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Description

- This course reviews and analyzes selected requirements for commercial design and plan review of mechanical systems. The course will provide participants with a thorough understanding of key areas of the 2018 *International Mechanical Code*® (IMC®) and related standards.
- This seminar highlights key provisions of the and provides practice in applying key sections and requirements. It reinforces learning by supplying immediate feedback or clarification.



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Goal

- The course will provide participants with a thorough understanding of key areas of the 2018 International Mechanical Code (IMC) and related standards regarding design and plan review items.



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Objectives

Upon completion, participants will be better able to:

- Summarize the purpose and content of key areas covered in the 2018 IMC.
- Describe the intent and application of major sections of the 2018 IMC.
- Explain the application of the 2018 IMC through design, inspection, and plan review issues.
- Apply provisions of the 2018 IMC through design, inspection, and plan review processes.



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Course Overview

- General Administration: Approvals, Research Reports, Change in Occupancy, Additions & Alterations, Construction Documents.
- General Requirements: Evaluate design and plan review key areas related to equipment location, installation, piping support, and temperature control.
- Ventilation: Evaluate design and plan review key areas related to natural and mechanical ventilation systems.
- Duct Systems: Evaluate design and plan review key areas related to plenums, duct construction, and smoke detection.



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2018 IMC Chapter 1: General Administration

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Chapter 1: Introduction

- This chapter is largely concerned with maintaining “due process of law” in enforcing the performance criteria contained in the body of the code.
- Chapter 1 is geared toward code officials, design professionals, contractors and building owners.



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Chapter 1: Introduction

The responsibilities of the various professionals are also established:

- The **code official** reviews the proposed work for code compliance and enforces the code in an unbiased, proper manner.
- The **design professional** designs a safe, operational mechanical system.
- The **contractor** installs the system in strict accordance with the plans and/or manufacturer’s installation requirements.

“Every person is guaranteed equal code enforcement”



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Section 101.2 – Scope

- Describes the types of mechanical systems for which the code is intended to apply.
- Focuses on heating, ventilating and air conditioning (HVAC) systems.
- Items addressed in the code and items that make a building safe for occupation.

Please note: One exception directs the user to the *International Residential Code® (IRC®)* for one- and two-family dwellings and multiple single-family dwellings (townhouses).



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Section 101.3 – Intent

- The intent of the code is to set forth requirements that establish the minimum acceptable level to safeguard life or limb, health, property and public welfare. The code does not concern itself with convenience, aesthetics or economics.

[A] 101.3 Intent. The purpose of this code is to establish minimum standards to provide a reasonable level of safety, health, property protection and public welfare by regulating and controlling the design, construction, installation, quality of materials, location, operation and maintenance or use of mechanical systems.



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Section 102 – Applicability

- Administrative provisions for applying the code to the use and installation of all mechanical systems is set forth in this section.

102.2 Existing installations	102.8 Referenced codes and standards
102.3 Maintenance	102.8.1 Conflicts
102.4 Additions, alterations or repairs	102.8.2 Provisions in referenced codes and standards
102.5 Change in occupancy	102.9 Requirements not covered by this code



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Section 102.5 – Change of Occupancy

- If an office building is converted to a restaurant, the mechanical systems must be altered as necessary to comply with what the code prescribes for such assembly occupancies.
- *Outside air may be required for the dining areas, hoods and make up air will be required over the cooking equipment, exhaust ducts may require shafts or enclosures, these are just a few of the mechanical system issues in such a change of occupancy*



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Section 104 – Duties and Powers of the Code Official

- Interpreting and enforcing code provisions
- Receiving applications and issuing permits
- Issuing notices and orders
- Making required inspections
- Carrying credentials
- Keeping department records
- Preparing annual operations reports



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105.1 Modifications

- Modifications from the code may be granted when the spirit and intent of the law are observed.



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105.2.1 – Research Reports

- The code official is responsible for determining if a requested alternative provides the equivalent level of protection to public property, health, safety and welfare as required by the code.



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Section 106 – Permits

The administrative rules and procedures concerning the issuance, suspension, revocation or modification of mechanical permits are established for all activities regulated by the code.



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Section 106 – Permits

When is a mechanical permit required?

[A] 106.1 Where required. An owner, owner's authorized agent or contractor who desires to erect, install, enlarge, alter, repair, remove, convert or replace a mechanical system, the installation of which is regulated by this code, or to cause such work to be performed, shall first make application to the code official and obtain the required permit for the work.

Exception: Where *equipment* and *appliance* replacements or repairs must be performed in an emergency situation, the permit application shall be submitted within the next working business day of the department of mechanical inspection.



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Section 106 – Permits

- Section 106.1.1 Annual permit.
 - On previously approved installations, an annual permit may be issued for changes to the installation. The work must be done by qualified tradesmen.
- Section 106.1.2 Annual permit records.
 - Detailed records of the changes shall be kept and made available to the AHJ upon request.



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106.2 – Permits not required

- Permits shall not be required for any of the following:
 - Portable ventilation appliances and equipment
 - Portable evaporative coolers



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106.2 – Permits not required

- Permits shall not be required for any of the following:
 - Portable heating appliances;
 - Portable ventilation appliances and equipment;
 - Portable cooling units;
 - Steam, hot water or chilled water piping within any heating or cooling equipment or appliances regulated by this code;
 - Replacement of any minor part that does not alter approval of equipment or an appliance or make such equipment or appliance unsafe;



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106.2 – Permits not required (cont.)

- Portable evaporative coolers;
- Self-contained refrigeration systems containing 10 pounds (4.5 kg) or less of refrigerant, or actuated by motors of 1 horsepower (0.75 kW) or less; or
- Portable fuel cell appliances that do not connect to fixed piping systems or the power grid.



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106.2 – Permits not required

- Exemption from the permit requirements of this code shall not be deemed to grant authorization for work to be done in violation of the provisions of this code or other laws or ordinances of the jurisdiction.
- The mechanical installations intended to be exempt from the requirement for a permit are very limited, as indicated.



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Section 106 – Permits

▪ 106.5 Fees

- All fees are to be paid prior to permit issuance.

▪ 106.5.1 Work commencing before permit issuance

- This section is intended to serve as a deterrent to proceeding with work on a mechanical system without a permit.

[A] 106.5.1 Work commencing before permit issuance. Any person who commences work on a mechanical system before obtaining the necessary permits shall be subject to 100 percent of the usual permit fee in addition to the required permit fees.



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Section 107 – Inspections and Testing

- All portions of the mechanical system are to be inspected before and after the equipment is installed.



The code official has the authority to require all noncomplying installations to be brought into compliance and re-inspected.



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Section 107.2.2 – Inspection Requests

- It shall be the duty of the permit holder to provide access to and means for inspections of such work that are required by this code.



It shall be the duty of the holder of the permit or their duly authorized agent to notify the code official when work is ready for inspection.



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Section 108 - Violations

This section describes the citing, recording and actions to be taken pursuant to observed code violations. All installations, repairs, alterations and maintenance must comply with the code. If not:

- The code official serves notice of the violation.
- If the notice is disregarded, the code official can request legal counsel to initiate legal action.
- The code specifies penalties for noncompliance.
- The imposition of penalties shall not prevent the legal officer from taking appropriate action.



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Section 108 - Violations

- **108.5 Stop work orders**
- **108.7 Unsafe mechanical systems**

An existing mechanical system that is not safe, Section 102.2 notwithstanding, must not continue to exist in such condition. Unsafe conditions include those that constitute a health hazard, fire hazard, explosion hazard, shock hazard, asphyxiation hazard, physical injury hazard, or are otherwise dangerous to human life and property.

- **108.7.2 Authority to order disconnection of energy sources**



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Section 109 – Means of Appeal

- Any person has the right to appeal the code official's decision when the following exist:
 - The provisions of the code do not apply
 - A person believes that the code has been incorrectly interpreted or misapplied
 - Application for appeal must be founded in the intent of the code and the equivalency of the alternative method or material

Additionally, this section prescribes the creation of a Board of Appeals, the makeup of the board membership and the hearing procedures.



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Section 110—Temporary Equipment, Systems and Uses

- AHJ can issue a permit for temporary equipment, systems and uses, these permits sunset after 180 days.
- Installations shall meet all required code.
- Equipment, systems or uses can be supplied with utilities at the discretion of the AHJ.
- Used to regulate fireworks stands, Christmas tree lots, haunted houses and similar activities that may require sanitary facilities, electricity and other utilities for a limited time.



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QUESTION & ANSWER

Questions and Answers

- **Question 1:** Changing a building's occupancy classification could result in a change to the mechanical systems?

True or False



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QUESTION & ANSWER

Questions and Answers

True
Section 102.5

Recall Previous Example: If an office building is converted to a restaurant, the mechanical systems must be altered as necessary to comply with what the code prescribes for such assembly occupancies.



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QUESTION & ANSWER

Questions and Answers

- **Question 2:**
Given: On a cold night (5 degrees F) in Newark, New Jersey at 8:30 pm a heating contractor discovers holes in a heat exchanger for an oil-fuel fired furnace at a 24-hour convenient store. The contractor has a new furnace at the shop and will replace the existing furnace by 11:00 pm that night.

Is a permit required for this replacement?



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Questions and Answers

Yes

Section 106.1

▪ **Question 2 (Cont.):**
The building department is probably not open for business after normal business hours.

When must the owner or owner's authorized agent submit application for permit to the code official?



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Questions and Answers

Within the next working business day

Section 106.1 Exception

[A] 106.1 Where required. An owner, owner's authorized agent or contractor who desires to erect, install, enlarge, alter, repair, remove, convert or replace a mechanical system, the installation of which is regulated by this code, or to cause such work to be performed, shall first make application to the code official and obtain the required permit for the work.

Exception: Where *equipment* and *appliance* replacements or repairs must be performed in an emergency situation the permit application shall be submitted within the next working business day of the department of mechanical inspection.



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2018 IMC Chapter 2: Definitions



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Chapter 2: Introduction

▪ Definitions are found in this chapter. Codes, by their very nature, are technical documents. As such, literally every word, term and punctuation mark can add to or change the meaning of the intended result.



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Definitions

Some key newer definitions to the 2018 IMC include:

- **Discrete products**
- **Ductless mini-split systems**

Some key older definitions in the 2018 IMC include:

- **Appliance**
- **Equipment**



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Discrete products.

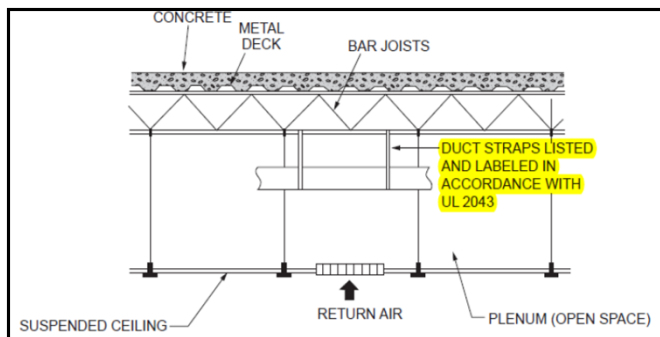
- Products that are not part of a piece of listed mechanical equipment, but are part of the mechanical system as a whole.

DISCRETE PRODUCT. Products that are noncontinuous, individual, distinct pieces such as, but not limited to, electrical, plumbing and mechanical products and duct straps, duct fittings, duct registers and pipe hangers.

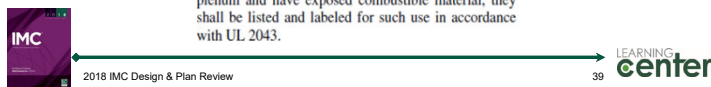


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Discrete products.



602.2.1.5 Discrete plumbing and mechanical products in plenums. Where discrete plumbing and mechanical products and appurtenances are located in a plenum and have exposed combustible material, they shall be listed and labeled for such use in accordance with UL 2043.

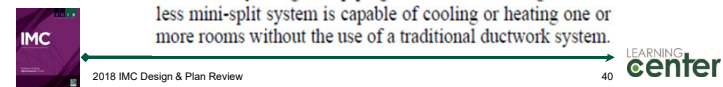


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Ductless mini-split system



DUCTLESS MINI-SPLIT SYSTEM. A heating and cooling system that is comprised of one or multiple indoor evaporator/air-handling units and an outdoor condensing unit that is connected by refrigerant piping and electrical wiring. A ductless mini-split system is capable of cooling or heating one or more rooms without the use of a traditional ductwork system.



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Appliance



APPLIANCE. A device or apparatus that is manufactured and designed to utilize energy and for which this code provides specific requirements.



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Equipment



EQUIPMENT. All piping, ducts, vents, control devices and other components of systems other than appliances which are permanently installed and integrated to provide control of environmental conditions for buildings. This definition shall also include other systems specifically regulated in this code.



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2018 IMC Chapter 3: General Requirements

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Chapter 3: Introduction

- This chapter governs the approval and installation of all mechanical equipment and appliances that are regulated by the code.
- Recall---Section 101.2 establishes the scope of application of the code.



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Section 301 - General

■ 301.7 – Listed and labeled

- The code intends to require listing and labeling for appliances, such as boilers, furnaces, condensing units, factory-built fireplaces, direct-fired heaters, cooking appliances, rooftop HVAC units, etc.



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Section 303 – Equipment and Appliance Location

- Mechanical systems and their components must be located as indicated by the manufacturer's installation instructions for the listed equipment or appliances.
- Limits the location of fuel-fired appliances in specific rooms or spaces.



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Section 303 – Equipment and Appliance Location

■ 303.2 – Hazardous locations

- A hazardous location does not necessarily warrant classification as a high-hazard use group in accordance with the building code.



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Section 303 – Equipment and Appliance Location

■ 303.3 – Prohibited locations

- Fuel-fired appliances shall not be located in, or obtain combustion air from, any of the following rooms or spaces:
 - Sleeping rooms
 - Bathrooms
 - Toilet rooms
 - Storage closets
 - Surgical rooms



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Section 304 – Installation

- All equipment and appliances must comply with the code and manufacturer's installation instructions.



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Section 304 – Installation

- **304.3 – Elevation of ignition source**
 - This section will effectively prohibit the installation of most furnaces, boilers, space heaters, clothes dryers and water heaters directly on the floor of residential garages and other occupancies where flammable or combustible vapors may be present.



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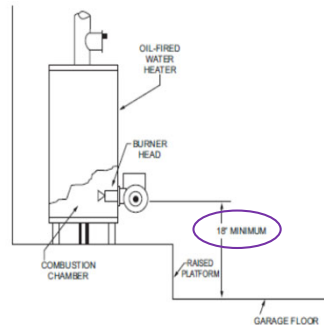
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Section 304 – Installation

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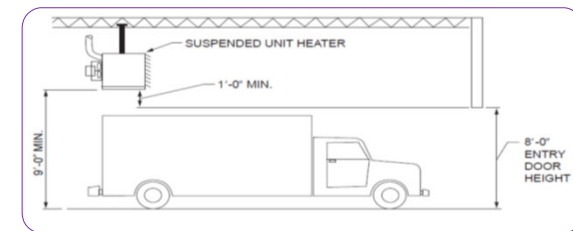


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Section 304 – Installation

- **304.6 – Public garages**

304.6 Public garages. Appliances located in public garages, motor fueling-dispensing facilities, repair garages or other areas frequented by motor vehicles, shall be installed not less than 8 feet (2438 mm) above the floor. Where motor vehicles are capable of passing under an appliance, the appliance shall be installed at the clearances required by the appliance manufacturer and not less than 1 foot (305 mm) higher than the tallest vehicle garage door opening.



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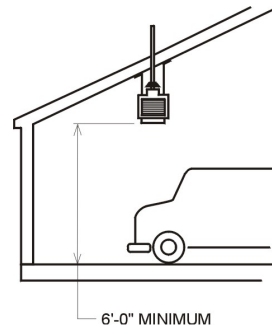


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Section 304.7 Private garages

304.7 – Private garages

- Appliances installed in a private garage shall be a minimum of 6 feet above the floor unless the appliance complies with Section 303.4.

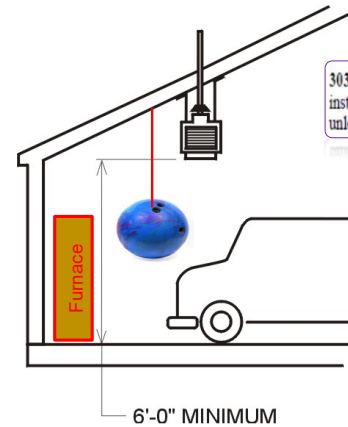


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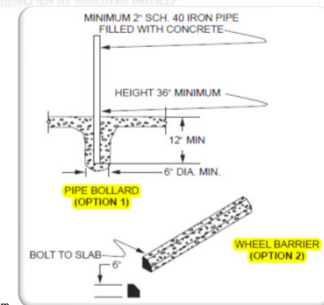
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Section 304.7 Private garages



303.4 Protection from damage. Appliances shall not be installed in a location where subject to mechanical damage unless protected by approved barriers.



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

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Section 304 – Installation

304.11 – Guards

- Guards are required to provide protection for personnel working on or servicing equipment, appliances or components that are within 10 feet (3048 mm) of a roof edge or surface that is more than 30 inches (762 mm) above the surface below.

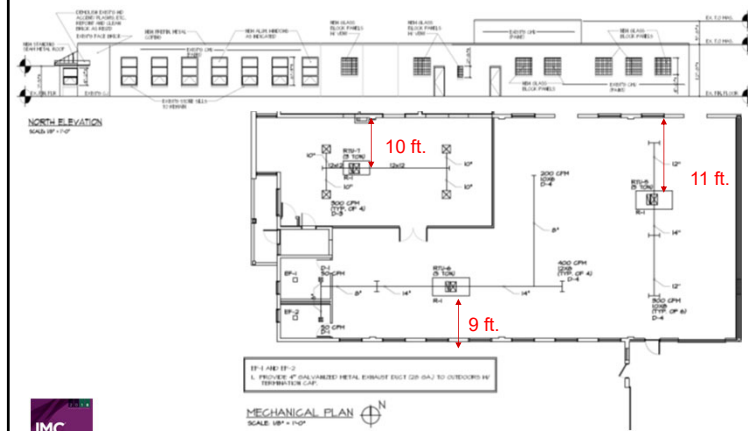


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Guards Required?

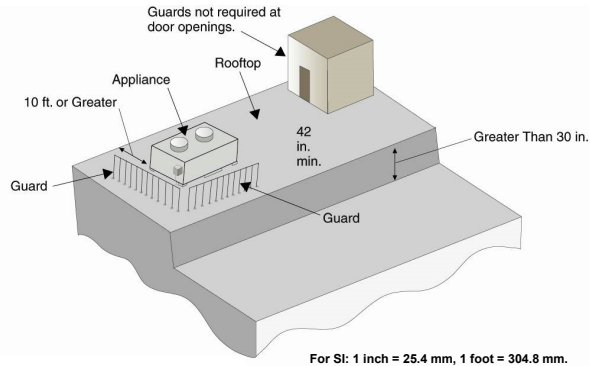


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Section 304.11 Guards



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Section 304.11 Guards

- **Exception:** Guards are not required where permanent fall arrest/restraint anchorage connector devices that comply with ANSI/ASSE Z359.1 are affixed for use during the entire roof covering lifetime.
- The devices shall be re-evaluated for possible replacement when the entire roof covering is replaced.
- The devices shall be placed not more than 10 feet (3048 mm) on center along hip and ridge lines and placed not less than 10 feet (3048 mm) from the roof edge or open side of the walking surface.



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Section 305 – Piping Support

- Piping systems, including refrigerant, and fuel oil, must be supported in accordance with section requirements.
- Support of the system is as important as any other part of the overall design.
- Piping in concealed locations, other than cast-iron or steel that is installed through holes or notches in structural members, must be protected by steel shield plates to prevent damage



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Table 305.4 Piping Support

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
Brass pipe	10	10
Brass tubing, 1 1/4-inch diameter and smaller	6	10
Brass tubing, 1 1/2-inch diameter and larger	10	10
Cast-iron pipe ^b	5	15
Copper or copper-alloy pipe	12	10
Copper or copper-alloy tubing, 1 1/2-inch diameter and smaller	6	10
Copper or copper-alloy tubing, 1 1/2-inch diameter and larger	10	10
CPVC pipe or tubing, 1 inch and smaller	3	10'
CPVC pipe or tubing, 1 1/4-inch and larger	4	10'
Lead pipe	Continuous	4
PB pipe or tubing	2 1/2 (32 inches)	4
PE-RT 1 inch and smaller	2 1/2 (32 inches)	10'
PE-RT 1 1/4 inches and larger	4	10'
PEX tubing	2 1/2 (32 inches)	10'
Polypropylene (PP) pipe or tubing, 1 inch and smaller	2 1/2 (32 inches)	10'
Polypropylene (PP) pipe or tubing, 1 1/4 inches and larger	4	10'
PVC pipe	4	10'
Steel tubing	8	10
Steel pipe	12	15

Notes to Table

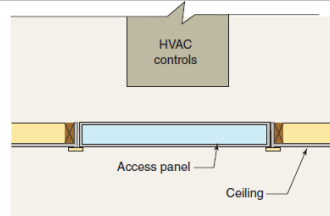
- a. See Section 301.18.
b. The maximum horizontal spacing of cast-iron pipe hangers shall be increased to 10 feet where 10-foot lengths of pipe are installed.
c. Mid-story guide.



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Section 306 – Access and Service Space



- Appliances, controls devices, heat exchangers and HVAC system components that utilize energy shall be accessible for inspection, service, repair and replacement.
- This allows access to all parts of a mechanical system without damaging or disconnection obstructions



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Section 306 – Access and Service Space

▪ 306.1.1 – Central furnaces

- The specified minimum clearances apply even though the manufacturer's instructions might permit less clearance.

▪ 306.3 – Appliances in attics

- Requires a suitable access opening, passageway and work space that will allow reasonably easy access without endangering the service person.



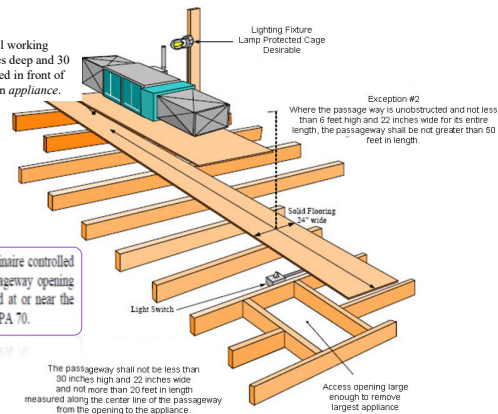
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Section 306.3 – Appliances in attics

IMC Section 306.1: 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.



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



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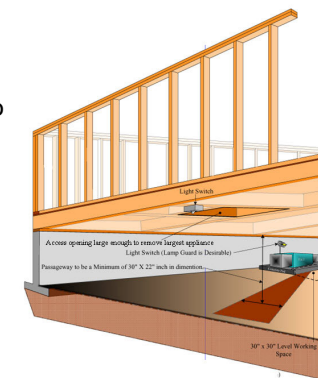
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Section 306 – Access and Service Space

▪ 306.4 – Appliances under floors

- The access passageway to the appliances can be extended to unlimited length under floors, if the passageway has a minimum height of 6 feet and width of 22 inches for the entire length.



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Section 306 – Access and Service Space

306.4.1 – Electrical requirements

- This section requires that a switched light be located at the required passageway opening and a receptacle outlet be provided at or near the appliance in accordance with the NFPA 70.



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Section 306 – Access and Service Space

306.5 – Equipment and appliances on roofs or elevated structures

- This section intends to prevent portable ladders from being the only means of access to appliances located more than 16 feet (4877 mm) above grade or roof surface.
- Specific requirements for permanent ladders and catwalks are provided.



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Section 306 – Access and Service Space

306.5 – Equipment and appliances on roofs or elevated structures

- This section provides a permanent means of access for equipment or appliances that are located on a roof or elevated structure.
- Once it is determined that a permanent means of access is required, even if a roof hatch is provided inside the building, a permanent ladder to the roof hatch would be required.

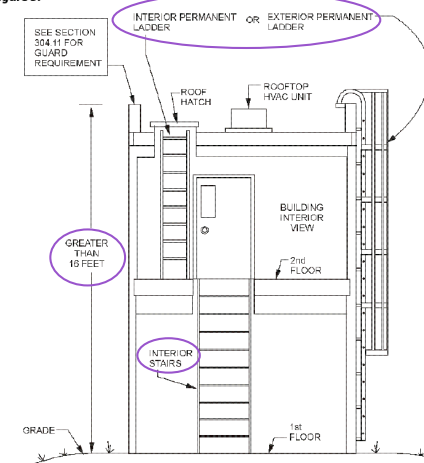


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Figure 5:



This means that just about every two story building will require a permanent means of access.



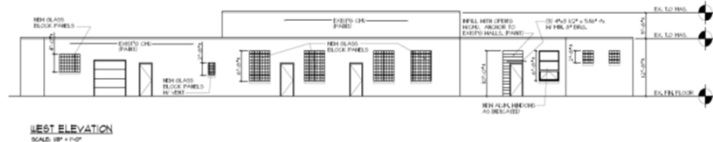
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306.5 – Equipment and appliances on roofs or elevated structures

Rooftop packaged HVAC appliances are proposed to be installed. Will a permanent means be required to access the roof?



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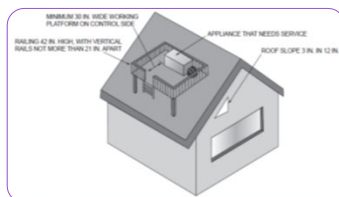
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Section 306.5.1 Sloped Roofs

- **306.5.1 – Sloped roofs**

- Section intends to include equipment such as kitchen exhaust and makeup air fans that require routine servicing to be provided with platform and guards.



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806.5.1 Sloped roofs. Where appliances, equipment, fans or other components that require service are installed on a roof having a slope of three units vertical in 12 units horizontal (25-percent slope) or greater and having an edge more than 30 inches (762 mm) above grade at such edge, a level platform shall be provided on each side of the appliance or equipment to which access is required for service, repair or maintenance. The platform shall be not less than 30 inches (762 mm) in any dimension and shall be provided with guards. The guards shall extend not less than 42 inches (1067 mm) above the platform, shall be constructed so as to prevent the passage of a 21-inch-diameter (533 mm) sphere and shall comply with the loading requirements for guards specified in the *International Building Code*. Access shall not require walking on roofs having a slope greater than four units vertical in 12 units horizontal (33-percent slope). Where access involves obstructions greater than 30 inches (762 mm) in height, such obstructions shall be provided with ladders installed in accordance with Section 306.5 or stairways installed in accordance with the requirements specified in the *International Building Code* in the path of travel and from appliances, fans or equipment requiring service.



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This installation involved new kitchen equipment and an existing sloped roof building. The kitchen exhaust/hood systems were submitted separately and after the building alteration A/M/E plan reviews. It was cited on the kitchen exhaust/hood plan review that platforms/guards were required for the sloped roofs. The revised hood plans indicated platforms/guards, etc. with details, all "to be provided by Owner". Apparently the Hood Provider, Architect and Owner didn't collaborate the entire design, and the platforms/guards weren't installed.



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Section 307 – Condensate disposal

- Condensate from all cooling coils and evaporators shall be conveyed from the drain pan outlet to an *approved* place of disposal.
- Condensate shall not discharge into a street, alley or other areas so as to cause a nuisance.



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Section 307 – Condensate disposal

- **307.1 – Fuel-burning appliances**
 - Condensation must be collected in accordance with manufacturer's installation instructions and this section.
- **307.2.1 – Condensate disposal**
 - Prohibits condensate drains from directly connecting to a sanitary sewer.
 - Must be approved by jurisdiction based on sewage treatment capacity, sewer loading, etc.



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Section 307 – Condensate disposal

- **307.2.2 – Drain pipe materials and sizes**
 - Must be constructed of corrosion-resistant materials.
 - All horizontal sections of drain piping must be installed in uniform alignment at a uniform slope.



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Section 307 – Condensate disposal

- **307.2.2 – Drain pipe materials and sizes**

TABLE 307.2.2
CONDENSATE DRAIN SIZING

EQUIPMENT CAPACITY	MINIMUM CONDENSATE PIPE DIAMETER
Up to 20 tons of refrigeration	$\frac{3}{4}$ inch
Over 20 tons to 40 tons of refrigeration	1 inch
Over 40 tons to 90 tons of refrigeration	$1\frac{1}{4}$ inch
Over 90 tons to 125 tons of refrigeration	$1\frac{1}{2}$ inch
Over 125 tons to 250 tons of refrigeration	2 inch

1 inch = 25.4 mm, 1 ton = 3.517 kW.



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Section 307 – Condensate disposal

- **307.2.3 – Auxiliary and secondary drain system**
 - Required for equipment and appliance locations where condensate overflow would cause damage to a building or its contents.
 - Requirement added for drain pans under fuel-fired appliances that produce condensate with an exception for appliances that shut down when a blockage occurs in the condensate drain system.



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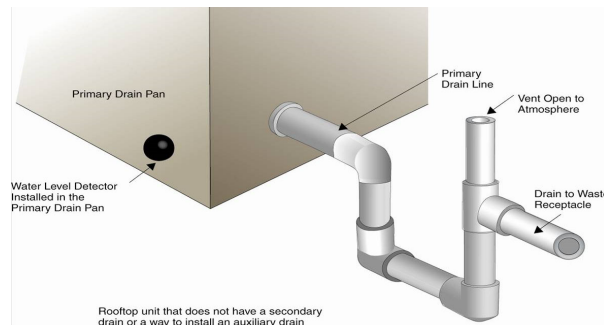
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307.2.3 – Auxiliary and secondary drain system

One of several methods of preventing pan overflow uses a water level detection device in the primary drain pan.



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Section 307 – Condensate disposal

307.2.3.1 – Water-level monitoring devices

- This subsection adds a requirement for rooftop package units and other coils with “no secondary drain pan” to have a water level detection device installed in the primary drain pan to shut down the appliance.



Figure 307.2.3(1)
PRIMARY AND AUXILIARY
DRAIN PAN FLOAT SWITCH
(Courtesy of SMD Research, Inc.)



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Section 307 – Condensate disposal

307.2.3.4 – Traps

- The traps addressed in this section are unrelated to plumbing traps and serve a different purpose.
- Condensate drain traps must not directly connect in any way to the plumbing drainage waste and venting system of a building.

Condensate drains shall be trapped as required by the equipment or appliance manufacturer.



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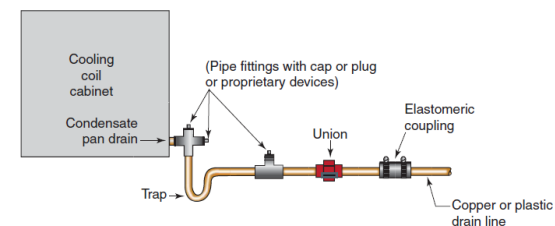
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307.2.5 Drain line maintenance

- Drains that convey condensate water from cooling coils and evaporators are known to develop blockages as a result of debris and biological growth in the system.
- These drains are commonly cleared of blockages by a compressed gas such as air or nitrogen being forced through the drain.



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Section 309 – Temperature Control

309.1 – Space-heating systems

- Interior spaces intended for human occupancy shall be provided with active or passive space-heating systems capable of maintaining an indoor temperature of not less than 68°F (20°C) at a point 3 feet above floor on the design heating day.
- The installation of portable space heaters shall not be used to achieve compliance with this section.
- **Exceptions:** 1. Interior spaces where the primary purpose is not associated with human comfort.
2. Group F, H, S and U occupancies.



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Section 312 – Heating and Cooling Load Calculations

312.1 – Load calculations

- Previous editions of the IMC did not specify load calculation methodology. As part of plan review, the designer's load calculation method will have to be verified as being consistent with ASHRAE or other equipment methods

**SECTION 312
HEATING AND COOLING LOAD CALCULATIONS**
312.1 Load calculations. Heating and cooling system design loads for the purpose of sizing systems, appliances and equipment shall be determined in accordance with the procedures described in the ASHRAE/ACCA Standard 183. Alternatively, design loads shall be determined by an approved equivalent computation procedure, using the design parameters specified in Chapter 3 [CE] of the International Energy Conservation Code.



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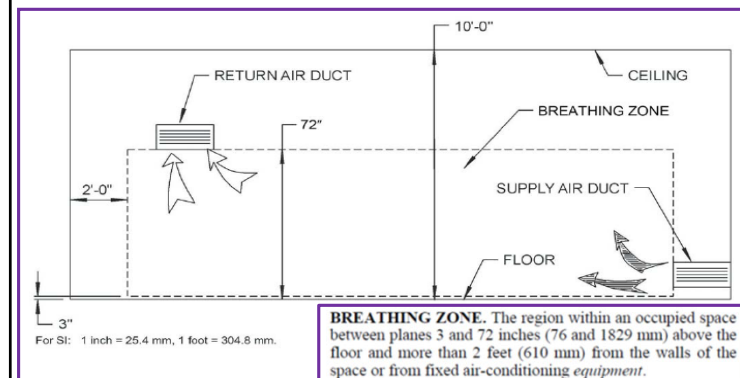
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2018 IMC Chapter 4: Ventilation

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IMC Chapter 2 Definitions



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IMC Chapter 2 Definitions

Are we sitting, standing, or working in the “Breathing Zone?”



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Chapter 4: Introduction

- Ventilation controls air contaminants and moisture.
- Chapter 4 provides requirements for ventilation in buildings intended to be occupied when the space or room in the building is occupied.
- We will look into key areas and discuss details regarding the following:
 - Ventilation Requirements
 - Intake Opening Locations
 - Natural & Mechanical Ventilation



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Section 401 – General

- **401.2 – Ventilation required**
 - Method of ventilation to be provided, mechanical or natural, is the choice of the owner or designer.



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401.2, 407.1, Table 403.3.1.1 Ventilation Required

- Occupancies including hospitals, nursing homes, detoxification facilities and ambulatory care facilities must be ventilated in accordance with ASHRAE 170.



Ambulatory care facilities must be ventilated in accordance with ASHRAE 170.



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Section 401 – General

■ 401.3 – When required

- The mechanical ventilation system shall be designed with controls that provide for continuous ventilation air movement during the entire time that the building is occupied.

■ 401.4 – Intake opening location

- This section includes requirements for outdoor exhaust and intake openings.



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401.4 Intake openings

- Both this section and Section 501.3.1 addresses exhaust openings.
- These two sections must be applied in harmony because they both can affect the separation between intakes and exhaust openings.

401.4 Intake opening location. Air intake openings shall comply with all of the following:

1. Intake openings shall be located not less than 10 feet (3048 mm) from lot lines or buildings on the same lot.
2. Mechanical and gravity outdoor air intake openings shall be located not less than 10 feet (3048 mm) horizontally from any hazardous or noxious contaminant source, such as vents, streets, alleys, parking lots and loading docks, except as specified in Item 3 or Section 501.3.1. Outdoor air intake openings shall be permitted to be located less than 10 feet (3048 mm) horizontally from streets, alleys, parking lots and loading docks provided that the openings are located not less than 25 feet (7620 mm) vertically above such locations. Where openings front on a street or public way, the distance shall be measured from the closest edge of the street or public way.
3. 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.
4. Intake openings on structures in flood hazard areas shall be at or above the elevation required by Section 1612 of the *International Building Code* for utilities and attendant equipment.



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401.4 Intake openings

- **Item 1** requires a minimum separation of 10 feet between outdoor air intake openings and any lot lines or buildings on the same lot.
- **Item 2** addresses intake openings that face a street or public way. The 10- foot distance would be measured from the closest edge of a street, alley, parking lot and loading dock.



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Section 401.4

■ Intake opening location

Intake openings must be located a **minimum of 10 feet** from lot lines or buildings on the same lot.

- Where openings front on a street or public way, the distance shall be measured from the **closest edge** of the street or public way.



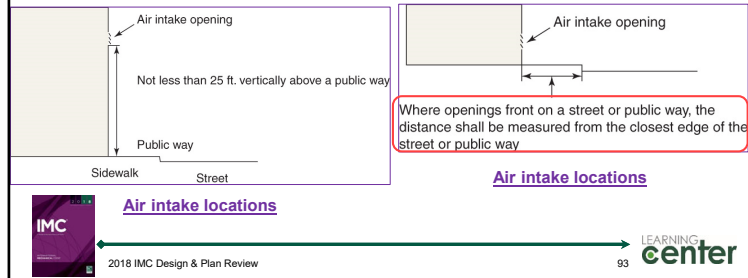
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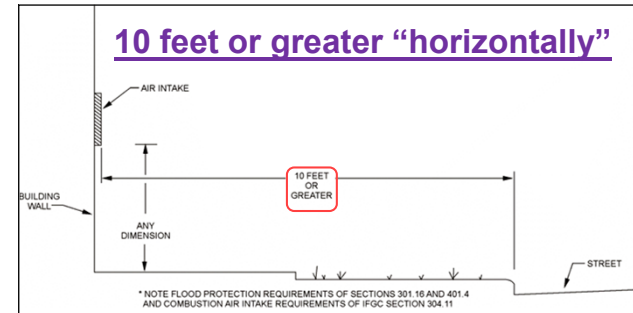
401.4 Intake Opening Location

- The minimum clearance between an air intake opening and any public way is now measured from the opening to the lot line, **not** to the centerline of the public way.



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401.4 Intake Opening Location

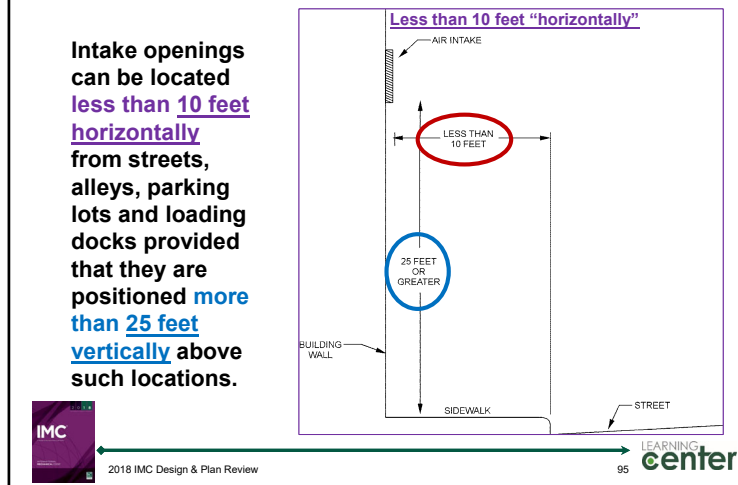


There are no vertical height requirements for outdoor air intake openings where they are located 10 feet (3048 mm) or more horizontally from the source of contamination.

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401.4 Intake Opening Location

Intake openings can be located **less than 10 feet horizontally** from streets, alleys, parking lots and loading docks provided that they are positioned **more than 25 feet vertically** above such locations.

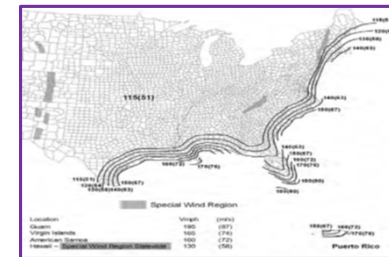


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Section 401 – General

401.5 – Outdoor opening protection

- Provides specific criteria for various types of opening protection. In hurricane-prone regions, the opening protection must comply with AMCA 550 (Test Method for High Velocity Wind Driven Rain Resistant Louvers).



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Section 401 – General

401.6 – Contaminant sources

- Ducts cannot terminate in attics and crawl spaces
- Exhaust ducts must connect directly to terminals that pass through the building envelope to the outside atmosphere.
- **Examples:** nail salons, indoor firing ranges, internal combustion engine repair shops and painting operations (see Section 502).



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Section 402 – Natural Ventilation

- Natural ventilation requirements are also found in Section 1203.4 of the IBC.
- Section 402.2: Natural ventilation openings must be 4 percent of the floor area being ventilated.
- Bathtubs, showers, spas or similar bathing fixtures must be mechanically ventilated



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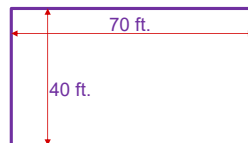
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Questions and Answers

- **Question 1:** 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

$$2,800 \times 0.04 = 112 \text{ sq. ft. (Min. required area)}$$

Section 402.2

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



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Section 403 – Mechanical Ventilation

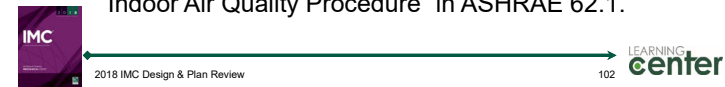
- Addresses the mechanical means of ventilation.
- Mechanical ventilation is the alternative to providing natural ventilation.
- Mechanical ventilation systems must also comply with the applicable sections of Chapters 3, 5 and 6 of the code.



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Section 403 – Mechanical Ventilation

- **403.2 – Outdoor air required**
 - Design professional to demonstrate to the code official that a proposed engineered system will provide air quality at least equivalent to that achievable by the ventilation rate method of Section 403.
 - This section includes a exception that allows a reduction of required outdoor air. An engineered ventilation system is more of a direct method of controlling air quality and would be classified as an “Indoor Air Quality Procedure” in ASHRAE 62.1.



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Section 403 – Mechanical Ventilation

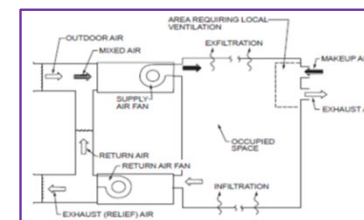
- **403.2.1 – Recirculation of air**
 - Only the ventilation air that is in excess of the required amount is allowed to be recirculated.
 - Table 403.3.1.1 prescribes outdoor air only and the occupant load calculation is determined by the table as opposed to the building code.



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Section 403 – Mechanical Ventilation

- **403.2.1 – Recirculation of air**
 - The ventilation air amounts specified by Table 403.3.1.1 consist of 100-percent outdoor air, none of which can be recirculated except as listed in the 4 exceptions.



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403.2.1, Table 403.3.1.1 Recirculation of Air

- The revisions to Section 403.2.1 and notes b and g of Table 403.3.1.1 clarify that recirculation of air within a space is permitted.

TABLE 403.3.1.1 Minimum Ventilation Rates

Occupancy Classification	Occupant Density #/1000 Ft ²	People Outdoor Airflow Rate in Breathing Zone, R _p Cfm/Person	Area Outdoor Airflow Rate in Breathing Zone, R _a Cfm/Ft ²	Exhaust Airflow Rate Cfm/Ft ²
Public spaces				
Corridors			0.06	
Elevator car				1.0
Shower room (per shower head) ^b				50/20 ^c
Smoking lounges ^b	70	60		
Toilet rooms—public ^b				50/70 ^c

b. Mechanical exhaust required and the recirculation of air from such spaces is prohibited. Recirculation of air that is contained completely within such spaces shall not be prohibited (see Section 403.2.1, Item 3).

g. Mechanical exhaust is required and recirculation from such spaces is prohibited except that recirculation shall be permitted where the resulting supply airstream consists of not more than 10 percent air recirculated from these spaces. Recirculation of air that is contained completely within such spaces shall not be prohibited (see Section 403.2.1, Items 2 and 4).

Only portions of the table are shown for brevity and clarity.



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Minimum Ventilation Rates

- [Link to Table](#)

2018 IMC,
Table
403.3.1.1
Pages
36-39



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REFER TO
CODE BOOK
2018 IMC,
Table
403.3.1.1

**TABLE 403.3.1.1—continued
MINIMUM VENTILATION RATES**

OCCUPANCY CLASSIFICATION	OCCUPANT DENSITY #/1000 FT ²	PEOPLE OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R _p CFM/PERSON	AREA OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R _a CFM/FT ²	EXHAUST AIRFLOW RATE CFM/FT ²
Specialty shops				
Automotive motor-fuel dispensing stations ^b	—	—	—	1.5
Barber	25	7.5	0.06	0.5
Beauty salons ^b	25	20	0.12	0.6
Nail salons ^{b, c}	25	20	0.12	0.6
Embalming rooms ^b	—	—	—	2.0
Pet shops (animal areas) ^b	10	7.5	0.18	0.9
Supermarkets	8	7.5	0.06	—
Sports and amusement				
Bowling alleys (seating areas)	40	10	0.12	—
Disc/dance floors	100	20	0.06	—
Game arcades	20	7.5	0.18	—
Gym, stadium, arena (play area)	7	20	0.18	—
Health club/aerobics room	40	20	0.06	—
Ice arenas without combustion engines	10	20	0.06	—
Spectator areas	150	7.5	0.30	0.5
Swimming pools (pool and deck area)	—	—	0.06	—
Storage				
Repair garages, enclosed parking garages ^d	—	—	—	0.75
Refrigerated warehouses/freezers	—	10	—	—
Warehouses	—	10	0.06	—
Theaters				
Auditoriums (see "Education")	—	—	—	—
Lobbies	150	5	0.06	—
Stages, studios	70	10	0.06	—
Ticket booths	60	5	0.06	—
Transportation				
Platforms	100	7.5	0.06	—
Transportation waiting	100	7.5	0.06	—

(continued)



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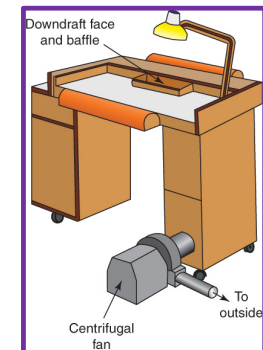
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Table 403.3.1.1 Minimum Rates

- Manicure and pedicure stations must each be provided with a source capture system.

Based on the definition of a source capture system, the exhaust from a station in a nail salon is required to capture the air contaminants at their source and terminate them to the outdoor atmosphere.



Nail salon station



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REFER TO
2015 IMC,
Table
403.3.1.1
CODE BOOK

Table 403.3.1.1

TABLE 403.3.1.1—continued
MINIMUM VENTILATION RATES

OCCUPANCY CLASSIFICATION	OCCUPANT DENSITY #/1000 FT ² ^a	PEOPLE OUTDOOR AIRFLOW RATE IN BREATHING ZONE, P _o CFM/PERSON	AREA OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R _a CFM/FT ² ^a	EXHAUST AIRFLOW RATE CFM/FT ² ^a
Specialty shops				
Automotive motor-fuel dispensing stations ^b	—	—	—	1.5
Barber	25	7.5	0.06	0.5
Beauty salons ^b	25	20	0.12	0.6
Nail salons ^{b,h}	25	20	0.12	0.6
Embalming room ^b	—	—	—	2.0
Pet shops (animal areas) ^b	10	7.5	0.18	0.9
Supermarkets	8	7.5	0.06	—

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REFER TO
2015 IMC,
Table
403.3.1.1
CODE BOOK

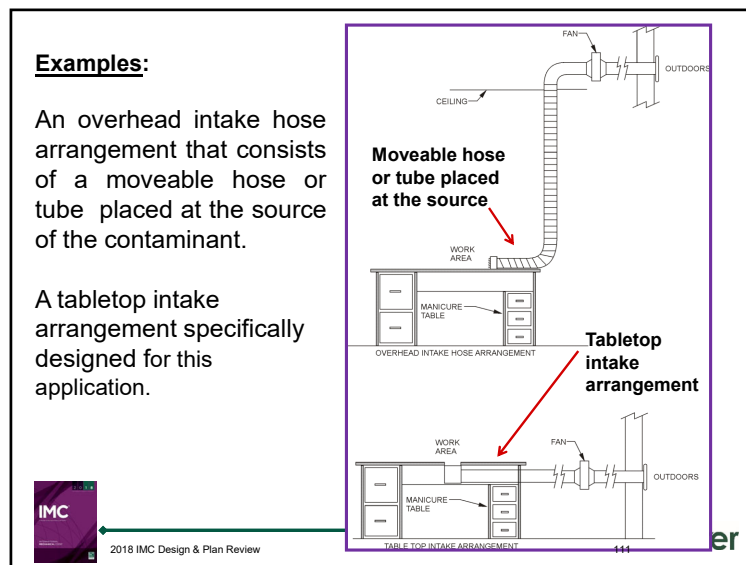
Table 403.3.1.1 notes

a. Based upon net occupiable floor area.
b. Mechanical exhaust required and the recirculation of air from such spaces is prohibited. Recirculation of air that is contained completely within such spaces shall not be prohibited (see Section 403.2.1, Item 3).
c. Spaces unheated or maintained below 50°F are not covered by these requirements unless the occupancy is continuous.
d. Ventilation systems in enclosed parking garages shall comply with Section 404.
e. Rates are per water closet or urinal. The higher rate shall be provided where the exhaust system is designed to operate intermittently. The lower rate shall be permitted only where the exhaust system is designed to operate continuously while occupied.
f. Rates are per room unless otherwise indicated. The higher rate shall be provided where the exhaust system is designed to operate intermittently. The lower rate shall be permitted only where the exhaust system is designed to operate continuously while occupied.
g. Mechanical exhaust is required and recirculation from such spaces is prohibited except that recirculation shall be permitted where the resulting supply airstream consists of not more than 10 percent air recirculated from these spaces. Recirculation of air that is contained completely within such spaces shall not be prohibited (see Section 403.2.1, Items 2 and 4).
h. For nail salons, each manicure and pedicure station shall be provided with a source capture system capable of exhausting not less than 50 cfm per station. Exhaust inlets shall be located in accordance with Section 502.20. Where one or more required source capture systems operate continuously during occupancy, the exhaust rate from such systems shall be permitted to be applied to the exhaust flow rate required by Table 403.3.1.1 for the nail salon.

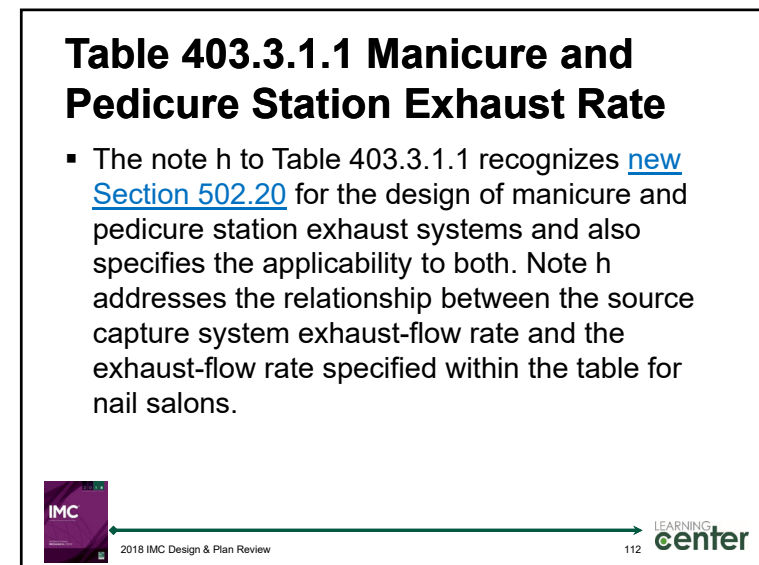
Note h clarifies that for each manicure and pedicure station a source capture system capable of exhausting not less than 50 cfm per station shall be provided.

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502.20 Manicure and Pedicure Station Exhaust System

- New text specifically covers manicure and pedicure stations and states exhaust requirements in addition to those in Table 403.3.1.1. In previous editions of the code, pedicure stations were not specifically called out, as the text in Table 403.3.1.1 referred only to nail salons generically.

502.20 Manicure and pedicure stations. Manicure and pedicure stations shall be provided with an exhaust system in accordance with Table 403.3.1.1, Note h. Manicure tables and pedicure stations not provided with factory-installed exhaust inlets shall be provided with exhaust inlets located not more than 12 inches (305 mm) horizontally and vertically from the point of chemical application.



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403.3.1.1.1 Breathing zone outdoor airflow

$$V_{bz} = R_p P_z + R_a A_z \text{ (Equation 4-1)}$$

- The equation sums the rate per person times the number of occupants and the rate per area times the square footage of the zone floor.

403.3.1.1.1 Breathing zone outdoor airflow. The outdoor airflow rate required in the breathing zone (V_{bz}) of the occupiable space or spaces in a zone shall be determined in accordance with Equation 4-1.

$$V_{bz} = R_p P_z + R_a A_z \text{ (Equation 4.1)}$$

where:

A_z = Zone floor area: the net occupiable floor area of the space or spaces in the zone.

P_z = Zone population: the number of people in the space or spaces in the zone.

R_p = People outdoor air rate: the outdoor airflow rate required per person from Table 403.3.1.1.

R_a = Area outdoor air rate: the outdoor airflow rate required per unit area from Table 403.3.1.1.



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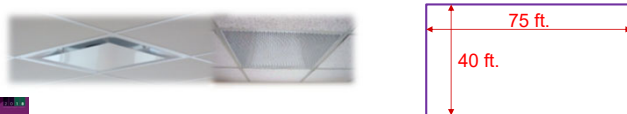
Application:



Example: Single Zone Recirculating System

A 3,000 square foot dining room is served by a rooftop air handling unit by means of ducted ceiling supply registers and ceiling return grilles.

Determine the system's outdoor air intake flow rate (V_{ot}) for the dining room.



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Application:

**TABLE 403.3.1.1
MINIMUM VENTILATION RATES**

OCCUPANCY CLASSIFICATION	OCCUPANT DENSITY #/1000 FT ² *	PEOPLE OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_p CFM/PERSON	AREA OUTDOOR AIRFLOW RATE IN BREATHING ZONE, R_a CFM/FT ² *	EXHAUST AIRFLOW RATE CFM/FT ² *
Food and beverage service				
Bars, cocktail lounges	100	7.5	0.18	—
Cafeteria, fast food	100	7.5	0.18	—
Dining rooms	70	7.5	0.18	—
Kitchens (cooking) ^b	20	7.5	0.12	0.7

Example : Single Zone Recirculating System: Application

This dining room with a single rooftop unit is considered a single zone system. In order to determine the outdoor air intake flow rate (V_{ot}) for a single zone system using Equation 4-3, the breathing zone airflow rate (V_{bz}) of the occupied space must first be determined using Equation 4-1. Then, the zone airflow effectiveness (E_z) must be determined in accordance with Table 403.3.1.1.1.2. Next, the zone outdoor airflow rate (V_{oz}) must be determined using Equation 4-2. The outdoor air intake flow rate for a single zone system is then simply $V_{ot} = V_{oz}$, Equation 4-3.



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Application:**Example : Single Zone Recirculating System**

Step 1: Determine occupant load (P_z) for the room for use in Equation 4-1:

No specific occupancy criterion is given for the dining room, therefore, from Table 403.3.1.1 for dining rooms, the default occupant density is used (70 occupants/1,000 sq ft):

$$3,000 \text{ sq ft} \times \frac{70 \text{ occupants}}{1,000 \text{ sq ft}} = 210 \text{ occupants} = P_z$$



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Application:**Example : Single Zone Recirculating System**

Step 2: Determine the breathing zone outdoor airflow (V_{bz}) for the room:

First, the outdoor air rates for people (R_p) and area (R_a) must be obtained for the dining room from Table 403.3.1.1:

$$R_p = 7.5 \text{ cfm/person and } R_a = 0.18 \text{ cfm/sq ft.}$$



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Application:**Example : Single Zone Recirculating System****Step 2 (continued)**

Equation 4-1 can now be solved:

$$V_{bz} = R_p P_z + R_a A_z$$

$$V_{bz} = [7.5 \text{ cfm/person} \times 210 \text{ people}] + [0.18 \text{ cfm/sq ft} \times 3,000 \text{ sq ft}]$$

$$V_{bz} = 2,115 \text{ cfm}$$



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Application:**Step 3: Determine the zone outdoor airflow (V_{oz}):**

It is given that the room is served by a rooftop air handling unit by means of ducted ceiling supply registers and ceiling return grilles, thus, the zone air distribution effectiveness (E_z), can be obtained from Table 403.3.1.1.2. In cooling mode $E_z = 1.0$ and in heating mode $E_z = 0.8$ (assume notes do not apply).

403.3.1.1.3 Zone outdoor airflow. The zone outdoor airflow rate (V_{oz}), shall be determined in accordance with Equation 4-2.

$$V_{oz} = \frac{V_{bz}}{E_z} \quad (\text{Equation 4-2})$$



TABLE 403.3.1.1.2 ZONE AIR DISTRIBUTION EFFECTIVENESS ^{a,b,c,d}	
AIR DISTRIBUTION CONFIGURATION	E_z
Ceiling or floor supply of cool air	1.0 ^a
Ceiling or floor supply of warm air and floor return	1.0
Ceiling supply of warm air and ceiling return	0.8 ^d
Floor supply of warm air and ceiling return	0.7
Makeup air drawn in on the opposite side of the room from the exhaust and/or return	0.8
Makeup air drawn in near to the exhaust and/or return location	0.5

For SI: 1 foot = 304.8 mm, 1 foot per minute = 0.00506 m/s,
^aC = [(F) - 32]/1.8.
 a. "Cool air" is air cooler than space temperature.
 b. "Warm air" is air warmer than space temperature.
 c. "Ceiling" includes any point above the breathing zone.
 d. "Floor" includes any point below the breathing zone.



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Application:**Step 3 (continued)**

Equation 4-2 can now be solved for the zone:

403.3.1.1.3 Zone outdoor airflow. The zone outdoor airflow rate (V_{oz}), shall be determined in accordance with Equation 4-2.

$$V_{oz} = \frac{V_{bz}}{E_z} \quad (\text{Equation 4-2})$$

$$V_{oz} = \frac{V_{bz}}{E_z}$$

Cooling Mode: $V_{oz} = \frac{2,115}{1.0} = 2,115 \text{ cfm}$

Heating Mode: $V_{oz} = \frac{2,115 \text{ cfm}}{0.8} = 2,644 \text{ cfm}$

The most restrictive value must be used: $E_z = 0.8$



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Application:**Example : Single Zone Recirculating System**

As a result, the dining room requires 2,115 cfm of outdoor air in cooling mode and 2,644 cfm of outdoor air in heating mode. Use the value of V_{oz} , **2,644 cfm**, to determine the system outdoor air intake flow rate (V_{ot}) required, Equation 4-3:

$$V_{ot} = V_{oz} = \underline{\underline{2,644 \text{ cfm}}}$$

403.3.1.1.2.1 Single zone systems. Where one air handler supplies a mixture of outdoor air and recirculated return air to only one zone, the system outdoor air intake flow rate (V_{ot}) shall be determined in accordance with Equation 4-3.

$$V_{ot} = V_{oz} \quad (\text{Equation 4-3})$$



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Section 403 – Mechanical Ventilation

403.3.1.5 – Balancing

- This section requires systems to be balanced by a method approved by the code official.
- Outside air circulation in the quantities provided by the code can only be determined using special equipment.



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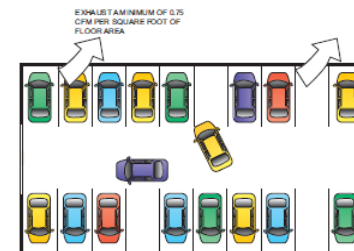
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Section 404.1 – Enclosed parking garages

404.1 – Enclosed parking garages

- Mechanical ventilation systems for enclosed parking garages are permitted to operate intermittently where the system is designed to operate automatically upon detection of vehicle operation or presence of occupants.

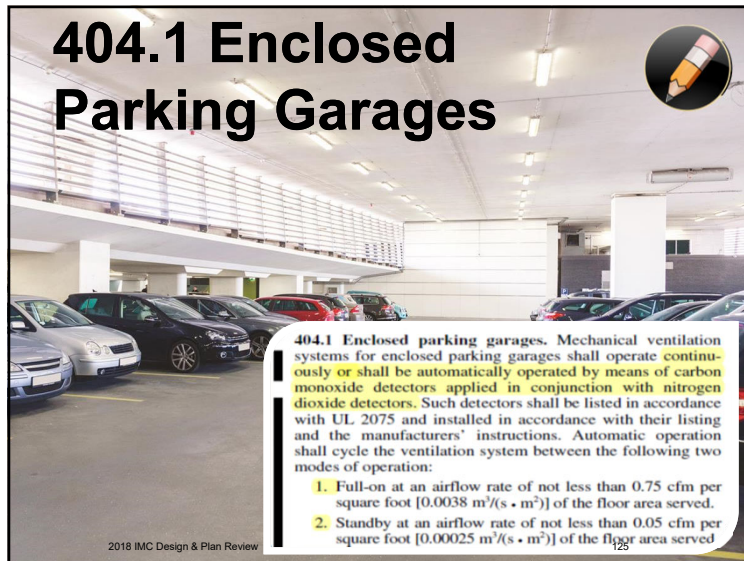


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404.1 Enclosed Parking Garages



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Section 405 – Systems Control

405.1 General. Mechanical ventilation systems shall be provided with manual or automatic controls that will operate such systems whenever the spaces are occupied. Air conditioning systems that supply required ventilation air shall be provided with controls designed to automatically maintain the required outdoor air supply rate during occupancy.

	Mechanical Ventilation			Required Ventilation cfm
	P _o -Occupant Density	R _o -cfm/person	R _o -cfm/sq.ft.	
RTU-1	10	5	0.06	170 cfm
RTU-2	2	5	0.06	70 cfm
RTU-3	2	5	0.06	70 cfm
RTU-4	2	10	0.18	185 cfm
RTU-5	3	10	0.18	290 cfm
RTU-6	10	5	0.18	260 cfm
RTU-7	2	10	0.18	210 cfm

Contractor shall provide minimum outdoor ventilation rates for systems while building is occupied.



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Section 407—Ambulatory Care Facilities and Group I-2 Occupancies

- Ambulatory Care Facilities and Group I-2 Occupancies shall have ventilation in accordance with this code and ASHRAE 170 - 2017 Ventilation of Health Care Facilities.



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2018 IMC Chapter 6: Duct Systems

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Chapter 6: Introduction

This chapter regulates the materials and methods used for the construction and installation of the following:

- Ducts
- System controls
- Exhausts
- Fire protection systems
- Related components that affect the overall performance of a building's air distribution system



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Section 601 – General

- **Section 601.1:** Duct systems used for the movement of air in air-conditioning, heating, ventilating and exhaust systems shall conform to the provisions of this chapter except as otherwise specified in Chapters 5 and 7.
- **601.2 – Air movement in egress elements**
 - This section prohibits exits and exit access corridors 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.



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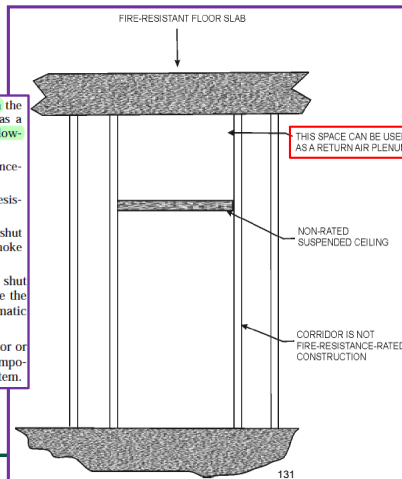


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601.2 – Air movement in egress elements

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

1. The corridor is not required to be of fire-resistance-rated construction;
2. The corridor is separated from the plenum by fire-resistance-rated construction;
3. The air-handling system serving the corridor is shut down upon activation of the air-handling unit smoke detectors required by this code;
4. The air-handling system serving the corridor is shut down upon detection of sprinkler waterflow where the building is equipped throughout with an automatic sprinkler system; or
5. The space between the corridor ceiling and the floor or roof structure above the corridor is used as a component of an *approved* engineered smoke control system.



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Section 601 – General

- **601.4 - Contamination prevention**
- To prevent cross contamination:
 - Exhaust ducts under positive pressure **and** chimneys and vents are **not permitted** to extend into or pass through ducts or plenums.



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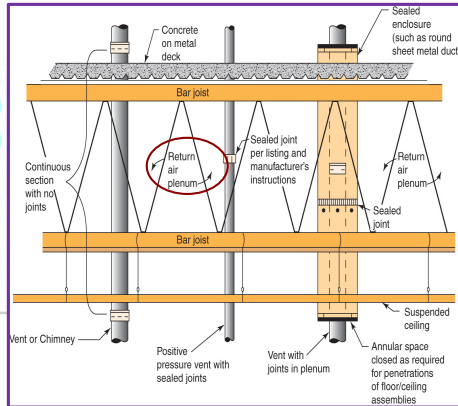


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Section 601.4 - Contamination prevention

2015 IMC (601.4, Exception. 2)

- 2 This section shall not apply to chimneys and vents that pass through plenums where such venting systems comply with one of the following requirements:
 - 2.1 The venting system shall be listed for positive pressure applications and shall be sealed in accordance with the vent manufacturer's instructions.
 - 2.2 The venting system shall be installed such that fittings and joints between sections are not installed in the above ceiling space.
 - 2.3 The venting system shall be installed in a conduit or enclosure with sealed joints separating the interior of the conduit or enclosure from the ceiling space.



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Section 601.5

Return Air Openings



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601.5 Return air openings. Return air openings for heating, ventilation and air-conditioning systems shall comply with all of the following:

- 1) Openings shall not be located less than 10 feet (3048 mm) measured in any direction from an open combustion chamber or draft hood of another appliance located in the same room or space.
- 2) Return air shall not be taken from a hazardous or insitary location or a refrigeration room as defined in this code.
- 3) The amount of return air taken from any room or space shall be not greater than the flow rate of supply air delivered to such room or space.
- 4) Return and transfer openings shall be sized in accordance with the appliance or equipment manufacturer's installation instructions, ACCA Manual D or the design of the registered design professional.
- 5) Return air taken from one dwelling unit shall not be discharged into another dwelling unit.
- 6) Taking return air from a crawl space shall not be accomplished through a direct connection to the return side of a forced air furnace. Transfer openings in the crawl space enclosure shall not be prohibited.
- 7) Return air shall not be taken from a closet, bathroom, toilet room, kitchen, garage, boiler room, furnace room or unconditioned attic.

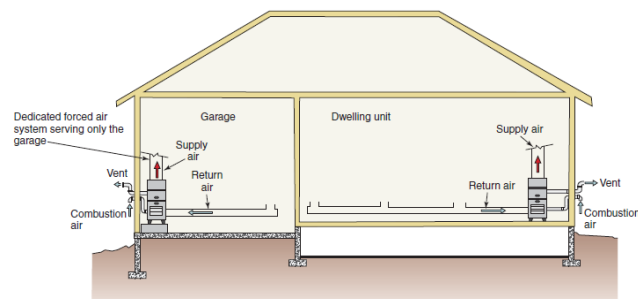
Exceptions:

1. Taking return air from a kitchen is not prohibited where such return air openings serve the kitchen and are located not less than 10 feet (3048 mm) from the cooking appliances.
2. Dedicated forced air systems serving only the garage shall not be prohibited from obtaining return air from the garage.

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Return air openings – 601.5



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Section 602 – Plenums

Air plenum spaces are restricted to:

- uninhabitable
 - unoccupiable
 - interstitial spaces
 - Cavities
- Plenums are restricted to one fire area as defined by the International Building Code. This would require dedicated HVAC systems for each fire area. Fuel fired appliances shall not be installed in plenums



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Section 602 – Plenums

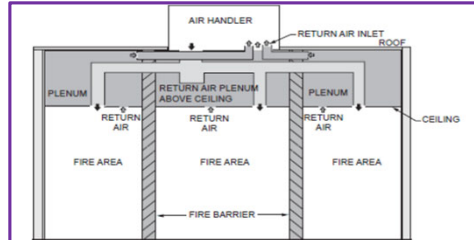


Figure 602.1(3)
MULTIPLE FIRE AREAS

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



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Section 602 – Plenums

602.2 – Construction

- Requires the plenum to be constructed of or formed by materials that are consistent with the materials allowed for the building's construction type.



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Section 602 – Plenums

602.2.1 – Materials within plenums

- Materials located within a plenum must be noncombustible or must have a flame spread index of 25 or less and a smoke developed index of 50 or less when tested in accordance with ASTM E 84 or UL 723.

Regardless of whether the plenum is constructed of or bounded by combustible or noncombustible materials



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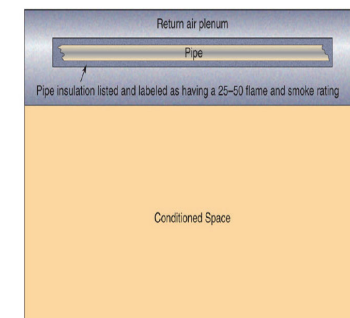
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Sections 602.2.1 & 602.2.1.8

602.2.1 Materials within plenums. Except as required by Sections 602.2.1.1 through 602.2.1.8, materials within plenums shall be noncombustible or shall 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.

Exception 5 recognizes the practice of enclosing combustible materials, such as plastic piping, in gypsum board assemblies or in insulation materials that are listed and labeled for this specific application. It also allows for the installation of electrical wiring and cable in a noncombustible raceway that is completely enclosed and continuous throughout the plenum. If a combustible material is covered by an approved thermal barrier meeting the flame spread and smoke-developed index of this section and the covering will remain intact for the anticipated time for egress, the material would no longer be subject to fire exposure and the intent of the code would be met.

Materials Within a Plenum



602.2.1.7 Plastic plumbing pipe and tube. Plastic piping and tubing used in plumbing systems shall be listed and shall exhibit a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with ASTM E 84 or UL 723.

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602.2.1.8 Pipe and Duct Insulation with Plenums (NEW)

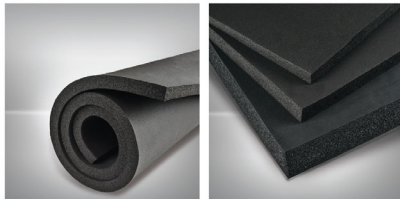
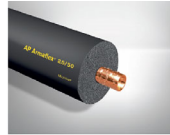


Photo courtesy of Armaflex, LLC

Pipe and duct insulation for use in plenums must meet the limitations and conditions specified in Section 602.2.1.8.



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Section 603 – Duct Construction and Installation

Ducts are constructed, braced, reinforced and installed such that they provide structural strength and durability, and do not affect fire protection requirements.



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Section 603 – Duct Construction and Installation

■ 603.2 – Duct sizing

- Ducts installed within a single dwelling unit shall be sized in accordance with ACCA Manual D, the appliance manufacturer's installation instructions or other approved methods. Ducts installed within all other buildings shall be sized in accordance with the ASHRAE *Handbook of Fundamentals* or other equivalent computation procedure.

■ 603.4 – Metallic ducts.

- Constructed per SMACNA
- Exception of this section permits ducts, installed within a single dwelling unit, to be constructed with the minimum thickness as specified in Table 603.4.



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Table 603.4

TABLE 603.4
DUCT CONSTRUCTION MINIMUM SHEET METAL THICKNESS FOR SINGLE DWELLING UNITS^a

ROUND DUCT DIAMETER (inches)	STATIC PRESSURE			
	1/2-inch water gage Thickness (inches)		1-inch water gage Thickness (inches)	
	Galvanized	Aluminum	Galvanized	Aluminum
< 12	0.013	0.018	0.013	0.018
12 to 14	0.013	0.018	0.016	0.023
15 to 17	0.016	0.023	0.019	0.027
18	0.016	0.023	0.024	0.034
19 to 20	0.019	0.027	0.024	0.034
RECTANGULAR DUCT DIMENSION (inches)	STATIC PRESSURE			
	1/2-inch water gage Thickness (inches)		1-inch water gage Thickness (inches)	
	Galvanized	Aluminum	Galvanized	Aluminum
≤ 8	0.013	0.018	0.013	0.018
9 to 10	0.013	0.018	0.016	0.023
11 to 12	0.016	0.023	0.019	0.027
13 to 16	0.019	0.027	0.019	0.027
17 to 18	0.019	0.027	0.024	0.034
19 to 20	0.024	0.034	0.024	0.034

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

^a Ductwork that exceeds 20 inches by dimension or exceeds a pressure of 1-inch water gage shall be constructed in accordance with SMACNA *HVAC Duct Construction Standards—Metal and Flexible*.

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Section 603 Duct Construction and Installation

- 603.5 – Nonmetallic ducts
- 603.5.1 – Gypsum ducts
- 603.6 – Flexible air ducts and flexible air connectors



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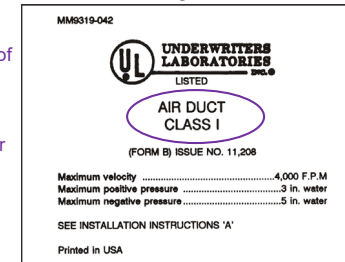
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Section 603 Duct Construction and Installation

- 603.6.1 – Flexible air ducts
 - Flexible air duct labels are rectangular in shape. Flexible air ducts are not limited in length.

Class 0 - Air ducts and air connectors having surface burning characteristics of zero.

Class 1 - Air ducts and air connectors having a flame-spread index of not over 25 without evidence of continued progressive combustion and a smoke-developed index of not over 50.



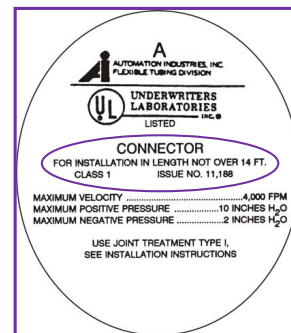
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Section 603 Duct Construction and Installation

- 603.6.2 – Flexible air connectors
 - Current air connector labels are oval in shape, thereby being readily distinguishable from flexible air duct labels.
- 603.6.2.1 –Connector length
 - Flexible air connectors shall be limited in length to 14 feet .



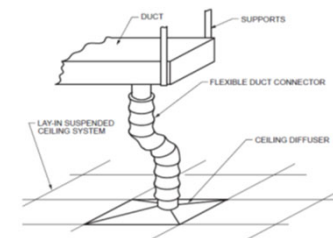
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Section 603 Duct Construction and Installation

- 603.6.3 – Air temperature
 - The air temperature in flexible air ducts and flexible air connectors must be less than 250°F (121°C).



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Section 603 Duct Construction and Installation

- **603.8 – Underground ducts**
- Ducts installed underground must be able to resist the following:
 - Forces imposed on them by materials that surround them
 - Forces created by floodwaters
 - Corrosion
- **603.8.3 – Plastic ducts and fittings**
 - Allowed underground only and are used for their corrosion and moisture resistant properties.



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Section 603 Duct Construction and Installation

- **Section 603.9 Joints, seams and connections**
- Shall be constructed as specified in:
 - Sheet Metal and Air Conditioning Contractors' National Association (**SMACNA**) HVAC Duct Construction Standards.
 - North American Insulation Manufacturers Association (**NAIMA**) Fibrous Glass Duct Construction Standards. Ducts listed to UL 181 and metallic ducts shall have closure systems that comply with UL 181A or UL 181B.



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Section 603.9

- **Joints, seams and connections**

Clarifies that unlisted duct tape is not allowed as a sealant on any type of a duct system.

- The previous limitation only applied to metal ducts.



Listed duct tape



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Section 603.9

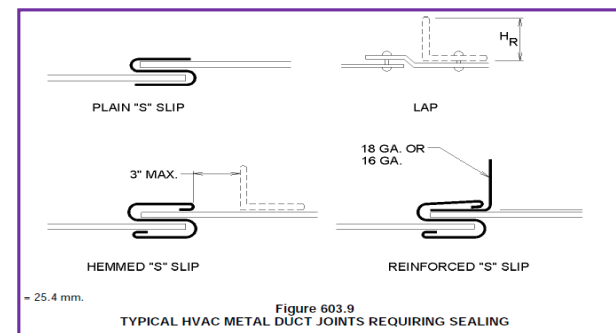


Figure 603.9
TYPICAL HVAC METAL DUCT JOINTS REQUIRING SEALING



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Section 603 Duct Construction and Installation

603.10 – Supports

- Ducts must be supported with approved hangers at a maximum spacing of 12 feet or by the approved system designed to meet the building code.

603.14 – Location

- Unless a duct is approved for underground installation, it must not be located within 4 inches of grade level.

Unless a duct is approved for underground installation, it must not be located in or within 4 inches (102 mm) of the ground. The 4-inch (102 mm) clearance is considered adequate to keep the duct from contacting the ground and possible moisture, which can cause duct deterioration.



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Section 603.14 Location

603.14 – Location

- Unless a duct is approved for underground installation, it must not be located within 4 inches of grade level.



Sheet metal mitered elbow wrapped with duct tape.
Would you approve this installation?



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Section 603.17 – Air Dispersion System

An air dispersion system is a tubular-shaped exposed supply air system that is made of air impermeable fabric material. The system is:

- Fitted with air holes or nozzles to direct air into the area served by the duct
- Generally used in open ceiling installations where the floor or roof deck is visible
- Can be thought of as a duct and a diffuser all in one.



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Section 603.17

Air dispersion systems

Air dispersion systems as defined in Section 202 and recognized in UL 2518 are now permitted to be installed.

- **Definition:** Any diffuser system designed to both convey air within a room, space or area and diffuse air into that space while operating under positive pressure. Systems are commonly constructed of, but not limited to, fabric or plastic film.



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Section 603.17 Air Dispersion System

Section 603.17 establishes criteria for the use of fabric air dispersion systems, limiting them to installation in exposed locations, prohibiting penetration of rated construction, requiring them to operate under positive pressure and to comply with UL 2518.



Photo courtesy of DuctSox



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Section 606 – Smoke Detection Systems Control

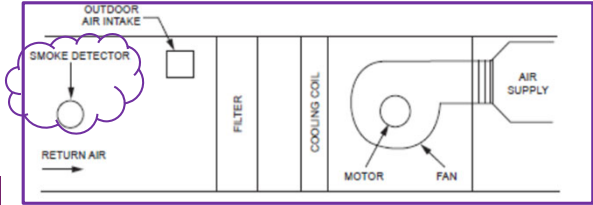
- **606.2 Where required - smoke detectors**
 - The intent of this section is to prevent air distribution systems from distributing smoke to areas where the occupants might not be aware of the fire.
 - Requiring smoke detectors to be located in air distribution systems the hope is that the detector will sense any smoke and shut down the system before the smoke can be spread beyond the room of origin.

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Section 606 – Smoke Detection Systems Control

- **606.2.1 – Return air systems**
 - Smoke detectors shall be installed in return air systems with a design capacity greater than 2,000 cfm, the detectors must be installed in the path of airflow before (upstream of) any filters, exhaust air connections, outdoor air connections or decontamination equipment that occur in the system.



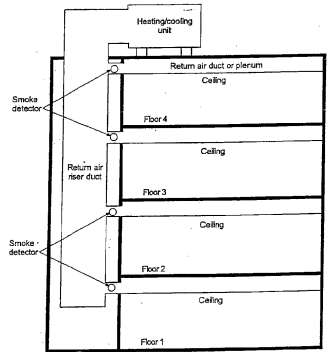
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Section 606 – Smoke Detection Systems Control

- **606.2.3 – Return air risers**

Where a return air system with a design capacity greater than 15,000 cfm serves more than one story, the return air from each story must be monitored before intermixing the return in the common riser.



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Section 606 – Smoke Detection Systems Control

[F] 606.4.1 Supervision. The duct smoke detectors shall be connected to a fire alarm system where a fire alarm system is required by Section 907.2 of the *International Fire Code*. The actuation of a duct smoke detector shall activate a visible and audible supervisory signal at a constantly attended location. In facilities that are required to be monitored by a supervising station, duct smoke detectors shall report only as a supervisory signal, not as a fire alarm.

Exceptions:

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



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Final Reflection

This slide will help the learner to reflect on the day and what they will take back to the job and apply.

- **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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