must slope not less than 1/4 unit vertical in 12 units horizontal (2-percent slope) toward the hood or toward a grease reservoir. When horizontal ducts exceed 75 feet in length, the slope must be not less than 1 unit vertical in 12 units horizontal (8.3-per-cent slope).
- Grease ducts that are inaccessible from the hood or discharge openings shall be provided with cleanout openings spaced not more than 20 feet apart and not more than 10 feet from changes in direction greater than 45 degrees.

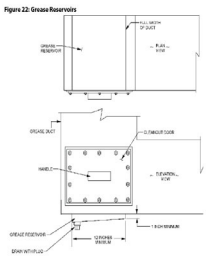
Cleanouts and openings are required to have a thickness not less than that required for the duct and must be equipped with tight-fitting doors constructed of steel. Gasket and sealing materials shall be rated for not less than 1,500°F



106

Grease Duct Reservoirs



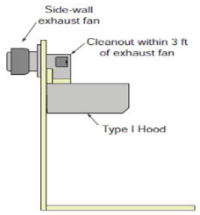


506.3.7.1 – Grease duct reservoirs.
Provides prescriptive requirements on how to construct a grease reservoir.
Seven items provided for construction of grease reservoir

107

Types of Exhaust Systems (Commercial Kitchen Exhaust Systems)

- Grease duct horizontal cleanouts are required to be located within 3 feet of horizontal discharge fans.



Cleanout located within 3 feet of a horizontal discharge fan.

108

Types of Exhaust Systems (Commercial Kitchen Exhaust Systems)

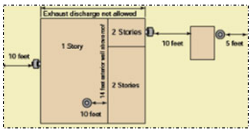
- Exhaust outlets are connected to fans that terminate above the roof and have the discharge opening located not less than 40 inches above the roof surface.

Fan discharge opening located not less than 40 inches above the roof surface.

109

Types of Exhaust Systems (Commercial Kitchen Exhaust Systems)

- Exhaust outlets must be at least 10 feet horizontally from parts of the same or contiguous buildings, adjacent buildings and adjacent property lines. An exception allows a reduced horizontal clearance to 5 feet where the exhaust discharge is directed so as not to affect any property or enter any building.
- Exhaust outlets are to be located not less than 10 feet above grade.



Note: This side of building is less than 5 feet from property line and exhaust discharge cannot be directed upward to meet IMC Section 506.3.13.3 Exception.

110

Types of Exhaust Systems (Commercial Kitchen Exhaust Systems)

- Type I hoods must be installed with a clearance to combustibles of not less than 18 inches. Similar to grease ducts, the 18 inches is to provide airspace as a convective cooling method for surrounding combustible materials due to the potential of abnormally high temperatures within hoods that could be caused by grease fires.

IMC 507.2.6: One of two exceptions allows zero clearance from gypsum wallboard or 1/2 inch or thicker cementitious wallboard attached to noncombustible structures.

Type I hood where back edge is in contact with stainless steel sheet over gypsum wallboard attached to metal studs. Note that the stainless steel sheet appears not to extend a minimum of 18 inches in all directions from the hood.

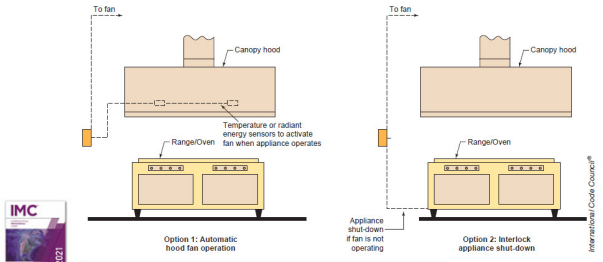
111

Types of Exhaust Systems (Commercial Kitchen Exhaust Systems)

- Type I hoods not UL listed and labeled are to be constructed of steel having a minimum thickness of 0.0466 inch (No. 18 gage) or stainless steel not less than 0.0335 inch (No. 20 MSG) in thickness.
- Conversely, Type II hoods are permitted to be constructed of lighter materials such as; steel having a minimum thickness of 0.0296 inch (No. 22 gage) or stainless steel not less than 0.0220 inch (No. 24 gage) in thickness.
- The exhaust fan serving a Type I hood will have automatic controls that will activate the fan when any appliance that requires such Type I hood is turned on, or a means of interlock must be provided that will prevent operation of such appliances when the exhaust fan is not turned on.

112

Hood & Equipment Interlock



113

Types of Exhaust Systems (Commercial Kitchen Exhaust Systems)

- Type I hoods must be equipped with grease filters that are listed and labeled in accordance with UL 1046 in order to capture much of the grease from cooking operations.
- Filters must be located above cooking and heating surfaces to prevent high-temperature cooking vapors and open flames from igniting the grease collected on the filters.
- Grease filters must be installed at an angle of not less than 45 degrees from the horizontal and shall be equipped with a drip tray beneath the lower edge of the filters to allow drainage of captured liquefied grease.

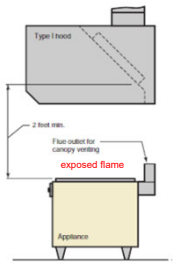
114

Types of Exhaust Systems (Commercial Kitchen Exhaust Systems)

- Table 507.2.8 indicates the minimum distance that grease filters must be located above cooking and heating surfaces to prevent high-temperature cooking vapors and open flames from igniting the grease collected on the filters.

TABLE 507.2.8
MINIMUM DISTANCE BETWEEN THE LOWEST EDGE OF A GREASE FILTER AND THE COOKING SURFACE OR THE HEATING SURFACE

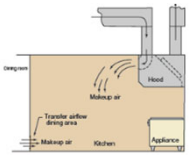
TYPE OF COOKING APPLIANCES	HEIGHT ABOVE COOKING SURFACE (feet)
Without exposed flame	0.5
Exposed flame and burners	2
Exposed charcoal and charbroil type	3.5



115

Types of Exhaust Systems (Commercial Kitchen Exhaust Systems)

- Commercial kitchen exhaust systems must be replaced with air called "makeup air" to allow the exhaust system to perform as designed and to prevent excessive negative pressure in the commercial cooking area. Mechanical makeup air systems must be automatically controlled to start and operate when the exhaust system is activated.

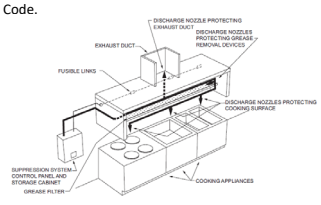


Example of a round makeup air duct installation above the ceiling to replenish exhaust air from a Type I kitchen exhaust system.

116

Types of Exhaust Systems (Commercial Kitchen Exhaust Systems)

- Cooking appliances required to have a Type I hood shall be pro-vided with an approved automatic fire suppression system complying with the International Building Code and the International Fire Code.



Fire suppression system for a Type I hood.

117

Part III – Ventilation and Exhaust Systems

1. A 1,500 square foot office space is to be ventilated through openable windows using the natural ventilation method. The total openable area of the windows provided for ventilation purposes shall be a minimum of ____ square feet.

A. 60
B. 80
C. 120
D. 140

"A"
IMC Section 402.2: Requires minimum outdoor opening area of 4% of the floor area being ventilated
1,500 x .04 = 60 square feet

118

Part III – Ventilation and Exhaust Systems

2. How many feet shall ducts conveying explosive vapors terminate from property lines?

A. 20 feet
B. 30 feet
C. 40 feet
D. 50 feet

B
30 feet

119

Break

120

Part IV

Duct Systems

121

Duct Systems

- A duct system is a continuous passageway for the transmission of air that, in addition to ducts, includes duct fittings, dampers, plenums, fans and accessory air-handling equipment and appliances.
- In order to distribute air through ducts for air conditioning, heating and environmental air purposes, duct systems must be constructed of materials required by the International Mechanical Code (IMC) that provide function and safety.
- Ducts constructed within buildings periodically penetrate fire-resistance-rated assemblies. Installing devices, such as fire dampers, smoke dampers combination fire/smoke dampers, and ceiling radiation dampers at these penetrations will maintain the integrity of the fire-resistance-rated assemblies.

122

- NOTES THROUGH THIS SLIDE

123

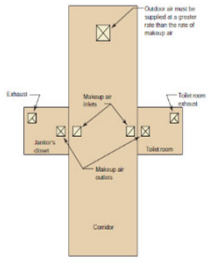
General Air Movement Requirements

- IMC Chapter 6 provides requirements for duct systems used for the movement of air in air-conditioning, heating, ventilating and exhaust systems except as otherwise specified in IMC Chapter 5, Exhaust Systems and IMC Chapter 7, Combustion Air.
- Air movement in egress elements such as corridors are prohibited from being used as air distribution system ducts because of the potential for spreading smoke and fire into elements of the building's required means of egress. The intent is to prohibit air movement that would introduce smoke into the corridor and restrict the ability of the occupants to safely use this egress element to get to an exit.

124

General Air Movement Requirements

- There are four exceptions that allow corridors to be used for air movement with specific requirements. One example of corridors permitted to be used as air movement is IMC 601.2 Exception 1.
- This exception considers the common practice of using air from the corridor as makeup air for small exhaust fans in adjacent rooms.
- The adjacent figure shows an example that allows the use of a corridor as a source of makeup air for exhaust systems in rooms that open directly onto such corridors, such as a toilet room or janitor closet.



125

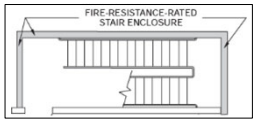
Equipment and Ductwork for Exit Enclosure Ventilation

- When specific egress elements, such as exit enclosures, are ventilated by mechanical systems, the mechanical equipment and duct systems must be installed based on certain requirements. Mainly the heating, ventilating and air-conditioning (HVAC) systems serving an exit enclosure must not serve any other room or space, along with protecting ductwork, equipment and openings into fire-resistant-rated shafts.
- Equipment and ductwork serving the exit enclosures must be enclosed in construction as required by the International Building Code (IBC) for shafts with the intent to protect the exit enclosures from the spread of smoke from other areas. [Ref. IMC 601.3]

126

Equipment and Ductwork for Exit Enclosure Ventilation

- In each case, openings into fire-resistance-rated construction shall be limited to those needed for maintenance and operation and shall be protected by self-closing fire-resistance-rated devices in accordance with the International Building Code for enclosure wall opening protectives.

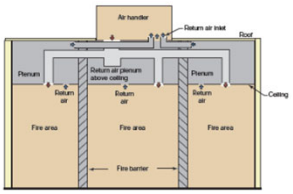


Interior exit stair enclosure.

127

Plenums

- A plenum is defined as an enclosed portion of the building structure, other than an occupiable space being conditioned, that is designed to allow air movement and thereby serves as part of an air distribution system. Air plenum spaces are restricted to uninhabitable, unoccupiable, interstitial spaces and cavities.
- Plenums are typically used to convey return air back to air handlers and are restricted to one fire area as defined by the International Building Code.



Connecting plenums in multiple fire areas.

128

Plenums

- All materials within plenums must be noncombustible or be listed and labeled as having a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with ASTM E84 or UL 723.
- However, the code permits combustible materials that are fully enclosed with materials that are listed and labeled for installation in a plenum.
- If pipe insulation is used as an enclosing material, the entire assembly of the pipe, the insulation and any coverings and adhesives are tested as a composite assembly.

129

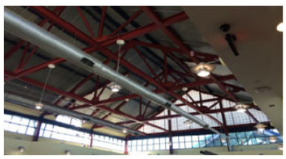
Duct Construction and Installation

- The IMC contains requirements for the construction of ducts used to transport environmental air for HVAC systems and for general exhaust purposes, such as toilet rooms, noncommercial kitchens and nonhazardous exhaust.
- Air distribution systems must be effectively designed to provide the required volume of air at specified pressures for general exhaust purposes, comfort conditioning, contaminant control or space pressurization.

130

Duct Construction and Installation

- Single dwelling unit duct installations must be sized in accordance with ACCA Manual D, and all other buildings are required to have duct systems sized in accordance with the ASHRAE Handbook of Fundamentals or other comparable sizing methods.



Duct system designed for a commercial retail building.

131

Duct Construction and Installation

- The pressure classification of ducts is required to be equal or exceed the design pressure of the air distribution in which the ducts are applied.
- The duct pressure classifications are 0.5, 1, 2, 3, 4, 6, or 10 inches water column. Pressures are based on the maximum operating pressure of the duct operating at positive or negative pressures.

Metal duct designed for 2 inches water column pressure.

132

Duct Construction and Installation

- Duct joints, seams and connections are required to be sealed. Ductwork shall be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, liquid sealants or tapes.

Construction and sealing of round metal ducts.

133

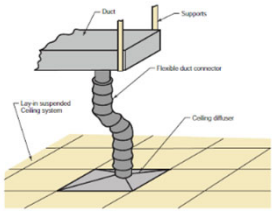
Duct Construction and Installation

- Nonmetallic ducts and duct materials must be tested and classified in accordance with the provisions of UL 181.
- Flexible air ducts are commonly used in mechanical construction for ease of installation within tight spaces, such as routing through floor/ceiling truss system webs where rigid ductwork would require many joints. Flexible air ducts are not to be limited in length.
- While flexible air connectors may look like flexible air ducts, they are limited in length to 14 feet due to less stringent testing compared to flexible air ducts. The air temperatures within flexible air connector ducts must not exceed 250°F.

134

Duct Construction and Installation

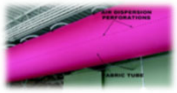
- Flexible connection from a rigid round duct to a ceiling diffuser that can be a flexible air connector when the length does not exceed 14 feet.



135

Duct Construction and Installation

- An air dispersion system is a diffuser system designed to both convey air within a room, space or area and diffuse air into that space while operating under positive pressure.
- These systems are exposed and supply air through circular-shaped air-impermeable fabric material or plastic film materials. The system is manufactured with air holes or nozzles to direct air into the area served by the duct. Air dispersion systems are actually a duct and a diffuser all in one.
- Applications for this particular system are open ceiling installations, such as offices, retail stores, schools and conditioned warehouses.



136

Duct Construction and Installation

- The requirements for using air dispersion systems are that they are not per-mitted to be installed in concealed locations; they must be installed entirely exposed.
- Air dispersion systems must be supplied with positive air pressure only and must not penetrate fire-resistance-rated construction. Air dispersion systems must also be listed and labeled in accordance with UL 2518.

137

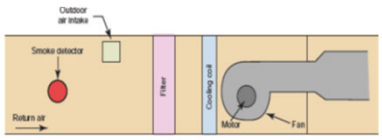
Smoke Detection

- In a fire condition, smoke will be drawn into the return air ducts and conveyed to the air handler and into the supply air distribution duct system. Ducted HVAC systems meeting certain requirements must be equipped with duct smoke detection methods that will essentially shut down the air handler, rooftop HVAC unit or other equipment producing airflow in a ducted system.
- UL 268A is used to evaluate duct smoke detectors that are specifically designed and tested to sense smoke within air ducts.

138

Smoke Detection

- Smoke detectors are required in a return air duct or plenum with a system design capacity greater than 2,000 cfm.
- Smoke detectors must be installed in a location upstream of any filters, exhaust air connections, outdoor air connections or decontamination equipment and appliances.

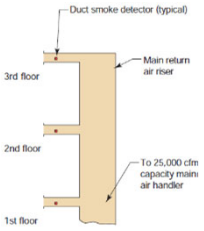


Required duct smoke detector and location.

139

Smoke Detection

- Duct smoke detectors are required in systems that are combined with multiple air handling units sharing common supply or return ducts or plenums that have a combined design capacity greater than 2,000 cfm.
- In buildings with two or more stories with return air risers having a design capacity greater than 15,000 cfm, duct smoke detectors are required at each story.



Multiple-story building with duct smoke detector at each story.

140

Smoke Detection

- Where a building is required to have a fire alarm system, duct smoke detectors must be connected to the fire alarm system. In buildings not required to be equipped with a fire alarm system, an audible and visible (AV device) signal must be activated at an approved location.

141

Duct and Transfer Openings

- Many fire-resistance-rated assemblies, such as fire walls, fire barriers, fire partitions and shafts, are systematically listed with specific protection requirements along with exceptions.
- Additionally, devices like fire dampers must comply with the requirements of UL 555 and have fire-resistance ratings not less than that specified in Table 607.3.2.1.

[BF] TABLE 607.3.2.1
FIRE DAMPER RATING

TYPE OF PENETRATION	MINIMUM DAMPER RATING (hour)
Less than 3-hour fire-resistance-rated assemblies	1½
3-hour or greater fire-resistance-rated assemblies	3

Fire Damper

142

Balancing

- Air distribution, ventilation and exhaust systems shall be provided with means to adjust the system to achieve the design airflow rates and shall be balanced by an approved method. Ventilation air distribution shall be balanced by an approved method and such balancing shall verify that the air distribution system is capable of supplying and exhausting the airflow rates required by Chapter 4.
- Air distribution, ventilation and exhaust systems shall be provided with means to adjust the system to achieve the design airflow rates and are to be balanced by an approved method.

Balancing damper installed in a duct as a means to adjust airflow for balancing a section of duct in an air distribution system.

143

Part IV – Duct Systems

1. Materials exposed within plenums shall be noncombustible or shall be listed and labeled as having a flame spread index of not more than _____ and a smoke-developed index of not more than when tested in accordance with ASTM E 84 or UL 723.

A. 50 and 450
B. 25 and 450
C. 25 and 500
D. 25 and 50

"D"
25 flame spread index and 50 smoke-developed index

144

Part IV – Duct Systems

2. How many fire areas are plenums limited to?

A. 1
B. 2
C. 3
D. Unlimited

"A"
1 fire area

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Part V

Combustion Air, Chimney and Vent Systems

146

Combustion Air

- Combustion air is necessary for mixing with a fuel and an ignition source to provide complete combustion and proper operation of various heating appliances. Following the requirements within the International Mechanical Code (IMC) and International Fuel Gas Code (IFGC) will ensure proper air supply for the combustion and venting process, as well as ventilation cooling for the appliances.
- Insufficient combustion air results in incomplete fuel combustion, which causes soot production, increased carbon monoxide production, serious appliance malfunction and the risk of fire or explosion.

147

Combustion Air Requirements (Mechanical Code)

- IMC Section 701.1 refers the users to:
  - the manufacturer's installation instructions for solid fuel burning appliances,
  - NFPA 31 for oil-fired appliance combustion air requirements and
  - the IFGC for gas appliances.

148

Combustion Air Requirements (Mechanical Code)

- Automatic dampers installed as combustion air openings must be interlocked with the firing circuit of the appliances served in order to prevent the operation of any appliance that draws combustion air from the room or space when any of the dampers are closed.

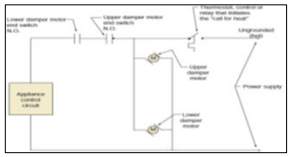

Figure shows an electrical interlock circuit that must prove both the upper and lower dampers are fully opened (end switches will close), then allow the appliance to operate.

149

Lunch Break

150

Combustion Air Requirements (Fuel Gas Code)

- Combustion air requirements for gas burning appliances are found in Chapter 3 of the IFGC – General Requirements.
- Several different methods exist to provide combustion air or gas fuel-fired appliances. The IFGC covers several methods of providing combustion air including: utilizing outdoor air, indoor air, combination indoor/outdoor air, engineered systems and the mechanical supply of combustion air.

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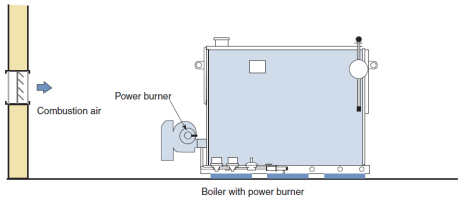
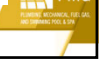
Combustion Air Requirements (Fuel Gas Code)

304 – Combustion, Ventilation, and Dilution Air





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Combustion Air Requirements (Fuel Gas Code)

304 – Combustion, Ventilation, and Dilution Air

- Gas utilization equipment requires air for combustion, ventilation and dilution of flue gases
- Requirements assure:
  - Proper air supply for the combustion and venting process
  - Ventilation cooling for appliances

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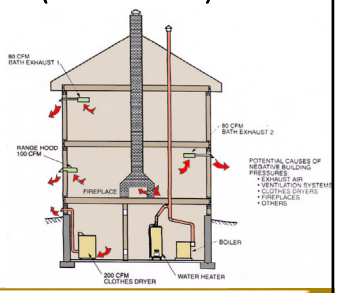
Combustion Air Requirements (Fuel Gas Code)

304.4 – Makeup Air Provisions

- Maintenance of appropriate relationships
  - Choice of appliance location / contaminated atmospheres
  - Advantages of direct-vent appliances



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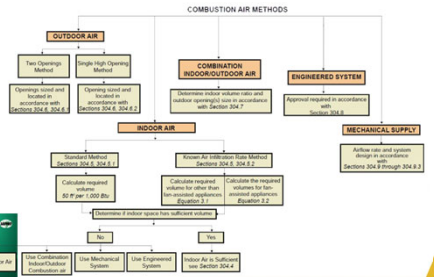
Combustion Air Requirements (Fuel Gas Code)



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Combustion Air Requirements (Fuel Gas Code)

304.5 – Indoor Combustion Air

304.5.1 Standard method. The minimum required volume shall be 50 cubic feet per 1,000 Btu/h (4.8 m3/kW) of the appliance input rating.

304.5.2 Known air-infiltration-rate method. Where the air infiltration rate of a structure is known, the minimum required volume shall be determined using Equation 3-1 or 3-2.

$$Required\ Volume_{other} \geq \frac{21\ \text{ft}^3}{ACH}\left(\frac{I_{other}}{1{,}000\ \text{Btu/h}}\right)$$

(Equation 3-1)

$$Required\ Volume_{fan} \geq \frac{15\ \text{ft}^3}{ACH}\left(\frac{I_{fan}}{1{,}000\ \text{Btu/h}}\right)$$

(Equation 3-2)

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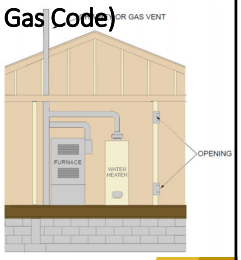
Combustion Air Requirements (Fuel Gas Code)

304.5 – Indoor Combustion Air

304.5.3 Indoor opening size and location.

- Where combining spaces on the same story, each opening shall have a minimum free area of 1 square inch per 1,000 Btu/h of the total input rating of all appliances in the space, but not less than 100 square inches.
- The volumes of spaces in different stories shall be considered to be communicating spaces where such spaces are connected by one or more permanent openings in doors or floors having a total minimum free area of 2 square inches per 1,000 Btu/h of total input rating.



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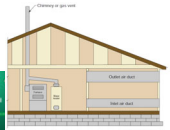
Combustion Air Requirements (Fuel Gas Code)

304.6 – Outdoor Combustion Air

- Outdoor combustion air shall be provided through opening(s) to the outdoors in accordance with Section 304.6.1 or 304.6.2. The minimum dimension of air openings shall be not less than 3 inches.
  1. Section 304.6.1 Two-permanent-openings method.
  2. Section 304.6.2 One-permanent-opening method.



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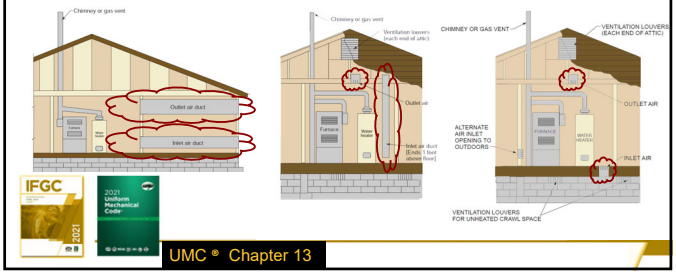
Combustion Air Requirements (Fuel Gas Code)

304.6 – Outdoor Combustion Air

304.6.1 – Two-permanent-openings method



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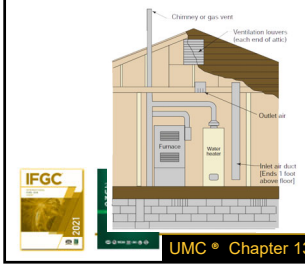
Combustion Air Requirements (Fuel Gas Code)

304.6 – Outdoor Combustion Air

304.6.1 – Two-permanent-openings method



- 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 of total input rating of all appliances in the enclosure

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Combustion Air Requirements (Fuel Gas Code)

304.6 – Outdoor Combustion Air

304.6.1 – Two-permanent-openings method

- Where communicating with the outdoors through horizontal ducts, each opening shall have a minimum free area of 1 square inch per 2,000 Btu/h of total input rating of all appliances in the enclosure

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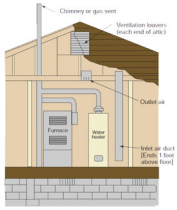
Example: Two opening method

- **Given:** A 150,000 Btu/h gas furnace and 50,000 Btu/h gas water heater will be installed in a mechanical room with two vertical combustion air ducts to a ventilated attic.
- Calculate the minimum net free area required for each vertical opening utilizing the "Two Opening Method"



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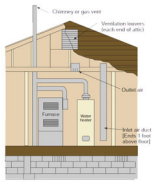
Example: Two opening method

Step 1: Sum of all gas appliances located within enclosure.
150,000 Btu/h + 50,000 Btu/h = 200,000 Btu/h

Step 2: Determine minimum net free area for each duct.
200,000Btu/h / (4,000 Btu/h / 1 sq. in.) = 50 square inches

Note: Some rectangular ducts that could be used are:

- 14x4 (56 sq. in.)
- 10x6 (60 sq. in.)
- 8x8 (64 sq. in.)



Calculate minimum round duct size?

$A = (\pi \times D^2) / 4$
Re-write equation to solve for diameter
$D = (A \times 4/\pi)^{1/2}$
$D = (50 \times 4/\pi)^{1/2}$
$D = 8$ inches

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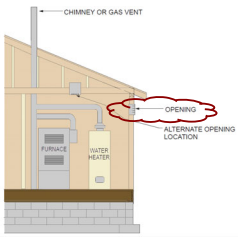
Combustion Air Requirements (Fuel Gas Code)

304.6 – Outdoor Combustion Air
304.6.2 One-permanent-opening method



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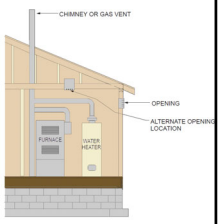
Combustion Air Requirements (Fuel Gas Code)

304.6 – Outdoor Combustion Air

304.6.2 One-permanent-opening method

- One permanent opening, commencing within 12 inches of the top of the enclosure, shall be provided. The appliance shall have clearances of not less than 1 inch from the sides and back and 6 inches 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 and shall have a minimum free area of 1 square inch per 3,000 Btu/h of the total input rating of all appliances and not less than the sum of the areas of all vent connectors in the space.



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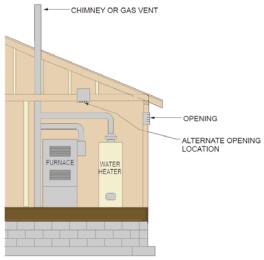
Example:
One opening method

- **Given:** A 200,000 Btu/h gas furnace with a 8" connector and 120,000 Btu/h gas water heater with a 5" connector will be installed in a mechanical room with one opening in the exterior wall.
- Calculated the net free area required for the exterior wall combustion air opening utilizing the "One Opening Method"



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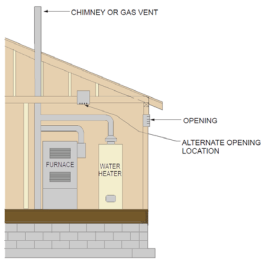
Example:
One opening method

Step 1: Sum of all gas appliances located within enclosure.
200,000 Btu/h + 120,000 Btu/h = 320,000 Btu/h

Step 2: Determine minimum net free area for the opening.
320,000Btu/h / (3,000 Btu/h / 1 sq. in.) = 107 square inches

Step 3: Check the total area for all appliance vent connectors.
$A = \pi \times D2/4$
$= [\pi \times 8^2/4] + [\pi \times 5^2/4]$
$= [50.27\ in^2] + [19.63\ in^2]$
$= 69.90\ in^2$ (Less than 107 in^2)



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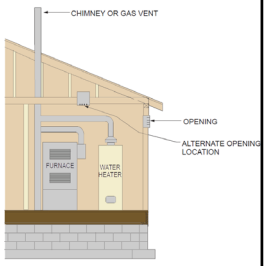
Example:
One opening method

Note: Some rectangular ducts that could be used are:

- 12x10 (120 sq. in.)
- 14x8 (112 sq. in.)
- 18x6 (108 sq. in.)



Calculate minimum round duct size?

$A = (\pi \times D^2) / 4$

Re-write equation to solve for diameter

$D = (A \times 4/\pi)^{1/2}$

$D = (107 \times 4/\pi)^{1/2}$

D = 12 inches

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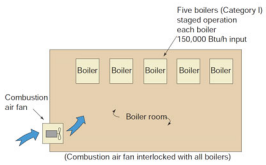
Combustion Air Requirements (Fuel Gas Code)

304.9 – Mechanical Combustion Air Supply

- Where all combustion air is provided by a mechanical air supply system, the combustion air shall be supplied from the outdoors at a rate not less than 0.35 cubic feet per minute per 1,000 Btu/h of total input rating of all appliances located within the space.
- Each of the appliances served shall be interlocked with the mechanical air supply system to prevent main burner operation when the mechanical air supply system is not in operation.



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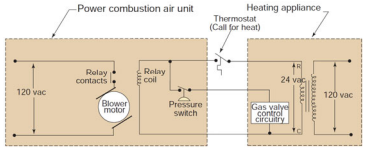
Combustion Air Requirements (Fuel Gas Code)

304.9.2 – Appliance Interlock

Each of the appliances served shall be interlocked with the mechanical air supply system to prevent main burner operation when the mechanical air supply system is not in operation.



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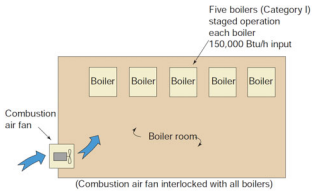
Mechanical Combustion Air Calculation

Given: Five gas boilers with input ratings of 150,000 Btu/h each will be installed in a boiler room.

Calculate the minimum mechanical combustion air supply in cubic feet per minute (cfm) required for the appliances assuming full load condition.



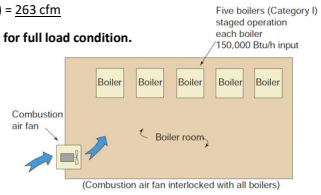
172

Mechanical Combustion Air Calculation

Step 1: Total gas input rating of all gas boilers located within enclosure.
150,000Btu/h x 5 = 750,000 Btu/h

Step 2: Determine minimum supply air flow rate (cfm) required.
750,000Btu/h / (1,000 Btu/h / 0.35 cfm) = 263 cfm

Therefore, a minimum of 263 cfm is required for full load condition.



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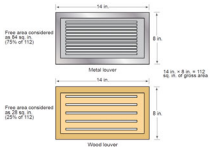
Combustion Air Requirements (Fuel Gas Code)

304.10 – Louvers and Grilles

- Free Area of an Opening
  - Where the free area through a 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.



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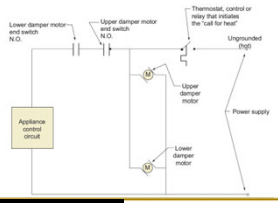
Combustion Air Requirements (Fuel Gas Code)

304.10 – Louvers and Grilles

- Motorized louvers and grilles
  - Louvers and grilles must be fixed in an open position or must be interlocked with the equipment so that the equipment cannot fire until the openings are proven to be open.



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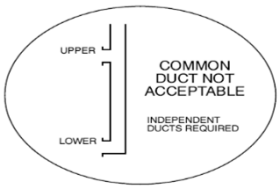
Combustion Air Requirements (Fuel Gas Code)

304.11 – Combustion Air Ducts

- In general, combustion air ducts must:
  - Be composed of corrosion-resistant material.
  - Terminate in an unobstructed space.
  - Serve a single appliance enclosure.
  - Not serve both upper / lower combustion openings.



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Combustion Air Requirements (Fuel Gas Code)

304.11 – Combustion Air Ducts

- In general, combustion air ducts must: **(cont.)**
  - Maintain separation between openings at air source.
  - Not be screened where terminating in attic.
  - Horizontal combustion air ducts shall not slope downward toward the source of combustion air.
  - Duct openings to outdoors are at least 12 inches above grade.

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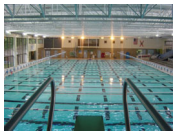
Combustion Air Requirements (Fuel Gas Code)

304.12 – Protection from Fumes and Gases



Contaminated Atmospheres

- If:
  - Indoor combustion air is contaminated or,
  - Contamination of occupancy is anticipated
- Then:
  - Outdoor combustion air must be provided

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Chimneys and Vents

- Chimneys and vents are the conduits to carry products of combustion from connected appliances to the outdoors. Natural draft-type appliances will produce a draft (negative pressure) at the appliance, and the buoyant gases that are lighter than air will flow into the connector to the chimney or vent system.
- Forced draft systems under positive pressure are also used to convey combustion products through vents to the outdoors. Venting of gas-fired appliances must be in accordance with the International Fuel Gas Code (IFGC).

179

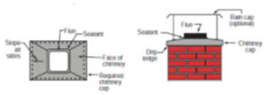
General Requirements (Mechanical Code)

- Oil-fired appliances are to be vented in accordance with NFPA 31. This standard contains venting requirements that rely on NFPA 211 and Type "L" vent manufacturer's instructions regarding oil-fired appliances.
- Masonry chimneys must be constructed in accordance with the International Building Code (IBC).
- Figure shows masonry chimneys venting fuel-fired appliances that are required to be located, constructed and sized as specified in the manufacturer's installation instructions for the appliances being vented.

180

General Requirements (Mechanical Code)

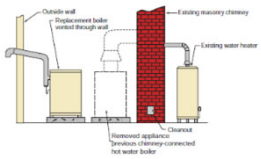
- Multiple appliances connected to an existing chimney, especially older lower efficiency appliances, will normally maintain high flue gas temperatures that are buoyant and provide the necessary draft and avoid condensation.
- Over time, appliances may be changed and removed from the existing chimney. The changing of an existing configuration by disconnecting and eliminating an appliance or by substituting a higher efficiency appliance can cause a decrease in flue gas temperature resulting in poor draft and/or condensation.



181

General Requirements (Mechanical Code)

- Many high-efficiency appliances are vented with plastic pipe materials. Where plastic piping is used to vent an appliance, the appliance shall be listed for use with such venting materials, and the appliance manufacturer's installation instructions must identify the specific plastic piping material.



Appliance removal affecting existing appliance.

182

Vent Application and Installation (Mechanical Code)

- Vent systems are required to be listed, labeled and shall be sized, installed and terminated in accordance with the vent and appliance manufacturer's installation instructions.
- Table 802.2 provides a description of the types of vents required for the appropriate types of appliances.

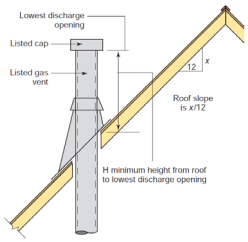
TABLE 802.2 Vent application

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

183

Vent Application and Installation (Mechanical Code)

- Vent systems shall be sized, installed and terminated in accordance with the vent and appliance manufacturer's installation instructions.
- Type L vents shall terminate with a listed and labeled cap in accordance with the vent manufacturer's installation instructions.
- Type L vents shall terminate not less than 2 feet above the highest point of the roof penetration and not less than 2 feet higher than any portion of a building within 10 feet.

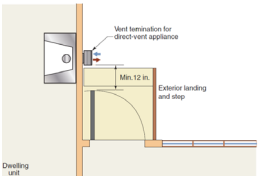


184

Vent Application and Installation (Mechanical Code)

802.9 – Door Swing

- Doors cannot swing within 12" of a vent terminal
- Doors stops or closers cannot be used to limit the swing



185

Vent Application and Installation (Mechanical Code)

- Establishes the minimum requirements for the design, construction and installation of chimney and vent connectors.

TABLE 8-2 Chimney Connector—Low Heat

DIAMETER OF CONNECTOR (inches)	MINIMUM NOMINAL THICKNESS (galvanized) (inches)
5 and smaller	0.022 (No. 26 gage)
Larger than 5 and up to 10	0.028 (No. 24 gage)
Larger than 10 and up to 16	0.034 (No. 22 gage)
Larger than 16	0.064 (No. 16 gage)

[Ref. IMC Table 803.9(1)]

TABLE 8-3 Chimney Connector—Medium and High Heat

AREA (square inches)	EQUIVALENT ROUND DIAMETER (inches)	MINIMUM THICKNESS (inches)
0–154	0–14	0.0575 (No. 16 gage)
155–201	15–16	0.075 (No. 14 gage)
202–254	17–18	0.0994 (No. 12 gage)
Greater than 254	Greater than 18	0.1292 (No. 10 gage)

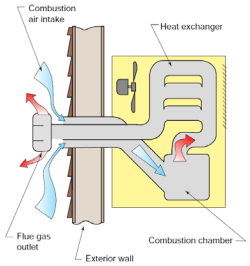
[Ref. IMC Table 803.9(2)]

186

Vent Application and Installation (Mechanical Code)

Addresses venting of fuel-burning appliances or equipment by means other than natural draft or by a means integral to the appliance.

- **804.1 – Direct-vent terminations**
  - Vent terminals for direct-vent appliances shall be installed in accordance with the manufacturer's instructions.



187

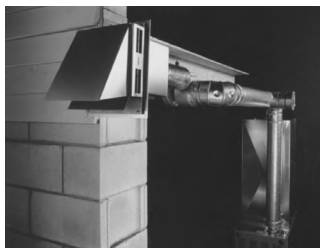
Vent Application and Installation (Mechanical Code)

- **804.2 – Appliances with integral vents**
  - Appliances incorporating integral venting means shall be installed in accordance with their listings and the manufacturer's installation instructions.

188

Vent Application and Installation (Mechanical Code)

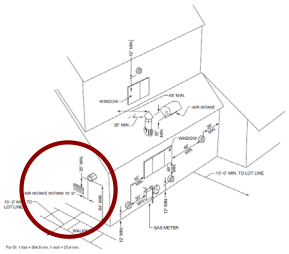
- **804.3 - Mechanical draft systems**
  - Appliance installations addressed in this section use auxiliary or integral fans and blowers to force the flow of combustion products to the outdoors.
  - Applies to externally installed power exhausters, integrally power-exhausted appliances and venting systems equipped with draft inducers.
  - Section does not address direct-vent appliances.



189

Vent Application and Installation (Mechanical Code)

- **804.3.4 – Horizontal terminations**
- The following requirements are for Mechanical Draft system horizontal terminations. They must be:
  - Located a minimum of 7 feet above the level of adjacent walkways.
  - 3 feet higher than any forced air intake area within 10 feet

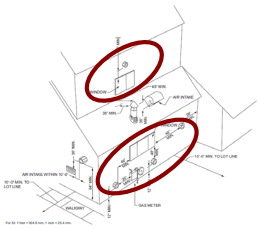


190

Vent Application and Installation (Mechanical Code)

- **804.3.4 – Horizontal terminations (Continued)**

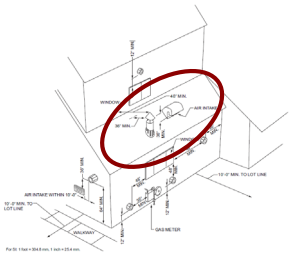
The vent system must terminate:
- *4 feet below;*
- *4 feet horizontally from; or*
- *1 foot above any door, window or gravity air intake area.*



191

Vent Application and Installation (Mechanical Code)

- **804.3.5 – Vertical terminations**
- The following requirements apply to vertical terminations:
  - A minimum of 7 feet above adj. walkways.
  - 3 feet higher than any forced air intake area within 10 feet.
  - If below an adjacent roof, it must terminate 3 feet from that roof structure.

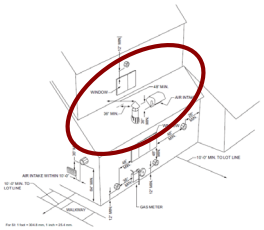


192

Vent Application and Installation (Mechanical Code)

- **804.3.4 – Vertical terminations (Continued)**

The vent system must terminate:
- *4 feet below;*
- *4 feet horizontally from; or*
- *1 foot above any door, window or gravity air intake area.*



193

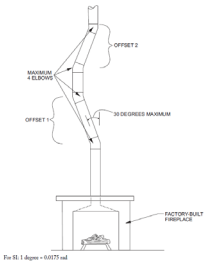
Vent Application and Installation (Mechanical Code)

- Contains requirements for all types of factory-built chimney systems including:
  - Component assembly
  - Clearances to combustibles
  - Support
  - Terminations
  - Connections
  - Protection from damage
  - Fireblocking.

194

Vent Application and Installation (Mechanical Code)

- **805.4 - Factory-built chimney offsets**
  - Offsets in factory-built chimneys are limited to not more than 30 degrees (0.52 rad) from vertical at any point in the assembly.
  - The chimney assembly must not have more than four elbows.



195

Vent Application and Installation (Mechanical Code)

- **805.7 – Decorative shrouds**
  - Section prohibits the practice of installing decorative shrouds over the termination of factory-built chimneys, except where such shrouds are listed for the specific application and installed in strict accordance with the manufacturer's installation instructions

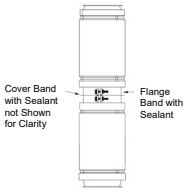
196

Break

197

Vent Application and Installation (Fuel Gas Code)

- Every fuel-burning appliance is required to be vented except as allowed by Section 501.8
- Venting method must be designed for particular type of appliance
- Venting material and method of installation depend on characteristics of gas utilization equipment



Positive Pressure Vent Connection

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Vent Application and Installation (Fuel Gas Code)

501 – Purpose of Venting

- Venting Systems
  - Convey products of combustion to the outdoors

501.2 General. Every *appliance* shall discharge the products of combustion to the outdoors, except for appliances exempted by Section 501.8.

Residential range not required to be vented

501.8 Appliances not required to be vented. The following appliances shall not be required to be vented:

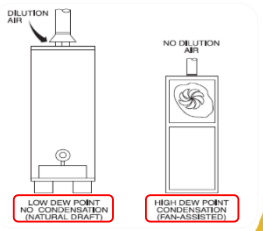
1. Ranges.
2. Built-in domestic cooking units *listed* and marked for optional venting.
3. Hot plates and laundry stoves.
4. Type 1 clothes dryers (Type 1 clothes dryers shall be exhausted in accordance with the requirements of Section 614).
5. A single booster-type automatic instantaneous water heater, where designed and used solely for the sanitizing rinse requirements of a dishwashing machine, provided that the heater is installed in a commercial kitchen having a mechanical exhaust system. Where installed in this manner, the draft hood, if required, shall be in place and unaltered and the draft hood outlet shall be not less than 36 inches (914 mm) vertically and 6 inches (152 mm) horizontally from any surface other than the heater.
6. Refrigerators.
7. Counter appliances.
8. Room heaters *listed* for unvented use.
9. Direct-fired makeup air heaters.
10. Other appliances *listed* for unvented use and not provided with flue collars.
11. Specialized appliances of limited input such as laboratory burners and gas lights.

199

Vent Application and Installation (Fuel Gas Code)

501 – Operating Characteristics

- Positive or non-positive pressure in the venting system
- Temperature of vent gases and possibility of condensation



200

Vent Application and Installation (Fuel Gas Code)

501.11 – Masonry chimneys

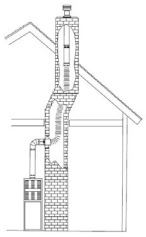
- Manufacturer's instructions for gas-fired appliances specify very limited conditions under which the appliance is allowed to vent to a masonry chimney.
- The conditions include: size; state or condition; location and construction of a chimney.

201

Vent Application and Installation (Fuel Gas Code)

501.13 – Category I appliance flue lining systems

- Flue lining systems for use with Category I appliances shall be limited to the following:
  1. Flue lining systems complying with Section 501.12.
  2. Chimney lining systems listed and labeled for use with gas appliances with draft hoods and other Category I gas appliances listed and labeled for use with Type B vents.



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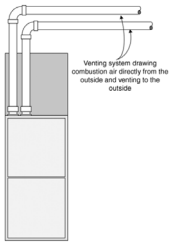
Vent Application and Installation (Fuel Gas Code)

501.14 – Category II, III and IV appliance venting systems

- The design, sizing and installation of vents for Category II, III and IV appliances shall be in accordance with the appliance manufacturer's instructions.



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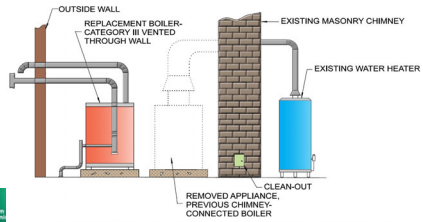
Vent Application and Installation (Fuel Gas Code)

501.15 – Existing Chimneys and Vents



REMOVING BOILER AND LEAVING A WATER HEATER AS THE ONLY APPLIANCE VENTED TO THE CHIMNEY

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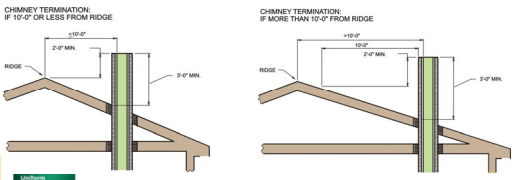
Vent Application and Installation (Fuel Gas Code)

501.3 and 503.5.3 – Masonry chimneys



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Vent Application and Installation (Fuel Gas Code)

Sizing of venting systems/General

- Minimize condensation. (It is essential to operate closer to maximum than minimum capacity, and also to use the smallest allowable vent size).
- Maintain the required draft in Category I appliance venting systems.
- Assure that products of combustion are conveyed to the outdoors.
- Prevent damage due to possible condensation from flue gases.
- Avoid overheating the equipment and surrounding building materials.

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Vent Application and Installation (Fuel Gas Code)

Category I – IV Chart

	Pressure		Excessive Condensation		Explanation
	Positive	Non-positive	Avoids	Creates	
Category I		✓	✓		Natural draft (draft hood or fan assisted) - typically B-vent.
Category II		✓		✓	Rare or nonexistent.
Category III	✓		✓		Appliances currently vented with special alloy stainless steel vents.
Category IV	✓			✓	Typically high efficiency condensing gas appliances vented with low temperature plastic vent materials.

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Vent Application and Installation (Fuel Gas Code)

502.1 – Types of Venting Systems

- Type B Gas Vent
- Type BW Gas Vent
- Type L Vent
- Chimney
- Single-Wall Metal Pipe
- Plastic Pipe and Stainless Steel special vents

502.1 General. Vents, except as provided in Section 503.7, 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 instructions.


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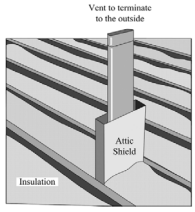
Vent Application and Installation (Fuel Gas Code)

502.4 Insulation Shield

- Where vents pass through insulated assemblies, an insulation shield constructed of steel having a minimum thickness of 0.0187 inch (No. 26 gage) shall be installed to provide clearance between the vent and the insulation material. The clearance shall be not less than the clearance to combustibles specified by the vent manufacturer's installation instructions. Where vents pass through attic space, the shield shall terminate not less than 2 inches above the insulation materials and shall be secured in place to prevent displacement. Insulation shields provided as part of a listed vent system shall be installed in accordance with the manufacturer's instructions.

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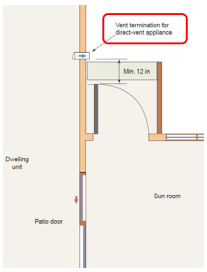
Vent Application and Installation (Fuel Gas Code)

502.7.1 Door Clearance to Vent Terminals

- Appliance and equipment vent terminals shall be located such that doors cannot swing within 12 inches horizontally of the vent terminal. Door stops or closers shall not be installed to obtain this clearance.

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Vent Application and Installation (Fuel Gas Code)

503.4 Type of venting system to be used

TABLE 503.4
TYPE OF VENTING SYSTEM TO BE USED

Listed Category I appliances Listed appliances equipped with draft hood Appliances listed for use with Type B gas vent	Type B gas vent (Section 503.6) Chimney (Section 503.5) Single-wall metal pipe (Section 503.7) Listed chimney lining system for gas venting (Section 503.5.4) Special gas vent listed for these appliances (Section 503.4.2)
Listed vented wall furnaces	Type B-W gas vent (Sections 503.6, 608)
Category II, Category III and Category IV appliances	As specified or furnished by manufacturers of listed appliances (Sections 503.4.1, 503.4.2)
Incinerators	In accordance with NFPA 82
Appliances that can be converted for use with solid fuel	Chimney (Section 503.5)
Unlisted combination gas and oil-burning appliances	Chimney (Section 503.5)
Listed combination gas and oil-burning appliances	Type L vent (Section 503.6) or chimney (Section 503.5)
Combination gas and solid fuel-burning appliances	Chimney (Section 503.5)
Appliances listed for use with chimneys only	Chimney (Section 503.5)
Unlisted appliances	Chimney (Section 503.5)
Decorative appliances in vented fireplaces	Chimney
Gas-fired toilets	Single-wall metal pipe (Section 626)
Direct-vent appliances	See Section 503.2.3
Appliances with integral vent	See Section 503.2.4

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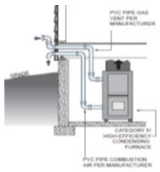
Vent Application and Installation (Fuel Gas Code)

503.4.1 Plastic Pipe Vents

- Because plastic pipes such PVC, ABS and CPVC plumbing pipes are not listed and labeled as appliance vents, (see the definition of "vent"), the code now requires appliance manufacturer's installation instructions to identify specific plastic piping materials.

503.4.1 Plastic piping. Where plastic piping is used to vent an appliance, the appliance shall be listed for use with such venting materials and the appliance manufacturer's installation instructions shall identify the specific plastic piping material.



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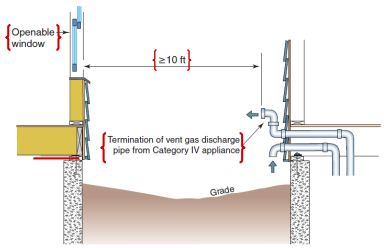
Vent Application and Installation (Fuel Gas Code)

503.8 Item #5– Venting system termination location (Category IV)

5. Vent systems for Category IV appliances that terminate through an outside wall of a building and discharge flue gases perpendicular to the adjacent wall shall be located not less than 10 feet (3048 mm) horizontally from an operable opening in an adjacent building. This requirement shall not apply to vent terminals that are 2 feet (607 mm) or more above or 25 feet (7620 mm) or more below operable openings.



UMC ® Chapter 13

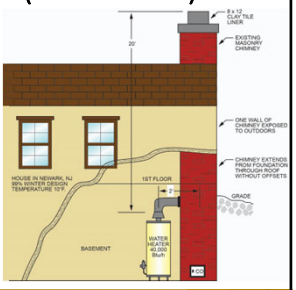
213

Vent Application and Installation (Fuel Gas Code)

503.5.6.1 Chimney Lining

- Chimneys shall be lined in accordance with NFPA 211.

~~**Exception:** Where an existing chimney complies with Sections 503.5.6 through 503.5.6.3 and its sizing is in accordance with Section 503.5.5, its continued use shall be allowed where the appliance vented by such chimney is replaced by an appliance of similar type, input rating and efficiency.~~



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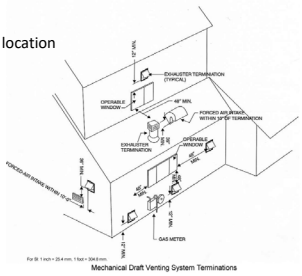
Vent Application and Installation (Fuel Gas Code)

503.3.3 – Mechanical draft systems
503.8 – Venting system termination location



Mechanical Draft Venting System Terminations

UMC ® Chapter 13

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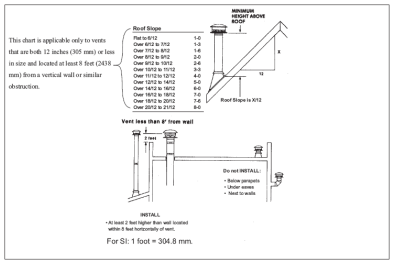
Vent Application and Installation (Fuel Gas Code)

503.6.4 – Gas vent terminations

503.6.6 Roof terminations. Gas vents shall extend through the roof flashing, roof jack or roof thimble and terminate with a *listed* cap or *listed* roof assembly.



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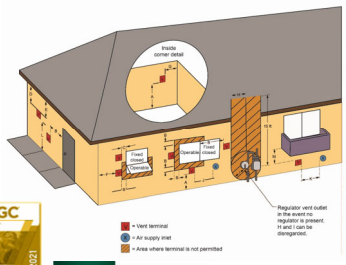
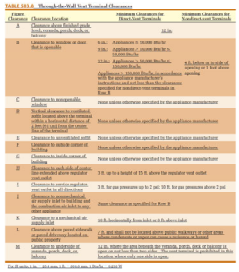
Vent Application and Installation (Fuel Gas Code)

FIGURE 503.8 Through-the-wall Vent Terminal Clearance





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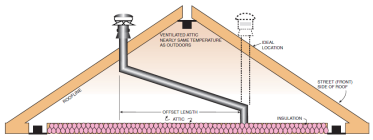
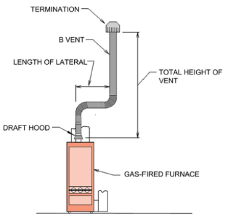
Vent Application and Installation (Fuel Gas Code)

Vent Sizing and Installation Requirements





UMC ® Chapter 13

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Vent Application and Installation (Fuel Gas Code)

ACTIVITY

1. What is the minimum required galvanized metal sheet gage for a 6-inch galvanized steel chimney connector serving an oil-fired low-heat appliance?

A. 26 gage
B. 24 gage
C. 22 gage
D. 16 gage

"B"
24 gage

219

Vent Application and Installation (Fuel Gas Code)

2. What is the minimum clearance required between a single-wall metal pipe connector and combustible materials for an unlisted gas residential appliance with a draft hood?

A. 6 inches
B. 9 inches
C. 18 inches
D. 36 inches

"B"
9 inches
[IFGC Table 503.10.5]

220

Part VI

Specific Appliances

221

Types of Appliances

- Chapter 9 of the International Mechanical Code (IMC) contains specific appliance and equipment requirements for many types of electrical, oil-fuel and solid fuel mechanical appliances. In addition to appliance listing and labeling requirements, many appliances have special requirements for installation in specific locations. However, the International Fuel Gas Code (IFGC) provides requirements for gas-fired appliances and equipment.
- The International Fuel Gas Code (IFGC) provides requirements for gas-fired appliances and equipment. Requirements include listing and labeling, installation, location, clearances, venting and exhausting, controls, support and combustion, and ventilation air.

222

Factory-built Fireplaces

- Factory-built fireplaces must be tested in accordance with UL 127 and installed with compatible components as identified and supplied by the fireplace manufacturer in strict accordance with its installation instructions. These specific solid fuel-burning appliances have a fire chamber that is intended to be either open to the room or equipped with doors.
- Gasketed doors must not be installed unless the fireplace has been specifically tested, listed and labeled for such use in accordance with UL 127. Specific requirements have been established for vented gas fireplaces (decorative appliances). These appliances are described as gas fireplaces because they are designed to simulate fire like a solid-fuel-burning fireplace

Vented gas fireplace (decorative appliance).

223

Clothes Dryers

- Clothes dryers are appliances used to dry wet laundry by means of heat and are required to be installed with the manufacturer's instructions for safe operation. UL 2158 is referenced for testing of electric residential clothes dryers and electric coin-operated clothes dryers, while UL 1240 is referenced in regards to testing for electric commercial clothes dryers.
- Installation of clothes dryers must be specifically installed in accordance with the manufacturer's instructions for clearances to combustibles. Gas clothes dryers are specifically regulated and must be listed in accordance with ANSI Z21.5.1/CSA 7.1 or ANSI Z21.5.2/CSA 7.2. In addition, clothes dryer exhaust systems are addressed.

Domestic-type clothes dryer.

224

Sauna Heaters

- Sauna heaters are electrical heating units producing high-heat outputs that must be located so as to minimize the possibility of accidental contact by a person in the sauna room.
- Approved guards or barriers are required to protect the occupants from accidental and possible burns from heaters. These guards must be constructed of a material that is a poor conductor of heat, such as wood, so that the guard itself will not present a burn hazard.
- Heaters are usually installed within manufactured sauna rooms built of cedar, bass-wood and hemlock lumber and must also be listed and labeled in accordance with UL 875.

225

Sauna Heaters

- Safe practices regarding the temperature limitation of sauna rooms require sauna heaters to be equipped with a thermostat that will limit room temperature to 194°F or a heat sensing element located within 6 inches of the ceiling.
- Timers that limit the heater operating time to 1 hour provide protection of occupants from overexposure to sauna room conditions. Allowing for the escape of hot air and providing ventilation for the occupants within the sauna room must be considered. A ventilation opening not less than 4 inches by 8 inches is to be located near the top of the sauna room.

Electronic temperature/time controller.

Ventilation opening at top of sauna room.

226

Cooking Appliances

- The installation of solid-fuel, electric and gas cooking appliances are all regulated. Commercial cooking appliances, such as grills, fryers, ranges, ovens, stoves, griddles and barbecues, shall be listed, labeled and installed specifically according to the manufacturer's instructions.
- Commercial cooking appliances are not permitted in dwellings due to their higher operating temperatures, lower insulation values and lack of child-safe push-type turn-on knobs. However, dual-listed appliances for both commercial and domestic use are permitted to be installed according to their listing.

Commercial cooking appliance.

227

Break

228

Part VII

Hydronic Systems

229

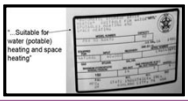
Water Heaters and Boilers

- Chapter 10 of the International Mechanical Code (IMC) provides requirements for boilers, water heaters and pressurized vessels. Boilers are defined as closed heating appliances intended to supply hot water or steam for space heating, processing or power purposes.
- Boilers operating at pressures less than or equal to 15 psi for steam and 160 psi for water are defined as low-pressure boilers. Boilers operating at pressures exceeding those pressures are defined as high pressure. A water heater is any heating appliance or equipment that heats potable water and supplies such water to the potable hot water distribution system. Some water heaters may also be used for space heating, depending on the appliance listing and label.

230

Water Heaters and Boilers

- Periodically, water heaters are utilized for both hot water space-heating and potable hot water distribution system. Water heaters are required to be listed and labeled and must be installed in accordance with the manufacturer's instructions and the IPC regarding this dual source application.
- Where space-heating temperatures are higher than the potable hot water distribution temperature, a temperature-actuated mixing valve that conforms to ASSE 1017 is required to be installed in order to temper the water supplied to the potable hot water distribution system to a temperature of 140°F or less.
- Boilers must be installed according to the manufacturer's instructions and applicable codes, although all controls must be set, adjusted and tested by the installer to confirm proper operation. The installer must also provide working clearances around the boiler, associated tanks, coils and controls to allow adjustments, maintenance, repairs and replacement.



231

Boiler Safety and Relief Valves

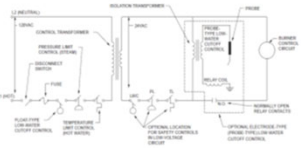
- Steam boilers are required to be equipped with a safety valve that is designed to open fully whenever the opening-setpoint pressure is reached and to close after a predetermined reduction in pressure.
- Hot water boilers are required to be equipped with a safety relief valve designed and installed to open in direct proportion to the water pressure force acting on its closure disk. The higher the pressure, the greater the force, and the more the valve opens. Safety and relief valves must be listed, labeled and rated for the minimum capacity for the equipment or appliances served.

Relief valve and discharge piping.

232

Boiler Safety and Relief Valves

- Low-water cutoff controls are required to be installed on both steam and hot water boilers to open the electrical control circuit on low water levels and stop the burner operation. Hazards resulting from low water levels are the same for both boilers.
- A flash steam explosion can also occur if makeup water is introduced into an over-heated steam or hot water boiler.



Example of interlocking safety controls

233

Hydronic Piping

- Chapter 12 of the International Mechanical Code (IMC) regulates hydronic systems that are part of heating, ventilation and air-conditioning systems. Chilled water, hot water, steam, hydronic piping system, steam condensate and ground source heat pump loop system requirements are covered in this chapter. Materials designed and installed for hydronic piping must be rated for the operating pressure and temperature of the system.

234

Hydronic Piping Systems

- Hydronic piping system materials must be suitable for the pressures, temperatures and type of fluids conveyed through the systems, and they must be adequately sized for the demand of the system. Piping materials, pipe fittings and joints are regulated with direction given for allowable pipe materials and fittings.
- Table 1202.4 lists those piping materials conforming to applicable referenced standards (listed in IMC Chapter 15), which provide a degree of assurance that the materials will perform adequately.

TABLE 1202.4
HYDRONIC PIPE

MATERIAL	STANDARD (see Chapter 15)
Acrylonitrile butadiene styrene (ABS) plastic pipe	ASTM D1527; ASTM F2806
Chlorinated polyvinyl chloride (CPVC) plastic pipe	ASTM D2846; ASTM F441; ASTM F442
Chlorinated polyvinyl chloride/aluminum/chlorinated polyvinyl chloride (CPVC/AL/CPVC)	ASTM F2855
Copper or copper alloy pipe	ASTM B42; ASTM B43; ASTM B302
Copper or copper alloy tube (Type K, L or M)	ASTM B75; ASTM B88; ASTM B135; ASTM B251
Cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX) pressure pipe	ASTM F1281; CSA CAN/CSA-B-137.10
Cross-linked polyethylene (PEX) tubing	ASTM F876; ASTM F2255; CSA B137.5
Ductile iron pipe	AWWA C151/A21.51; AWWA C153/A21.53
Lead pipe	FS WW-P-325B
Polyethylene/aluminum/polyethylene (PE-AL-PE) pressure pipe	ASTM F1282; CSA B137.9
Polypropylene (PP) plastic pipe	ASTM F2389
Polyvinyl chloride (PVC) plastic pipe	ASTM D1785; ASTM D2241
Raised temperature polyethylene (PE-RT)	ASTM F2623; ASTM F2769; CSA B137.18
Steel pipe	ASTM A53; ASTM A106
Steel tubing	ASTM A254

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PLUMBING, MECHANICAL, FUEL GAS, AND SWIMMING POOL & SPA

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Hydronic Piping Systems

- Joints and connections are required to be of an approved type and sealed. Frequently, equipment connections must be connected to piping of different materials, such as steel pipe to copper tubing.
- Approved adapter fittings are required at these connection points in order to avoid galvanic corrosion from direct contact between dissimilar metals. Dielectric fittings and brass converter fittings are used to prevent galvanic corrosion from occurring when two different metals are in contact in the presence of an electrolyte, such as water.

Dielectric grooved/threaded nipples.

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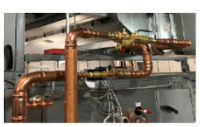
Hydronic Piping Systems

- Shutoff valves need to be installed at various locations in hydronic piping systems. The valve locations allow isolation of appliances and sections of piping and equipment to allow service, repair and replacement without affecting the rest of the hydronic system operation.



HWS and HWR valves located at hydronic hot water heating coil.

Hydronic valve/strainer assembly and electric flow control valve.

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Hydronic Piping Systems

- Hangers and supports are required to be constructed of materials of sufficient strength to support the piping and fluids within the piping and are to be fabricated from materials compatible with the piping material.
- Piping has to be supported at intervals not exceeding the spacing specified for the various types of materials.
- All field-installed piping must be tested hydrostatically at one and one-half times the maximum system design pressure, but not less than 100 psi for other than PEX piping systems.
- The duration of each test is not less than 15 minutes. Testing of hydronic piping systems are required to ensure a leak-free system. Periodically, chemical additives are designed into hydronic systems for high-temperature and low-temperature applications. A word of caution, air testing of other plastic piping materials systems can be dangerous and could rupture the piping, fittings or other equipment, endangering people and property caused by airborne pipe-fragment projectiles.

238

Piping Support

1206.10 Pipe support. Pipe shall be supported in accordance with Section 305.

305.4 Interval of support. Piping shall be supported at distances not exceeding the spacing specified in Table 305.4, or in accordance with ANSI/MSS SP-58.

Notes to Table

a. See Section 301.18.

b. The maximum horizontal spacing of cast-iron pipe hangers shall be increased to 10 feet where 10-foot lengths of pipe are installed.

c. Mid-story guide.

TABLE 305.4
PIPING SUPPORT SPACING[a]

PIPING MATERIAL	MAXIMUM HORIZONTAL SPACING (feet)	MAXIMUM VERTICAL SPACING (feet)
ABS pipe	4	10'
Aluminum pipe and tubing	10	15
Cast-iron pipe[b]	5	15
Copper or copper-alloy pipe	12	10
Copper or copper-alloy tubing	8	10
CPVC pipe or tubing, 1 inch and smaller	3	10'
CPVC pipe or tubing, 1¼ inches and larger	4	10'
Lead pipe	Continuous	4
PB pipe or tubing	2½ (32 inches)	4
PE-RT 1 inch and smaller	2½ (32 inches)	10'
PE-RT 1¼ inches and larger	4	10'
PEX tubing 1 inch and smaller	2½ (32 inches)	10'
PEX tubing 1¼ inches and larger	4	10'
Polypropylene (PP) pipe or tubing, 1 inch and smaller	2½ (32 inches)	10'
Polypropylene (PP) pipe or tubing, 1¼ inches and larger	4	10'
PVC pipe	4	10'
Steel tubing	8	10
Steel pipe	12	15

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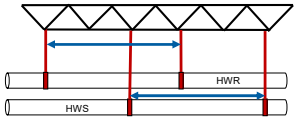
Piping Support

Hydronic system hot water supply and return mains consisting of 1-1/2 inch Type L copper tubing are proposed to be installed as indicated below.

According to Table 305.4, what is the maximum horizontal spacing of hangers permitted for this installation?



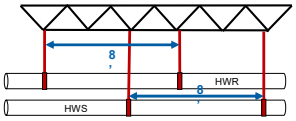
240

Piping Support

The maximum horizontal spacing of hangers permitted for this installation is 8 feet center to center.

TABLE 305.4
PIPING SUPPORT SPACING

PIPING MATERIAL	MAXIMUM HORIZONTAL SPACING (feet)	MAXIMUM VERTICAL SPACING (feet)
ABS pipe	4	10
Aluminum pipe and tubing	10	15
Cast-iron pipe	5	15
Copper or copper-alloy pipe	12	10
Copper or copper-alloy tubing	8	10



241

Hydronic Piping Systems

1. What is the maximum horizontal spacing for hangers permitted for 2-inch steel piping used in a hot water hydronic system?

A. 12 feet
B. 10 feet
C. 8 feet
D. 6 feet

"A"
12 feet
[IMC Table 305.4]

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Part VIII

Refrigeration Systems

243

Refrigeration Systems

- International Mechanical Code (IMC) Chapter 11 regulates refrigerants and refrigeration systems in order to provide safety to building occupants from the hazards of chemicals used within systems for heat transfer and the associated refrigeration equipment. Refrigeration is necessary for space air conditioning, food service walk-in coolers and freezers, as well as laboratories and food processing facilities. Certain chemicals used as refrigerants are benign; however, there are refrigerants that exhibit flammable and toxic characteristics.
- These regulations establish minimum requirements to achieve the proper design, construction, installation and operation of refrigerating systems. The provisions establish reasonable safeguards for the occupants by defining and mandating practices that are consistent with the practices and experience of the industry.

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Locking-type tamper-resistant caps.

- Refrigerant circuit access ports located outdoors are required to be equipped with locking-type tamper-resistant caps or be secured to prevent unauthorized access. Contact hazards associated with chemicals used in refrigeration systems by nonqualified people include, but are not limited to, frostbite, fire, inhalation hazards, chemical burns and long-term health problems.
- The purpose of this requirement is to prevent unauthorized access into the system by making it difficult, if not impossible, to remove these access port caps.

Locking-type tamper-resistant caps.

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Refrigerant Classification

- Refrigerants are classified in accordance with the referenced standard ASHRAE 34, Designation and Safety Classification of Refrigerants, which classifies refrigerants in safety groups according to their potential hazards regarding two parts, flammability and toxicity.

		SAFETY GROUP	
INCREASING FLAMMABILITY	HIGHER FLAMMABILITY	A3	B3
	LOWER FLAMMABILITY	A2, A2L	B2, B2L
	NO FLAME PROPOGATION	A1	B1
		LOWER TOXICITY	HIGHER TOXICITY
		INCREASING TOXICITY →	

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Refrigerant Classification

		SAFETY GROUP	
INCREASING FLAMMABILITY	HIGHER FLAMMABILITY	A3	B3
	LOWER FLAMMABILITY	A2, A2L	B2, B2L
	NO FLAME PROPOGATION	A1	B1
		LOWER TOXICITY	HIGHER TOXICITY
		INCREASING TOXICITY →	

Class 1. Indicates a refrigerant with no flame propagation.
Class 2. Indicates a refrigerant with low flammability.
Class 2L. Indicates a refrigerant with low flammability and low burning velocity.
Class 3. Indicates a refrigerant with high flammability.

Toxicity of refrigerants is based on assigning them to one of two classes, A or B. The definition for toxicity is as follows: An alphabetical designation used to identify the toxicity of refrigerants. **Class A** indicates a refrigerant with low toxicity. **Class B** indicates a refrigerant with high toxicity.

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System Applications

- A machinery room is required to house refrigeration systems if the amount of refrigerant in the system exceeds the amount indicated in IMC Table 1104.3.2.

TABLE 1104.3.2
MAXIMUM PERMISSIBLE QUANTITIES OF REFRIGERANTS

TYPE OF REFRIGERATION SYSTEM	MAXIMUM POUNDS FOR VARIOUS OCCUPANCIES			
	Institutional	Public assembly	Residential	All other occupancies
Sealed absorption system				
In exit access	0	0	3.3	3.3
In adjacent outdoor locations	0	0	22	22
In other than exit access	0	6.6	6.6	6.6
Unit systems				
In other than exit access	0	0	6.6	6.6

- Machinery rooms shall be constructed and maintained for Group A1 and B1 refrigerants. Additionally, the more flammable and toxic Group A2, B2, A3 and B3 refrigerants must also comply with special requirements.

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System Applications

- The designer will apply the applicable information based on the refrigerant classification and amount of refrigerant allowed per occupied space and com-pare the proposed space volume for compliance.
- Machinery rooms are also required to be designed and constructed in accordance with the IBC. Where machinery rooms are larger than 1,000 square feet, they must be provided with not less than two exits or exit access doorways with not more than 150 feet of travel distance to an exit or exit access doorway. Additionally, egress doors must be tight fitting, self-closing, swing in the direction of egress travel and be equipped with panic hardware.

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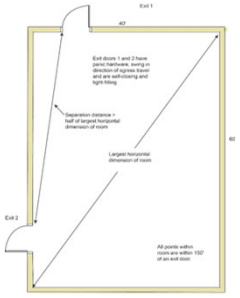
Machinery Room Means of Egress

Egress requirements for machinery rooms from the IBC were added to the IMC to prevent such requirements from being overlooked.



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System Applications

- Mechanical ventilation systems are required for machine rooms and must be capable of exhausting the minimum quantity of air both at normal operating conditions and emergency conditions. Refrigerant detectors must be provided in machinery rooms.
- Figure below shows a refrigerant gas detector that samples the air within the machine room for high levels of gas concentrations that will cause the mechanical ventilation system to produce an emergency exhaust airflow rate from the machinery room to the exterior of the building. A minimum quantity of exhaust air must be calculated and provided to account for emergency conditions.

Refrigerant gas detector.

Emergency exhaust fan interlocked with refrigerant gas detector.

251

Refrigerant Piping

- Piping material and installations for R-717 (ammonia) refrigeration systems must comply with IIAR 2, while the design of refrigerant piping must be in accordance with ASME B31.5.
- The IMC contains the requirements for joints, connections and piping installation as well as identifying materials for refrigeration pipe and tubing.
- Figure below shows seamless copper tube of Type ACR copper tubing complying with ASTM B280 for field installation.

Type ACR copper tubing complying with ASTM B280.

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Refrigerant Piping

- Valves must be provided at locations for refrigeration piping system containing more than 6.6 pounds of refrigerant. Certain valve locations are established in order to isolate parts of the system for servicing, repairs and replacements.

Stop valve on receiver tank.

1109.8.1 Refrigerating systems containing more than 6.6 pounds (3.0 kg) of refrigerant. Stop valves shall be installed in the following locations on refrigerating systems containing more than 6.6 pounds (3.0 kg) of refrigerant:

1. The suction inlet of each compressor, compressor unit or condensing unit.
2. The discharge outlet of each compressor, compressor unit or condensing unit.
3. The outlet of each liquid receiver.

1109.8.2 Refrigerating systems containing more than 100 pounds (45 kg) of refrigerant. In addition to stop valves required by Section 1109.8.1, systems containing more than 100 pounds (45 kg) of refrigerant shall have stop valves installed in the following locations:

1. Each inlet of each liquid receiver.
2. Each inlet and each outlet of each condenser where more than one condenser is used in parallel.

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Refrigerant Piping

- All parts and refrigeration piping systems that are field- constructed, other than R-717 (ammonia) refrigeration systems, must be pressure tested and leak tested. Design pressures for testing are the pressures listed on the condensing unit, compressor or compressor unit nameplate. Inert gases, such as dry nitrogen and carbon dioxide, are suitable for testing of refrigeration equipment.
- Oxygen, air, combustible gases and mixtures containing such gases are prohibited from being used as test gases due to potential flammability and explosion.
- Figure shows a test apparatus of compressed nitrogen with a pressure regulator.

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Break

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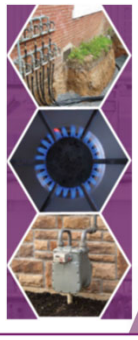
Part IX

Fuel Gas Piping Systems

256

Gas Piping Systems

- International Fuel Gas Code (IFGC) Chapter 4 provides requirements for gas piping systems, including allowable materials, design and sizing, connections to appliances, installation requirements, piping support, purging and testing.
- Chapter 24 of the International Residential Code (IRC) covers gas piping system requirements found in residential occupancies as referenced in the exception to IFGC Section 101.



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Gas Pipe Sizing

- The IFGC provides several methods for sizing both natural gas and LP-gas piping systems, including pipe sizing equations, prescriptive sizing tables, manufacturer's instructions and engineered methods. Gas appliances and equipment are designed to operate at certain minimum and maximum pressures and volume flow rates.
- The key to designing gas piping systems is to provide adequate pressure and volume throughout the piping system to supply the demand to each appliance (e.g., furnaces, boilers) and associated equipment (flow controls).
- Length of piping, fittings and equipment will reduce pressures and must be considered in the design. Prescriptive sizing of gas piping is easily accomplished by first understanding that the piping to be sized is from the point of delivery to the outlet of the appliance shutoff valves.

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Gas Piping System

- Tables in Chapter 4 determine sizing of gas piping.
- Variables to take into account
  1. Type of fuel gas
  2. Specific gravity of gas
  3. Gas supply pressure
  4. Pressure drop indicated
  5. Piping material used

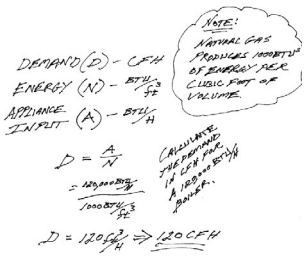
259

Variance of BTUs

- Natural gas is not a manufactured product and the heat value (BTU's) of the gas varies considerably from region to region.
- At a constant pressure a pipe can convey a set volume of gas per hour based on the diameter, we measure this as cubic feet per hour or CFH.
- BTU's of gas varies, but the amount of CFH a pipe can deliver is constant, the sizing tables use CFH to size the diameter of the pipe.

260

CFH Conversion



261

Gas System Sizing Problem

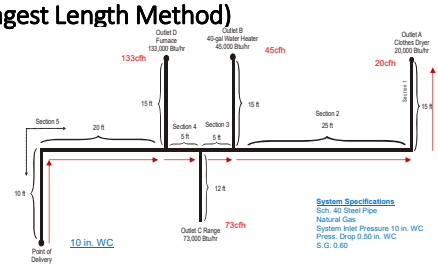
Given:

FUEL GAS	SPECIFIC GRAVITY	HEATING VALUE	MAXIMUM ALLOWABLE PRESSURE DROP	DELIVERY PRESSURE	PIPING MATERIAL
Natural	0.60	1,000 Btu per cubic foot	0.5 in wc	10 inches wc	Schedule 40 steel pipe

For SI: 1 inch water column = 0.2488 kPa, 1 British Thermal unit per cubic foot = 10.35 W/m^3.

262

Gas System Sizing Problem (Longest Length Method)



263

Gas System Sizing Problem

1. Determine maximum gas demand:

Outlet A:	20 cfh (ft^3/h)
Outlet B:	45 cfh (ft^3/h)
Outlet C:	73 cfh (ft^3/h)
Outlet D:	133 cfh (ft^3/h)
Total system gas demand:	271 cfh (ft^3/h)

264

Gas System Sizing Problem

2. Determine length to the most remote outlet:

Section 1:	15 ft.
Section 2:	25 ft.
Section 3:	5 ft.
Section 4:	5 ft.
Section 5:	30 ft.

Total pipe length to most remote outlet: 80 ft.

265

Table 402.4(2)

TABLE 402.4(2)
SCHEDULE 40 METALLIC PIPE

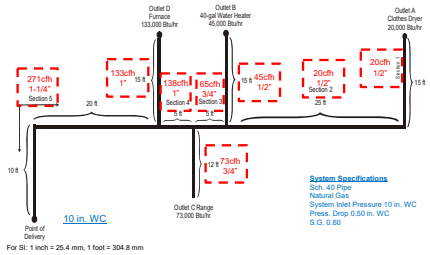
Gas: Natural
Inlet Pressure: Less than 2 psi
Pressure Drop: 0.5 in. w.c.
Specific Gravity: 0.60

PIPE SIZE (inch)

Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	5	6	8	10	12
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026	5.047	6.065	7.981	10.020	11.938
Length (ft)	Capacity in Cubic Feet of Gas Per Hour													
10	175	360	680	1,400	2,090	4,020	6,400	11,300	23,100	41,800	67,600	139,000	252,000	399,000
20	120	247	466	957	1,430	2,760	4,400	7,780	15,900	28,700	46,500	95,500	173,000	275,000
30	97	199	375	768	1,150	2,220	3,530	6,250	12,700	23,000	37,300	76,700	139,000	220,000
40	82	170	320	659	985	1,900	3,020	5,350	10,900	19,700	31,900	65,600	119,000	189,000
50	73	151	284	584	873	1,680	2,680	4,740	9,660	17,500	28,300	58,200	106,000	167,000
60	66	137	257	528	791	1,520	2,430	4,290	8,760	15,800	25,600	52,800	95,800	151,000
70	61	126	237	488	728	1,400	2,230	3,960	8,070	14,600	23,600	48,600	88,300	139,000
80	56	117	220	452	677	1,300	2,080	3,670	7,500	13,500	22,000	45,200	82,100	129,000
90	52	110	207	424	633	1,220	1,950	3,450	7,040	12,700	20,600	42,400	77,000	121,000
100	50	104	195	400	600	1,160	1,840	3,260	6,650	12,000	19,500	40,100	72,800	114,000
125	44	92	173	355	532	1,020	1,630	2,890	5,890	10,600	17,300	35,500	64,500	102,000
150	40	83	157	322	482	928	1,480	2,620	5,350	9,650	15,700	32,300	58,600	92,300
175	37	77	144	296	443	854	1,360	2,410	4,910	8,870	14,400	29,700	53,900	84,900
200	34	71	134	275	412	794	1,270	2,250	4,580	8,260	13,400	27,600	50,100	78,900

266

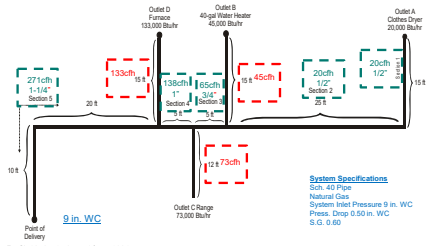
Gas System Sizing Problem (Longest Length)



267

ACTIVITY

Gas System Sizing Problem (Branch Method)



268

ACTIVITY

Table 402.4(2)

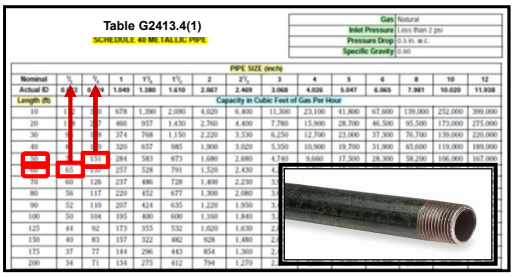


Table G2413.4(1)

SCHEDULE 40 METALLIC PIPE

Gas	Natural
Inlet Pressure	Less than 2 psi
Pressure Drop	0.5 in. w.c.
Specific Gravity	0.60

Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	5	6	8	10	12
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026	5.047	6.065	7.981	10.020	11.938
Length (ft)	Capacity in Cubic Feet of Gas Per Hour													
10	172	360	678	1,390	2,090	4,020	6,400	11,300	23,100	41,800	67,600	139,000	252,000	399,000
20	118	247	466	957	1,430	2,760	4,400	7,780	15,900	28,700	46,500	95,500	173,000	275,000
30	95	199	374	768	1,150	2,220	3,530	6,250	12,700	23,000	37,300	76,700	139,000	220,000
40	81	170	320	657	985	1,900	3,020	5,350	10,900	19,700	31,900	65,600	119,000	189,000
50	72	151	284	583	873	1,680	2,680	4,740	9,660	17,500	28,300	58,200	106,000	167,000
60	63	137	257	528	791	1,520	2,430	4,290	8,760	15,800	25,600	52,800	95,800	151,000
70	60	126	237	486	728	1,400	2,230	3,950	8,050	14,600	23,600	48,600	88,200	139,000
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100	50	104	195	400	600	1,160	1,840	3,260	6,640	12,000	19,500	40,000	73,000	114,000
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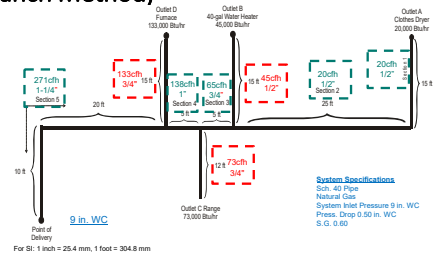
175	37	77	144	296	443	854	1,360	2,410	4,910	8,870	14,500	29,600	53,900	85,000
200	34	71	134	275	412	794	1,270	2,250	4,580	8,280	13,500	27,600	50,300	79,300

269

ACTIVITY

Gas System Sizing Problem (Branch Method)



270

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 bottommost opening of the tee or other device approved as an effective sediment trap.
- Illuminating appliances, ranges, clothes dryers, decorative vented appliances for installation in vented fireplaces, gas fireplaces, and outdoor grills need not be so equipped.

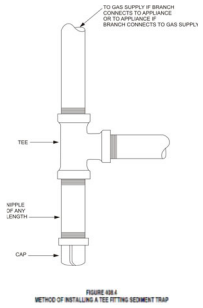


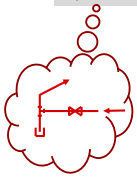
FIGURE 409.4
METHOD OF INSTALLING A TEE FITTING SEDIMENT TRAP

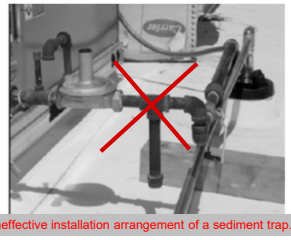
271

Sediment Trap

- A sediment trap shall be installed downstream of the appliance shutoff valve as close to the inlet of the appliance as practical.

Correct sediment trap installation



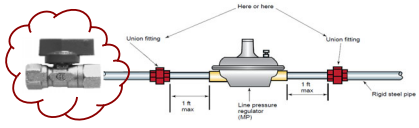


Ineffective installation arrangement of a sediment trap.

272

MP regulator valves

409.4 MP regulator valves. A *listed* shutoff valve shall be installed immediately ahead of each MP regulator.



Note: Where regulators are connected to rigid piping, a union shall be installed within 1 foot of either side of the MP regulator (**IFGC 410.2 Item #7**).

273

Shut-off Valves

409.3 Shutoff valves for multiple-house line systems. Where a single meter is used to supply gas to more than one building or tenant, a separate shutoff valve shall be provided for each building or tenant.

409.3.1 Multiple-tenant buildings. In multiple-tenant buildings, where a common *piping* system is installed to supply other than one- and two-family dwellings, shutoff valves shall be provided for each tenant. Each tenant shall have access to the shutoff valve serving that tenant's space.

409.3.2 Individual buildings. In a common system serving more than one building, shutoff valves shall be installed outdoors at each building.

409.3.3 Identification of shutoff valves. Each house line shutoff valve shall be plainly marked with an identification tag attached by the installer so that the *piping* systems supplied by such valves are readily identified.

409.4 MP regulator valves. A *listed* shutoff valve shall be installed immediately ahead of each MP regulator.

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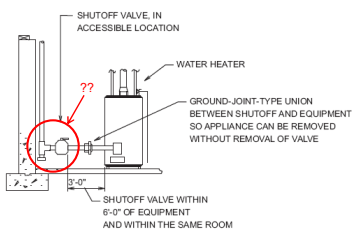
Shut-off Valves – 409.5



409.5 Appliance shutoff valve. Each appliance shall be provided with a shutoff valve in accordance with Section 409.5.1, 409.5.2 or 409.5.3.

409.5.1 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.

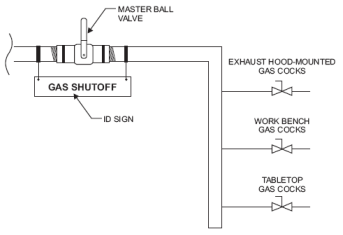
409.5.2 Vented decorative appliances and room heaters. Shutoff valves for vented decorative appliances, room heaters and decorative appliances for installation in vented *fireplaces* shall be permitted to be installed in an area remote from the appliances where such valves are provided with ready access. Such valves shall be permanently identified and shall not serve another *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 401 through 408.

409.5.3 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 401 through 408.

275

Shutoff Valve for Laboratories

409.6 Shutoff valve for laboratories. Where provided with two or more fuel gas outlets, including table-, bench- and hood-mounted outlets, each laboratory space in educational, research, commercial and industrial occupancies shall be provided with a single dedicated shutoff valve through which all such gas outlets shall be supplied. The dedicated shutoff valve shall be readily accessible, located within the laboratory space served, located adjacent to the egress door from the space and shall be identified by approved signage stating "Gas Shutoff."



Main Shutoff Valve for Laboratories

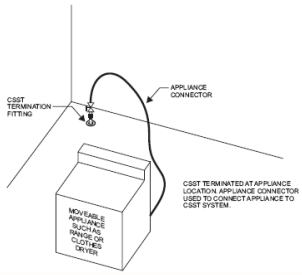
276

Appliance Connections

- Choice of the connection type to use must take into consideration:
  - Appliance movement
  - Vibration
  - Ambient conditions
  - Susceptibility to physical damage

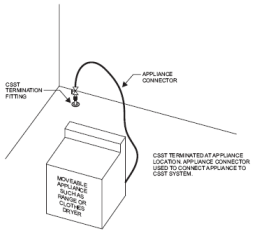
277

Connecting appliances



278

Connecting appliances



411.1 Connecting appliances. Except as required by Section 411.1.1, *appliances* shall be connected to the *piping* system by one of the following:

1. Rigid metallic pipe and fittings.
2. Corrugated stainless steel tubing (CSST) where installed in accordance with the manufacturer's instructions.
3. Semirigid metallic tubing and metallic fittings. Lengths shall not exceed 6 feet (1829 mm) and shall be located entirely in the same room as the *appliance*. Semirigid metallic tubing shall not enter a motor-operated *appliance* through an unprotected knockout opening.
4. *Listed* and *labeled appliance* connectors in compliance with ANSI Z21.24/CGA 6.10 and installed in accordance with the manufacturer's instructions and located entirely in the same room as the *appliance*.
5. *Listed* and *labeled* quick-disconnect devices in compliance with ANSI Z21.41/CGA 6.9 used in conjunction with *listed* and *labeled appliance* connectors.
6. *Listed* and *labeled* convenience outlets in compliance with ANSI Z21.90/CGA 6.24 used in conjunction with *listed* and *labeled appliance* connectors.
7. *Listed* and *labeled* outdoor *appliance* connectors in compliance with ANSI Z21.75/CSA 8.27 and installed in accordance with the manufacturer's instructions.
8. Listed outdoor gas hose connectors in compliance with ANSI Z21.54 used to connect portable outdoor appliances. The gas hose connection shall be made only in the outdoor area where the *appliance* is used, and shall be to the gas *piping* supply at an *appliance* shutoff valve, a listed quick-disconnect device or listed gas convenience outlet.
9. Gas hose connectors for use in laboratories and educational facilities in accordance with Section 411.4.

279

Connecting appliances

- Appliances to be connected to a piping system and listed outdoor gas hose connectors in compliance with ANSI Z21.54 used to connect portable outdoor appliances.
- The gas hose connection shall be made only in the outdoor area where the appliance is used, and shall be to the gas piping supply at an appliance shutoff valve, a listed quick-disconnect device or listed gas convenience outlet.

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Commercial cooking appliances

- Connectors listed to ANSI Z21.69 are required for all commercial cooking appliances that are moved from cleaning/sanitation purposes.
- Connectors are designed to tolerate repeated movement to allow for cleaning operations or relocation.

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Commercial cooking appliances

- Connectors listed to ANSI Z21.69 are required for all commercial cooking appliances that are moved from cleaning/sanitation purposes.
- Connectors are designed to tolerate repeated movement to allow for cleaning operations or relocation.

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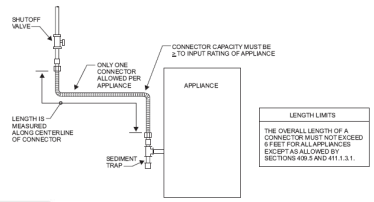
Connector Installation



411.1.3.1 Maximum length. Connectors shall have an overall length not to exceed 6 feet (1829 mm). Measurement shall be made along the centerline of the connector. Only one connector shall be used for each *appliance*.

Exception: Rigid metallic *piping* used to connect an *appliance* to the *piping* system shall be permitted to have a total length greater than 6 feet (1829 mm), provided that the connecting pipe is sized as part of the *piping* system in accordance with Section 402 and the location of the *appliance* shutoff valve complies with Section 409.5.

411.1.3.2 Minimum size. Connectors shall have the capacity for the total demand of the connected *appliance*.

Connector Installation

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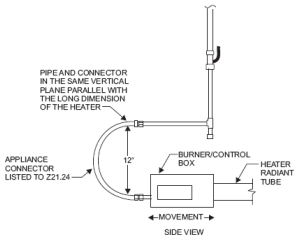
Suspended low-intensity infrared tube heaters

411.3 Suspended low-intensity infrared tube heaters. Suspended low-intensity infrared tube heaters shall be connected to the building *piping* system with a connector *listed* for the application complying with ANSI Z21.24/CGA 6.10. The connector shall be installed as specified by the tube heater manufacturer's instructions.



Suspended low-intensity infrared tube heaters

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Final Reflection

- **What?** What happened and what was observed in the training?
- **So what?** What did you learn? What difference did this training make?
- **Now what?** How will you do things differently back on the job as a result of this training?

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