Block D: Piping and Components

TRU Open Press

Plumbing Apprenticeship Program Level 1 Series

Block D: Piping and Components

BC Plumbing Apprenticeship, Level 1

SKILLEDTRADESBC

AUDREY CURRAN; MARK OVERGAARD; BC PIPING ARTICULATION AND CURRICULUM SUBCOMMITTEE; AND PAUL SIMPSON

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Block D: Piping and Components of the Plumbing Apprenticeship Program Level 1 Series features Skilled Trades BC industry-authority content focused on the core installation skills that form the foundation of plumbing systems. This block emphasizes the practical knowledge and techniques apprentices use to assemble, connect, and integrate piping systems accurately and safely within residential, commercial, and institutional settings.

In Block D, apprentices learn how to install pipe and tubing, valves, and fittings, as well as how to safely and effectively penetrate building structures. These competencies support proper system function, durability, and compliance with codes and specifications, while reinforcing precision, planning, and coordination with other trades on the job site.

Plumbing Apprenticeship Program Level 1 Series

The *Plumbing Apprenticeship Program Level 1 Series* offers comprehensive training materials designed to build on foundational skills and knowledge. The series is divided into four main blocks, each focusing on critical areas of plumbing systems and installations.

Block A: Safety Related Functions (https://a-safetyfunctions-bcplumbingapprl1.pressbooks.tru.ca)

A-1: Workplace Hazards
A-2: WorkSafeBC Regulations
A-3: Safe Handling of Hazardous Materials
A-4: Personal Safety Practices
A-5: Fire Safety

Block B: Tools and Equipment (https://b-handmeasuringtools-bcplumbingapprl1.pressbooks.tru.ca)

B-1: Use Hand Tools and Measuring Tools
B-2: Use Portable Power Tools and Use
B-3: Use Access Equipment
B-4: Use Rigging, Hoisting, Lifting and Positioning Equipment, and Rigging
B-5: Use Soldering and Brazing Equipment and Oxy-Fuel Cutting Equipment
B-6: Use Welding Equipment

Block C: Routine Trade Activities and Electrical Concepts (https://c-tradeactivities-electrical-bcplumbingapprl1.pressbooks.tru.ca)

C-1: Mathematics and Science
C-2: Electrical Concepts and Principles of Electricity

C-3: Drawings and Specifications
C-4: Codes, Regulations and Standards
C-5: Manufacturer and Supplier Documentation

Block D: Piping and Components (https://d-pipingcomponents-bcplumbingapprl1.pressbooks.tru.ca)

D-1: Install Pipe and Tubing
D-2: Install Valves
D-3: Install Fittings
D-4: Penetrate Structures

Plumbing Apprenticeship Program Overview and Upcoming Resources

- **Plumbing Apprenticeship Program Level 1 Series** (https://openpress.trubox.ca/2024/12/13/plumbing-apprentice-level-1/) can be found in the TRU Open Press Collection.
- **Plumbing Apprenticeship Program Level 2 Series (https://openpress.trubox.ca/2024/04/26/bc-plumbing-apprenticeship-level-2/)** can be found in the TRU Open Press Collection.
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Safety Advisory

The current Standards and Regulation in BC can be obtained at the WorkSafeBC website: http://www.worksafebc.com (http://www.worksafebc.com/)

Please note that it is always the responsibility of any person using these materials to inform themselves about the Occupational Health and Safety Regulation pertaining to their areas of work.

[From previous 2021 book – confirm this message with Skilled Trades]

Symbol Legend

Important Information

Potentially Toxic/ Poisonous Situation

Required or Optional Resources

Potentially Flammable Situation

Complete a Self-Test

Possibly Explosive Situation

Use Protective Equipment

Potential Electric Shock

Acknowledgements

The development of the *Plumbing Apprenticeship Level 1* learning resources was a collaborative effort driven by a commitment to excellence in trades education. These resources were created to support apprentices and journeypersons in mastering the skills and knowledge essential to the piping trades. This achievement would not have been possible without the dedication and expertise of *Skilled Trades BC* and the *Piping Trades Articulation Committee*, whose contributions, leadership, and guidance have been instrumental in shaping high-quality, industry-aligned training resources. We extend our sincere gratitude for their contributions and ongoing stewardship in advancing the piping trades.

The content for *Block D: Piping and Components* (https://d-pipingcomponents-bcplumbingapprl1.pressbooks.tru.ca/) is adapted from the Piping Trades Apprenticeship Program from SkilledTradesBC (2019 Harmonized).

The original materials were produced in collaboration with industry partners and aligned with the Industry Training Authority (ITA)/SkilledTradesBC harmonized program outlines for Plumbing, Steamfitting/Pipefitting, and Sprinkler Fitting. These works were released under a Creative Commons Attribution 4.0 International (CC-BY-NC-SA (https://creativecommons.org/licenses/by-nc-sa/4.0/)) licence, except where otherwise noted.

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This adapted version has been reformatted and integrated into the current Thompson Rivers University/TRU Open Press open educational resource in collaboration with the BC Piping Articulation and Curriculum Subcommittee and SkilledTradesBC, in support of open, accessible, and up-to-date apprenticeship training.

The Open Press

The Open Press combines TRU's open platforms and expertise in learning design and open resource development to support the creation and reuse of open educational resources, while encouraging open scholarship and research.

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Starting December 1, 2022, Industry Training Authority was officially renamed to SkilledTradesBC. Hear more in this video from SkilledTradesBC CEO, Shelley Gray, on what this means for the trades industry and British Columbians. Closed captioning and transcripts are available with this video, Introducing Skilled Trades BC (https://www.youtube.com/watch?v=OQgwdP0rNog) (2022) on YouTube.

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Camosun College. (n.d.). *Line E – Electrical Fundamentals Competency*. BCcampus. https://collection.bccampus.ca/textbook/Nf7jVbAg/

SkilledTradesBC. (2025). Plumber program outline (Implementation date: August 18, 2025; Last revised: December 16, 2025) [PDF]. Province of British Columbia. https://skilledtradesbc.ca/media/2776/download

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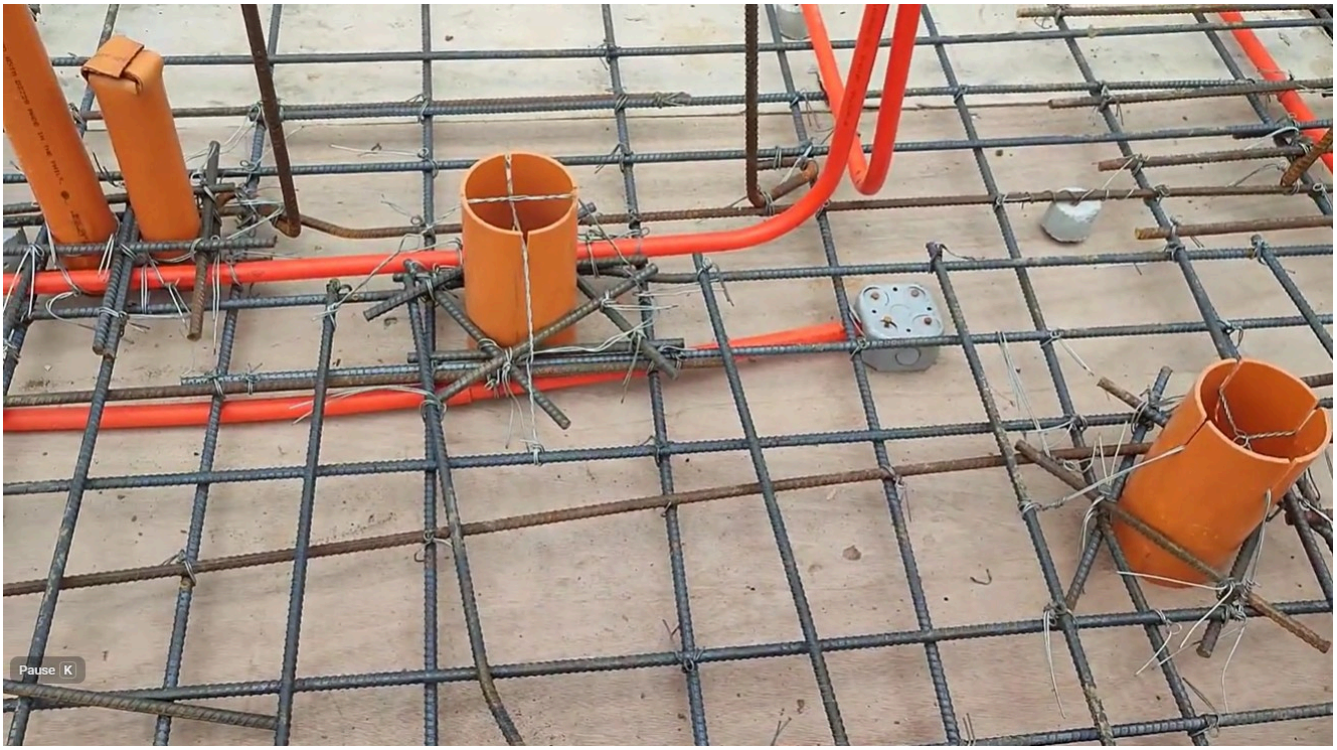
PART IV

D-4 PENETRATE STRUCTURES

Plumber Apprenticeship Program – Level 1



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D-4 Penetrate Structures Introduction

When installing piping systems, it is often necessary to pass through walls, floors, and other structural components of a building. These penetrations must be done carefully to avoid weakening the structure or compromising safety features such as fire separations. In this section, you will learn how to identify building structural components, understand the factors that affect structural penetrations, and apply safe methods for cutting, drilling, and installing piping through different types of construction. You will also become familiar with common terminology and components such as sleeves, block-outs, and supports. By the end of this section, you should be able to install piping through structural elements without compromising the integrity of the building.

Note: The information in this section is general in nature. Always refer to manufacturer specifications, job-site requirements, and applicable codes when performing structural penetrations.

Learning Objectives

After completing this section, you will be able to:

- Describe factors affecting penetrations in structures.
- Describe methods of structure penetration.
- Identify and describe building structural components and their structural integrities
- Define structural penetration terminology
- Visually identify the building structural components that are affected by penetration for piping, including fire separations, firewalls, structural supports and components
- Install piping without jeopardizing the structural integrities of the building structure
- Identify and install pipe sleeves, canning and block-outs
- Identify and apply procedures (cutting, drilling, and notching) used to penetrate various building structures for piping without jeopardizing the integrity of structural components, including wood-frame, steel and concrete construction; walls; floors and roof structures
- Apply various methods of firestopping for pipe penetrations, and read and interpret the related manufacturer's specifications, code regulations and job specifications
- Define firestopping terminology
- Identify and install firestops
- Install piping through vapour and air barriers and rain-screen exterior walls without affecting their structural integrity

Topic areas covered in this publication are in alignment with SkilledTradesBC Harmonized 2018 Program Outlines.

Terminology

The following terms may be used throughout this section. Note that some glossary terms may be in italics throughout the section content but are not included in this list. A complete list of terms can be found in the **Glossary.**

- **ablative:** resisting heat transfer by using the heat of the exposing fire to erode the material. The material, by sacrificing itself, protects the unexposed side from rapid temperature rise until it is spent. A typical example is a silicon-based firestop material. (Section D-4.2 (#chapter-d-4-2-describe-acceptable-methods-of-structure-penetration))
- **annular space**: The gap between a pipe and the sleeve or opening it passes through. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **block-out:** An opening intentionally formed in concrete or other structural components during construction to allow space for pipes, ducts, or other services to be installed later. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **bond beam:** A reinforced horizontal element in a masonry wall that strengthens and ties the wall together. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **caddy clip:** A fastening device used to secure pipe sleeves to formwork or structural surfaces. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **canning:** The process of installing pipe sleeves in formwork before concrete is poured. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **caulking gun:** A tool used to apply sealants into joints or openings. (Section D-4.2 (#chapter-d-4-2-describe-acceptable-methods-of-structure-penetration))
- **closure (fire-rated):** A device such as a door or shutter used to close an opening in a fire separation. (Section D-4.2 (#chapter-d-4-2-describe-acceptable-methods-of-structure-penetration))
- **concrete formwork:** Temporary structures used to shape and support concrete until it hardens. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **core drilling (coring):** A method of drilling circular holes in concrete using a specialized drill. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **draft stop:** A material intended to stop air movement and fire spread. (Section D-4.2 (#chapter-d-4-2-describe-acceptable-methods-of-structure-penetration))
- **exothermic:** A reaction that releases heat energy. (Section D-4.2 (#chapter-d-4-2-describe-acceptable-methods-of-structure-penetration))
- **fire-block:** A material installed to prevent the spread of fire through concealed spaces. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **fire load:** The amount of combustible material present in a space. (Section D-4.2 (#chapter-d-4-2-describe-acceptable-methods-of-structure-penetration))
- **fire-rated assembly:** A construction system designed to resist fire for a specified period of time. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **fire separation:** A construction assembly designed to resist the spread of fire. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **firestop:** A sealing system used to prevent fire and smoke from passing through penetrations. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **firewall:** A fire-resistant wall that separates buildings or sections of a building. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **flashing:** A material installed to prevent water penetration at roof or wall openings. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))

- **fusible link:** A heat-sensitive component that melts to activate a fire damper. (Section D-4.2 (#chapter-d-4-2-describe-acceptable-methods-of-structure-penetration))
- **glued-laminated beam:** (Also called *glulam* and *paralam*); an engineered wood beam made by bonding together layers of lumber with adhesive to create a strong, stable structural member. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **I-joist:** (Also called I-*beam*); a lightweight engineered wood beam shaped like the letter "I," commonly used in floors and roofs. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **load-bearing structural member:** A structural element designed to hold up the load above it, such as a second storey or roof. Cutting, drilling, or removing this support will weaken the structure. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **moment critical zone:** A section of a structural beam where stress is highest and drilling is restricted. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **non-load-bearing structural member:** A support that is installed as a partition to divide space in a structure and does not support the weight above it. Cutting, drilling or removing this support will not weaken the structure. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **party wall:** A shared wall between two adjoining buildings or units that acts as a fire separation and may also provide sound insulation. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **pipe chase:** A framed or enclosed space within a building used to conceal and protect pipes as they run vertically or horizontally through the structure. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **pipe sleeve:** A protective tube that allows a pipe to pass through a structure safely. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **post-tension slab:** A concrete slab reinforced with tensioned steel cables to increase strength and reduce cracking. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **rebar (reinforcing bar):** Steel bars embedded in concrete to provide strength and support. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **sleeve seal:** A sealing device used to close the gap between a pipe and a pipe sleeve. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **structural integrity:** The ability of a building or structure to remain strong, stable, and safe under loads without failure or damage. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **teleposts (telescopic):** Adjustable steel support posts used to temporarily support structures such as formwork or beams during construction, allowing height to be changed as needed. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **tendon (post-tension):** A steel cable used in post-tension concrete to apply compressive force. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **vibration isolator:** A device used to reduce the transfer of vibration and noise between components. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))
- **waterstop:** A material used to prevent water from passing through joints in concrete. (Section D-4.1 (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures))

D-4.1 Describe Factors Affecting Penetrations in Structures

As a pipe trades worker, it is your job to install, maintain, and repair piping systems and components. Much of the pipe you install will be within structures and will penetrate through foundations, walls, floors, ceilings, and roofs. When installing piping systems, you must maintain the integrity of the structure. You should be able to correctly make pipe penetrations through building structural components.

On the job, you should be aware of the function of the various building structural components. You cannot simply remove, cut, notch, drill, or otherwise alter a building's structural components without considering the effect you are having on that structural component's purpose.

Structural Integrity

Structural integrity is the ability of the ***structural component*** to perform its designed purpose.

When penetrating structural components with piping, you must consider, identify, and maintain the following:

- Structural support integrity of beams, columns, walls, floors, roofs, and ceilings
- Fire safety integrity of fire-rated assemblies, including firestops, firewalls, and separations
- Humidity, moisture, and water penetration integrity of the structure, roofs, walls and foundations, including protection against rain and groundwater penetration
- Energy efficiency, including heat loss and gain, insulation, and ***air barrier*** integrity
- Air quality, ventilation, air conditioning, and heat recovery system integrity
- Occupant health and safety integrity
- Appearance and environmental integrity
- Non-interference with adjoining properties
- Sound penetration integrity
- Other engineered structural concerns and requirements

You must have a clear understanding of the design purpose of the structural components within a structure. Every pipe system component installed must not compromise the structural integrity of the building. The following information identifies the related structural components of the building and the acceptable methods for penetrating piping components.

Wood-Frame Construction Components

The following definitions are important in understanding the restrictions around cutting floor, roof, and ceiling framing members:

- ***Load-bearing structural member*:** A structural element designed to support the load above it, such as a second

storey or roof. Cutting, drilling, or removing this support *will* weaken the structure.

- ***Non-load-bearing structural member***: A structural element that is installed as a partition to divide space and does not support the weight above it. Cutting, drilling or removing this support *will not* weaken the structure.

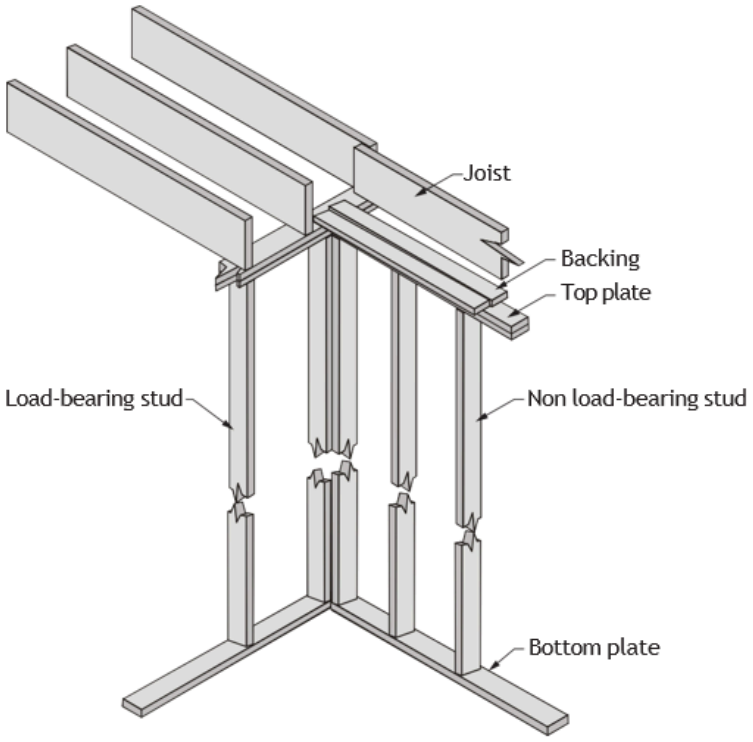

Figure 1—Typical wood framing components

Figure 1 *Typical wood framing components (BC Industry Training Authority, 2019).*
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Fire Separation

A ***fire separation*** is a construction assembly that resists the spread of fire. A fire separation is constructed of components that make up a ***fire-rated assembly*** or *system*. The ***fire rating*** of each component in the assembly contributes to the final fire rating for the fire-separation assembly.

Figure 2 shows a typical application of vertical and horizontal wood-frame fire separations and their locations.

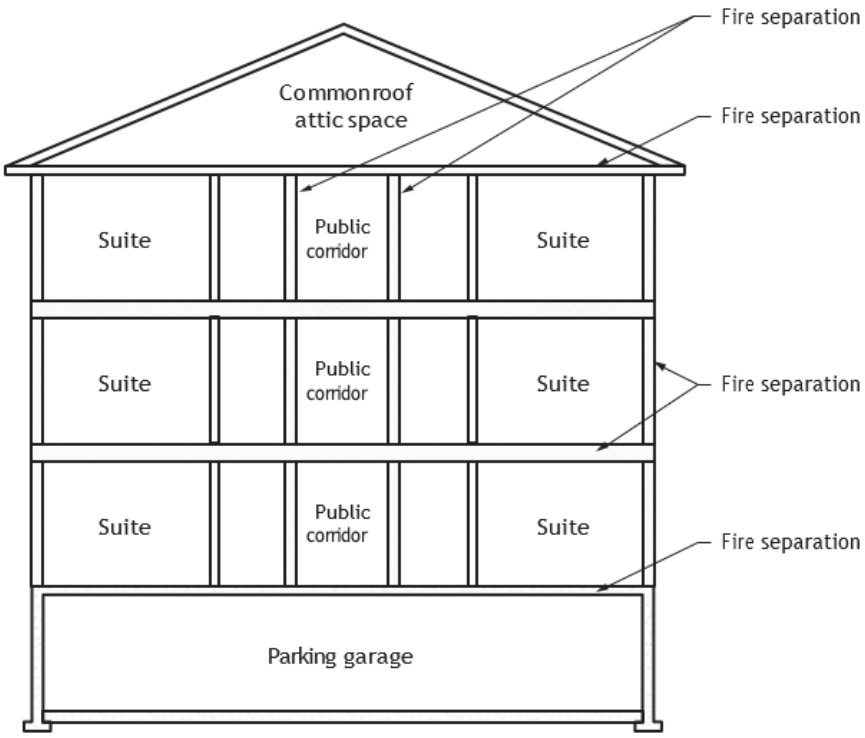


Figure 2 *Fire separation locations (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Firewalls

A ***firewall*** is defined by a building code as a type of fire separation made of non-combustible construction that subdivides a building, or separates adjoining buildings, to resist the spread of fire and remain structurally intact for the required period of time. Typically, a firewall is constructed of concrete or concrete block. A firewall has a higher overall fire rating than a fire separation.

An example of a firewall in a multi-storey wood-frame building is a concrete block wall that extends from the ground floor right up through the roof (Figure 3).

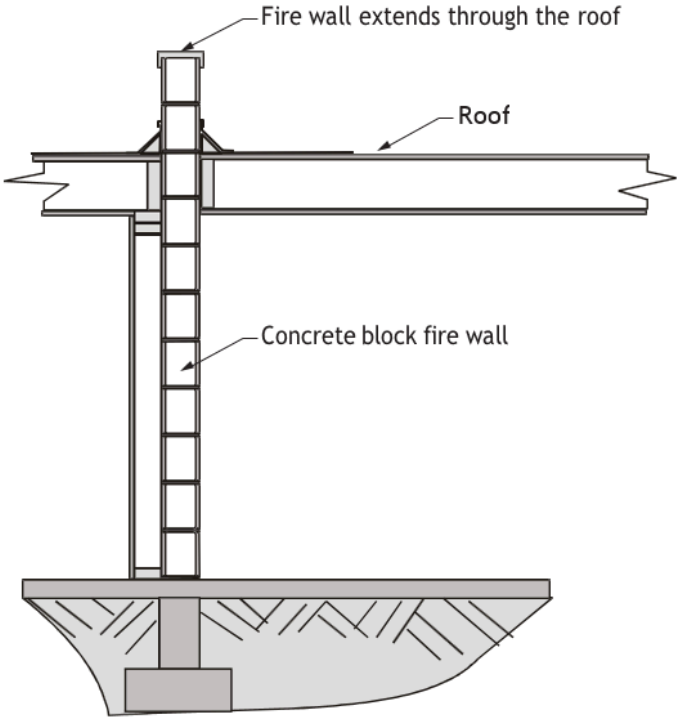


Figure 3 *Concrete block fire wall* (BC *Industry Training Authority*, 2019). CC BY-NC-SA 4.0 (*https://creativecommons.org/licenses/by-nc-sa/4.0/*)

Party Walls

A ***party wall*** is a fire-separation wall jointly owned and used by two parties under an easement agreement or by right in law, and erected at or upon a line separating two parcels of land, each of which is capable of being a separate real estate property.

An example of a fire separation in a multi-storey wood-frame residential building would be the party wall that is required between the suites and the wall between the suite and the community hallway. Both of these walls must meet a fire rating that is specified in the building code.

The party wall shown in Figure 4 separates two suites and acts as a fire separation and a sound barrier. The wall consists of a double wall with an air space between. One wall is sheeted on the inside, and each floor has a sheet metal firestop.

Note: Plumbing pipes should not be placed inside a party wall. Check with the authority having jurisdiction.

It is critical that piping systems do not compromise the integrity of fire separations, walls, and firestops.

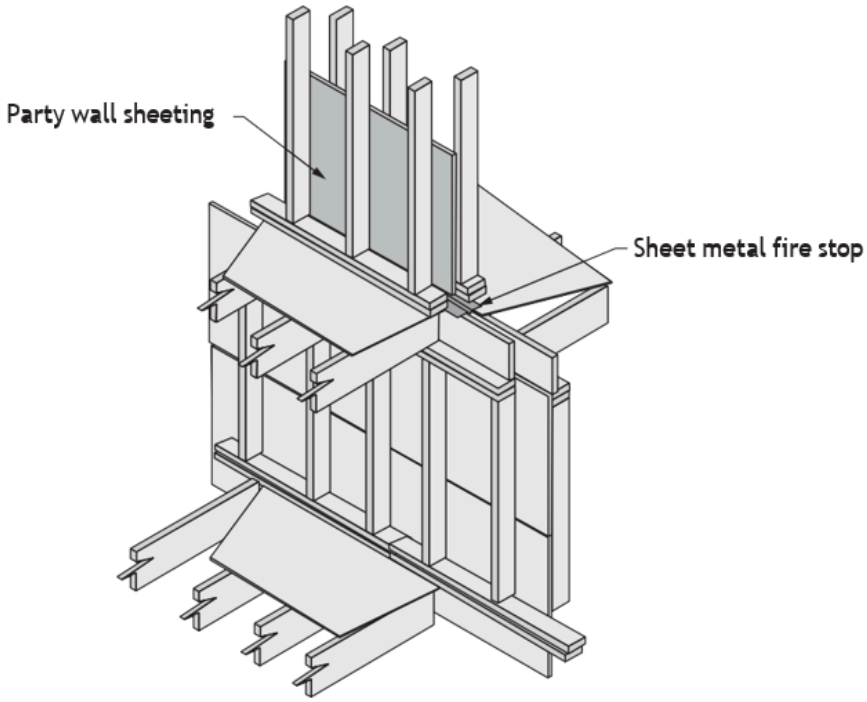


Figure 4 *Party wall (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Glued, Laminated Beams

Glued-laminated beams are commonly referred to by a variety of names, such as *glulam* and *paralam*. A glued-laminated beam consists of multiple layers of thin strips of wood glued together to create a beam of standard dimensions.

In general, avoid drilling or notching glued-laminated beams. However, the Engineered Wood Association (APA) says that you can field-drill small-diameter holes for wiring and conduit. The location, size and number of these holes are restricted. You must consult with the manufacturer and confirm with the inspection regulatory authority. Avoid cutting, notching or drilling laminated beams unless the manufacturer, engineer and building officials specifically approve. **Always consult the manufacturer's specifications and regulatory authority before making any modifications.**

Figure 5 *Laminated Veneer Lumber (LVL) beam (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Fire-Blocks

A ***fire-block*** is a firestop material installed during construction. A fire-block should not be confused with a *firestop*. Firestops are required when a higher degree of fire protection is required, particularly when there are penetrations through fire-rated separations. Firestops are covered in D-4.2 Describe Acceptable Methods of Structure Penetration (#chapter-d-4-2-describe-acceptable-methods-of-structure-penetration). Fire-blocking involves field-installing building materials to prevent undetected flames and gases from moving through concealed spaces to other areas.

Do not remove or damage fire-blocks, as this will compromise fire safety. During a fire, flame and heated products of combustion can spread via paths of least resistance. Certain structures, particularly wood-frame structures, have concealed voids or cavities within walls, ceilings, attics, and crawl spaces. These concealed spaces not only affect the spread of fire, but also make suppression more difficult. Frequently, and inevitably, pipes, vents, ducts, and similar items will penetrate fire-blocks. You must be able to recognize a fire-block when you see one so that you do not remove it or otherwise jeopardize its ability to restrict the spread of flames and gases.

Fire-blocks are required in the following locations:

- Between floors
- Between a top-storey and a roof or attic space
- In furred spaces or the cavities between studs in wall assemblies
- At connections between horizontal and vertical spaces created in floor joists or trusses, soffits, drop or cove ceilings, combustible exterior wall finishes and architectural elements
- Openings for pipes, vents, ducts, chimneys and fireplaces

Fire-blocks can be constructed of various materials, including:

- 2 inch nominal lumber
- Structural wood panels
- Gypsum board (drywall)
- Cement fibreboard for larger fire-blocks
- For smaller fire-blocks, batts or blankets of mineral wool or glass fibre, loose fill insulation and caulks, sealants, and putties

Check with the local authority having jurisdiction for appropriate fire-block material.

Figure 6 shows a fire-block in an attic space.

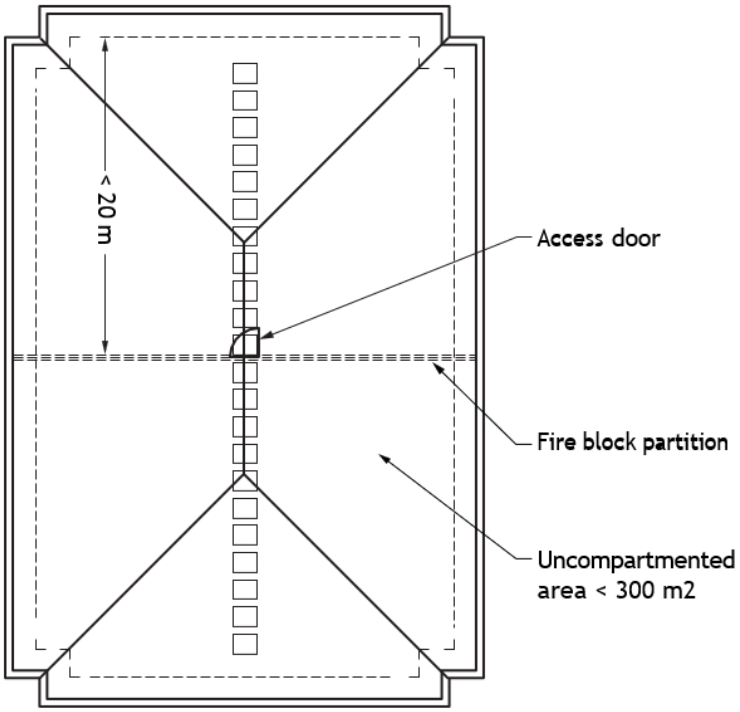


Figure 6 *Fire-block in a shared concealed attic space above two occupancies (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figure 7 shows an example of an attic firestop under construction. Any items penetrating this firestop will need to be fire blocked to prevent rapid fire spread.

Figure 7 *Attic fire block (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Wood-Frame Construction Penetrations

One important consideration when installing piping in wood-frame buildings is the placement of piping to avoid interfering with the integrity of the building's structural supports. Normally, drilling and notching structural support members is not permitted. There may be exceptions to this rule; however, consultation with and approval by engineers and building officials will be required.

The following information is generic in nature and is not specific to a particular code wording or manufacturer's specifications. The information is based on references to the *BC Building Code* (https://www2.gov.bc.ca/gov/content/industry/construction-industry/building-codes-standards/bc-codes/2024-bc-codes#2024)and manufacturer's information. On the job you will need to reference the building code and specific manufacturer's specifications for drilling and cutting of building framing.

Cutting Holes in I-Joists

Today, wood-based lightweight ***I-beams*** (also called *I-joists*) (Figure 8) are widely used in the construction industry. An important feature of these beams is that holes may be cut in the web, but not in the flange.

Figure 8 *Wood I-beam type joist components (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Hole-cutting specifications for wood I-joists:

- Round holes do not have to be centred on the joist centre but must not be closer than 1.25 cm ($\frac{1}{2}$ in.) from the joist flange.
- Do not cut or damage the joist flange.
- A maximum of three holes is permitted per joist.
- Cut all holes carefully.
- When more than one circular hole is cut, the distance of uncut web between the holes (Figure 9) must be twice the diameter of the largest diameter hole. For square holes, the minimum distance of uncut web between the holes must be two to four times the length of the largest adjacent hole.
- A maximum size of 3.75 cm (1 $\frac{1}{2}$ in.) holes may be cut anywhere in the web, provided the centre-to-centre measurement is 30 cm (1 foot) on centre.

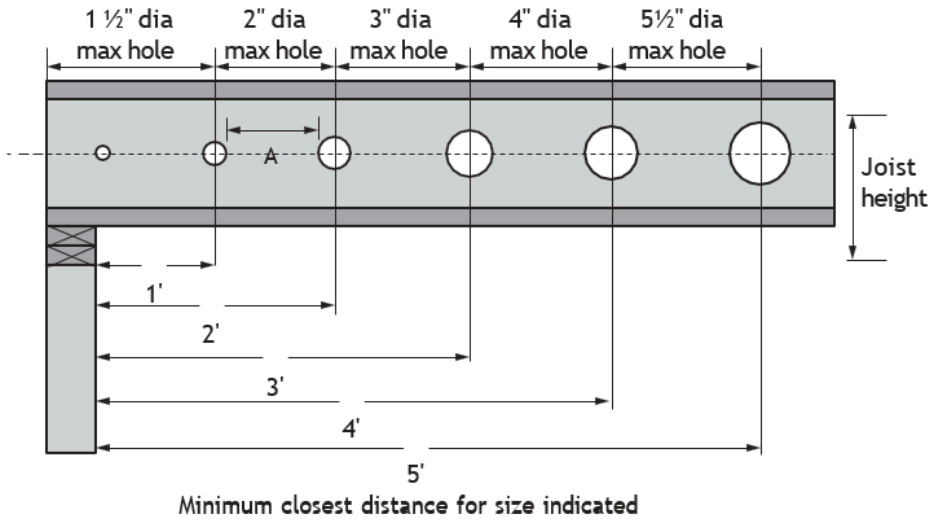


Figure 9 *Spacing of holes in wood I-joists (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figure 9 shows the typical maximum dimensions for round hole diameters and the minimum distance from the bearing support for joist depths of 237.5, 298 and 350 mm (9.5 in., 11 $\frac{7}{8}$" in. and 14 in.). Consult the manufacturer's specifications before cutting any holes.

- Square cut holes must be centered on the web.
- Some manufacturers require square or rectangular holes to be located in the middle third of the span.
- Some manufacturers will not allow any holes in a joist within 120 cm (48 in.) of the supporting member (Figure 10).

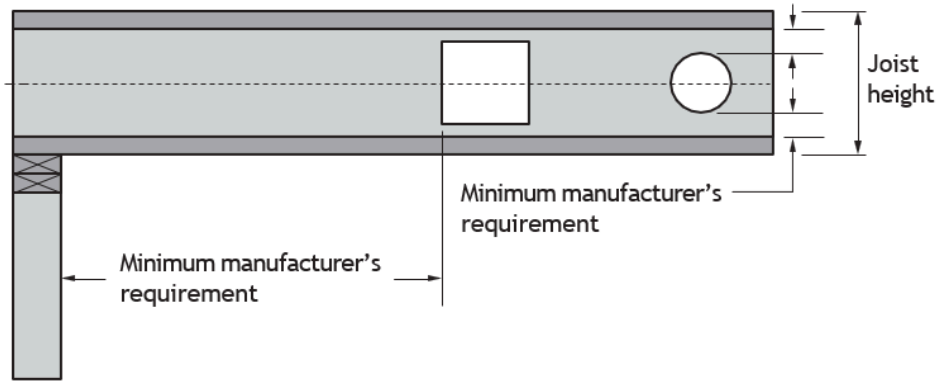


Figure 10 *Spacing of square and rectangular holes in a laminated I-joist (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Observe the following rules when cutting a laminated I-joist:

- Do not cut, drill, notch or chisel the flange.
- Do not over-size the holes in the web.
- Do not break out holes with a hammer.
- Do not cut holes too close to the bearing supports.

Do not assume that it is OK to cut or drill a hole in a beam for a small pipe. Always consult with the manufacturer's specifications, regulatory codes, inspection authority and design engineer before attempting to drill or cut a structural support. The job site supervisor (general contractor) would be a good source of information.

Specifications for Holes in Glued, Laminated Beams

Examples of access holes include those used for the passage of wires, electrical conduit, small-diameter sprinkler pipes, fibre-optic cables, and other small, lightweight materials. These field-drilled horizontal holes should meet the following guidelines.

- The hole diameter should not exceed 38 mm (1.5 in.) or $\frac{1}{10}$ the beam depth, whichever is smaller.
- The minimum distance from the edge of the hole to the bottom or top edge of the beam is four hole diameters.
- The minimum distance from the edge of the hole to the end of the beam is eight hole diameters.
- Holes 25 mm (1 in.) diameter or smaller should not be drilled in the area above and below the center rectangle (Figure 11) unless approved by the design engineer and regulative authority. This area is called the ***moment critical zone***. The dimension of the zone will be provided by the manufacturer.
- The horizontal hole should not be drilled in areas other than as defined in Figure 11 unless approved by an engineer or architect qualified in engineered timber design.
- Field-drilled horizontal holes should be used for access only and should not be used as attachment points for brackets or other load-bearing hardware unless specifically designed by the engineer or designer.

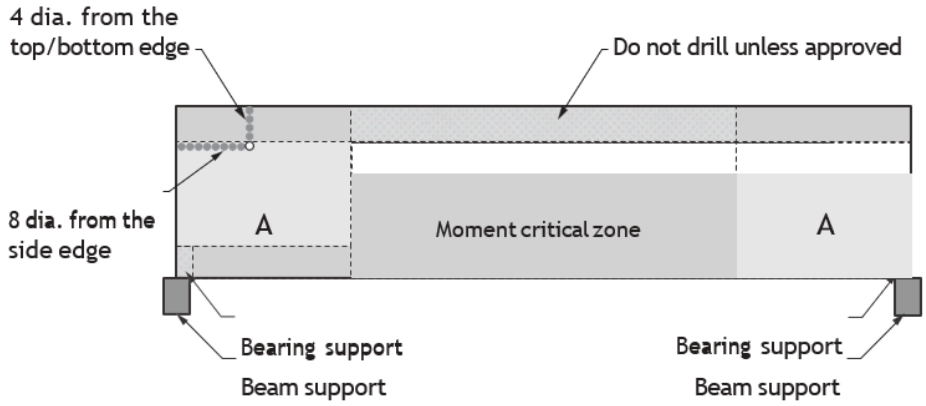


Figure 11 A = *Zones where small-diameter horizontal holes are permitted for passage of wires, conduit, etc. (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Notching and Drilling of Joists

The *BC Building Code* advises that holes in roof, floor, or ceiling framing members shall not be larger than one-quarter the depth of the member and must be located at least 50 mm (2 in.) from the edge, unless the depth of the member is increased by the size of the hole (Figure 12).

Note: Round holes are preferred over square holes or notches.

Nominal vs. Actual Joist Dimensions

The actual dimension of a 2″ x 10″ joist is 1 $\frac{1}{2}$″ × 9 $\frac{1}{2}$″.

The actual size of a 2″ x 12″ joist is 1 $\frac{1}{2}$″ × 11 $\frac{1}{2}$″.

Maximum hole sizes are calculated based on actual dimensions rather than nominal dimensions, as follows:

- The maximum diameter hole in a 2″ × 10″ joist is $\frac{23}{8}$″.
- The maximum diameter hole in a 2″ × 12″ joist is $\frac{27}{8}$″.

Note: To obtain the metric dimensions use the conversion factor 1 in. = 25.4 mm. Actual metric dimensions of some common nominal sizes are:

- 2″ × 10″ nominal joist = actual size 38 mm × 241 mm
- 2″ × 1″ nominal joist = actual size 38 mm × 292 mm

A nominal 3 in. diameter pipe has an outside diameter of approximately 3 $\frac{1}{2}$″ inches. The pipe therefore cannot be installed in a nominal 2″ × 10″ joist or 2″ × 12″ joist. A 3 in. pipe would require at least a 3 $\frac{5}{8}$″ in. hole to allow for clearance. This would mean a minimum 16 in. joist is needed.

Note: Never notch the bottom of a joist or cut sections out of a joist.

The *BC Building Code* advises to avoid notching if possible, but notching floor, roof and ceiling framing members is permissible under the following restrictions (Figure 12):

- The notch must be located on the top of the member within half the joist depth from the edge of the bearing.
- The notch must be not deeper than one-third the joist depth, unless the depth of the member is increased by the size of the notch.

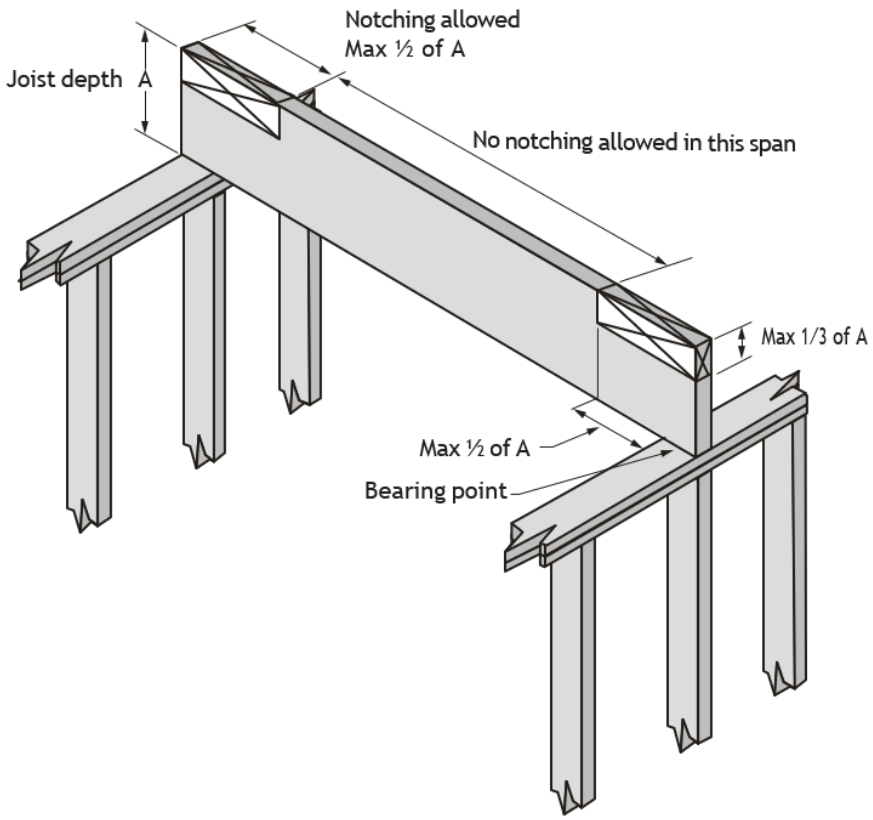


Figure 12 *Permissible notching of floor, roof and ceiling framing members (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Notching or Drilling Studs or Plates

Notching and drilling studs and plates is acceptable as long as the following *BC Building Code* requirements are followed.

Wall studs must not be notched, drilled, or otherwise damaged so that the undamaged portion of the stud is less than two-thirds the depth of the stud if the stud is load-bearing, or less than 40 mm (1.6 in.) if the stud is non-load-bearing, unless the weakened studs are suitably reinforced.

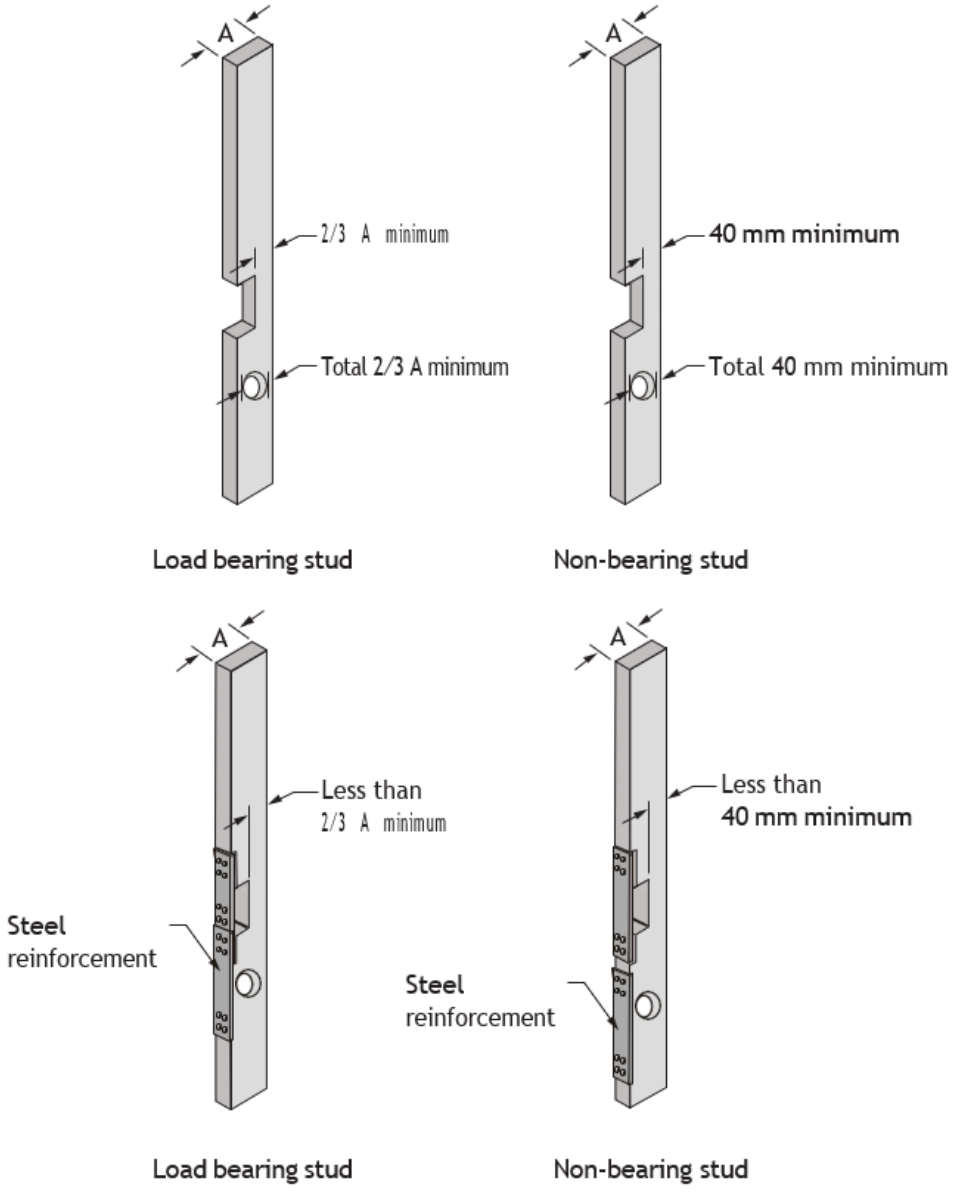


Figure 13 *Load-bearing and non-load-bearing stud notching: minimum requirements (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Top Plate Drilling and Notching (*BC Building Code* clause interpretation)

The top plates in a wall must not be notched, drilled or otherwise weakened by reducing the undamaged width to less than 50 mm (2 in.), unless the weakened plates are suitably reinforced (Figure 14).

Note: A 3 in. pipe cannot be installed through a 2″ × 6″ plate without additional reinforcement. Likewise, a 1 $\frac{1}{2}$„ in. pipe cannot be installed through a typical 2″ × 4″ plate without reinforcing.

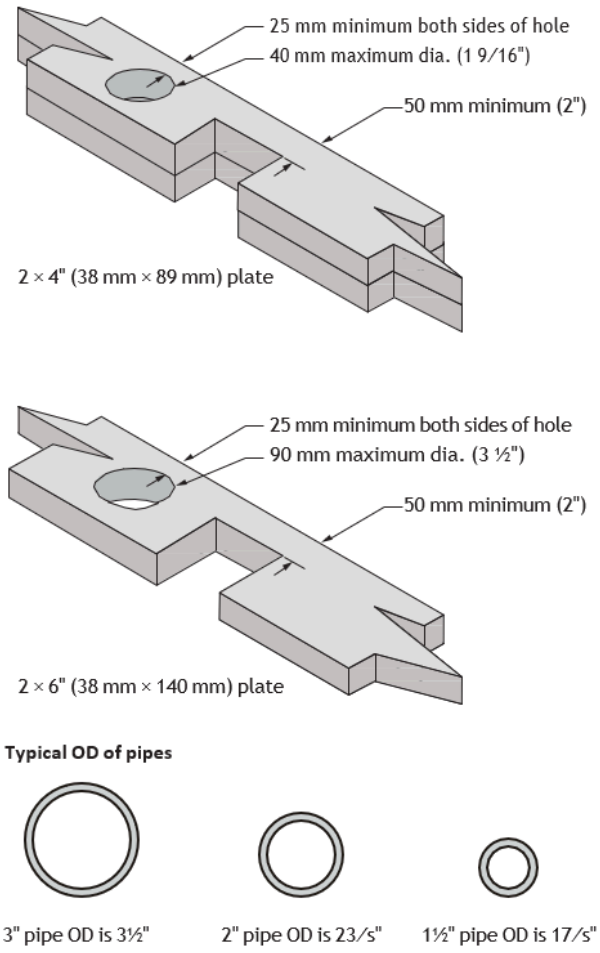


Figure 14 *Permissible cutting of wall top plate (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Top Plate Reinforcement

When a hole that is larger than permitted is cut in a plate, reinforcing must be installed, as shown in Figure 15.

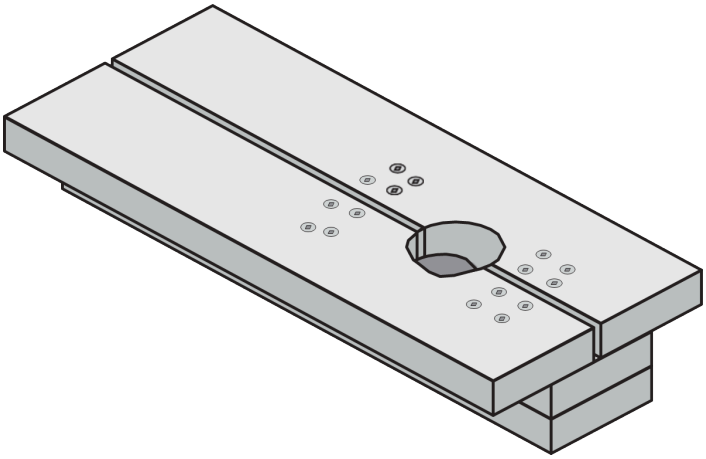


Figure 15 *Reinforcing plate added for oversized penetration (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figure 16 *Proper drilling of holes and pipe support (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

The top and bottom plates or tracks of the walls are sometimes riddled with openings for pipe and cable penetrations. The extent of such holes can affect the structural integrity of the wall. The practice of installing an excessive number of openings too close together should be avoided.

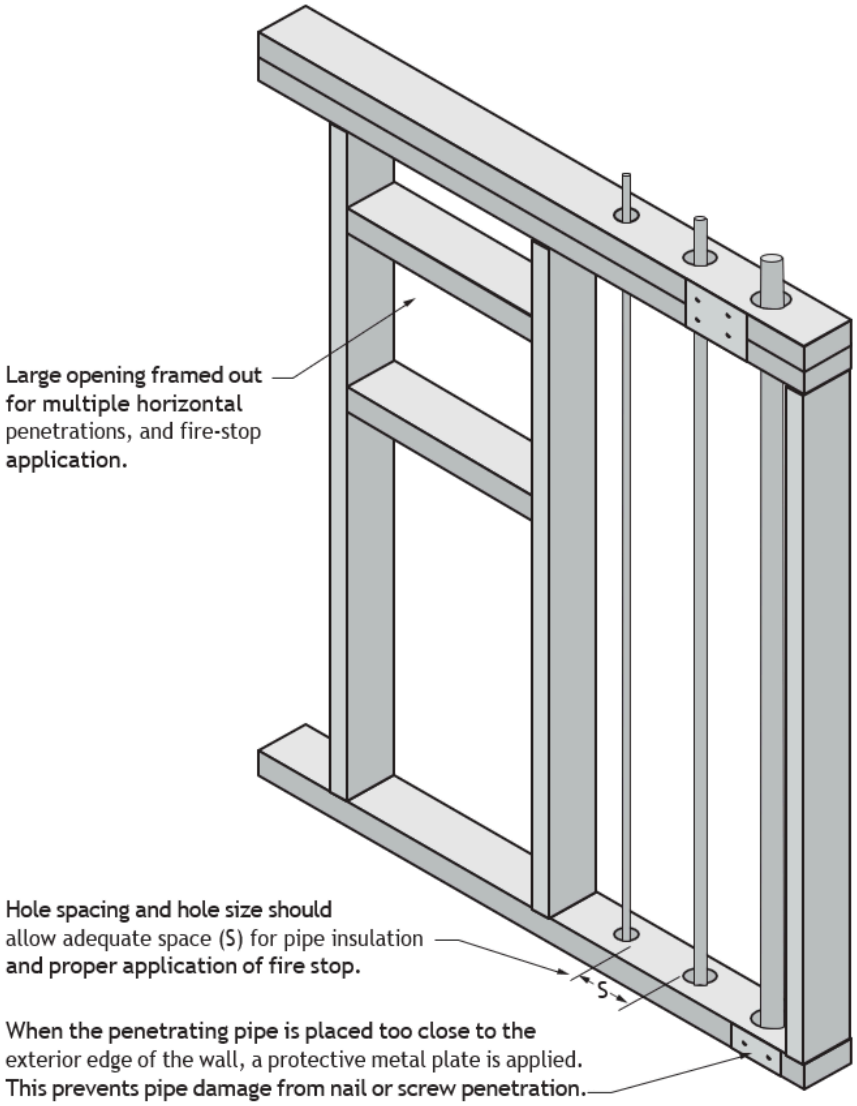


Figure 17 *Wood-framed wall hole location and protective metal plates* (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (*https://creativecommons.org/licenses/by-nc-sa/4.0/*)

When the penetrating pipe is placed too close to the exterior edge of the wall, a protective metal plate is applied. This prevents pipe damage from nail or screw penetration.

Where the plate and stud wall do not make up a fire separation, they are not affected by firestop requirements. In this situation, the recommended practice is to space the holes so that the minimum distance between them is the same as or larger than the largest adjacent pipe's diameter.

When a number of items are required to penetrate a fire separation, good practice dictates that they be spaced in such a manner that each penetrating item is surrounded by sufficient firestop material and separated by sufficient base construction material to ensure the stability and integrity of the firestop.

Sound Transmission Barrier Penetrations

Another important design feature in a structure is the elimination of ***sound transmission*** within the building. It is clear that an increase in sound transmission will occur when an opening is provided for the installation of piping. When sound transmission reduction is a component part of the structure then steps need to be taken to maintain the sound transmission integrity.

You need to identify the structural components that may require sound transmission reduction. Identifying locations where a sound barrier component is needed is not easy. Some things you need to look for include:

- Walls between occupancies (e.g., a library and a restaurant)
- Walls between a bathroom and an entertainment room

When pipe penetrates through or contacts a structural member that is acting as sound barrier, the structure's sound integrity can easily be destroyed. Pipe installed within a wall may not penetrate the wall; however, a pipe contacting a structure component can transmit and amplify sound throughout the structure. The use of sealed pipe sleeves, insulators, or ***vibration isolators*** can eliminate or reduce sound transmission. Avoid direct contact with the structural components.

Some visual indicators to help identify sound transmission barriers include:

- Walls with offset studs
- High-density insulation in interior walls
- Party walls between occupancies; these are usually double-stud wall fire separations containing a 25 mm (1 in.) air space between the stud walls
- Double layer of wall boarding
- Public corridor walls between the corridor and residential suites; these are usually single walls with smaller offset studs on a larger plate
- Firewalls and fire separations often have sound barrier qualities
- Floor assemblies between residential suites

To reduce sound transmission for vertically installed pipes, install the pipes as follows:

- In multi-storey buildings, install the piping in furred outer walls in front of double-stud walls, fire separations or party walls, or other interior walls; or
- Install the pipe in framed-out service spaces.

Note that wastewater flowing through an ABS pipe is considerably noisier than that flowing through a cast iron waste pipe.

For horizontally installed pipes in a multi-storey structure, install the pipe servicing the occupant unit located above within the rated floor assembly. Where possible, provide a false ceiling for services in the occupant unit below.

Typically, installing piping within or through walls, ceiling or floors will increase the possibility of sound penetration. You are responsible for maintaining the sound transmission prevention design integrity of a wall, ceiling or floor you are penetrating.

Protecting Pipe from Nail and Screw Damage

Figures 18 and 19 illustrate the proper application of pipe protection plates on studs where pipe is penetrating. When installing reinforcement on a stud surface, you must be aware of the thickness of the reinforcement plate. The thicker the plate, the more the wall finish will bulge, resulting in a product with a poor finish.

Figure 18 *Correct use of pipe protection plates (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figure 19 *Protection plate on a stud over an ABS pipe (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Residential Roof Penetrations

For new residential shingled roof applications, you would need to have the penetrating pipe installed before the roofing contractor arrives. You would supply the ***flashing*** and ***flashing cap***. Place the flashing over the pipe for the roofer. If a

flashing cap is required have that available for the roofer. The sealing of a pipe penetration is best left to the roofing contractor.

For existing shingled roofs, you may be required to waterproof the vent penetration. This may involve the use of counter flashing and waterproof sealing compounds. The plumbing code regulates the dimensions and material used for flashings as well as the size and distance above the roof that a vent pipe and flashing extend. In cold climates and conditions, the size of the penetrating vent pipe vent is increased. The increase in size helps prevent blockage caused by freezing over of the opening.

Figures 20 and 21 show vent pipe penetrations and flashings on sloped shingle roofs.

Figure 20 *Roof plumbing vent penetration, lead flashing* (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (*https://creativecommons.org/licenses/by-nc-sa/4.0/*)

Figure 21 *Roof plumbing vent penetration, poly flashing* (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (*https://creativecommons.org/licenses/by-nc-sa/4.0/*)

Wood Roof and Floor Trusses

The *BC Building Code* (https://www2.gov.bc.ca/gov/content/industry/construction-industry/building-codes-standards/bc-codes/2024-bc-codes#2024)advises that roof truss members (Figure 22) not be notched, drilled, or otherwise weakened unless such notching or drilling is allowed for in the design of the truss.

A roof or floor truss structural support should never be cut, drilled, notched or otherwise have its structural integrity jeopardized. It is a good idea for the piping installer to plan ahead for the routes that will be taken by the piping system. Conflicts with truss placement need to be solved before installing either trusses or piping.

Figure 22 *Wood roof truss (https://commons.wikimedia.org/wiki/File:Defense.gov_photo_essay_100713-A-5170O-167.jpg) (Sgt. Nicholas Olson/United States Army [ID (https://commons.wikimedia.org/wiki/Commons:VIRIN) 100713-A-5170O-167 (http://www.defense.gov/dodcmsshare/photoessay/2010-07/hires_100713-A-5170O-167a.jpg)]/Wikimedia Commons) Public Domain (https://en.wikipedia.org/wiki/public_domain)*

Metal Roof Trusses

Do not cut, drill, notch, or remove a truss or component from a ***metal roof or floor truss***.

Figure 23 *Metal roof and floor truss (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Metal Decking

At times, you will work on jobs that use metal trusses and ***metal decking***. Often the metal deck is covered with concrete. The floor is usually a fire separation. Firestopping and the installation of pipe sleeves or canning are often required.

Plumbing and mechanical system piping exiting through a roof require flashings to maintain structural integrity against moisture and rain penetration. Poor flashing installation or system design will increase the number of pipe penetrations and thus increase the possibility of jeopardizing the integrity of the roof structure. The trick here is to install the pipe through the roof and provide the flashing for the roofing contractor to install.

Penetrating Steel Columns and I-Beams

Steel columns and I-beams should not normally be cut or otherwise altered on the job.

Any holes required for pipe penetration should be done at the time of manufacturing. When holes are required in a beam or column, it is best to have them punched in the shop when the steel is fabricated.

Field holes may be cut in steel beams or columns; however, the approval of a structural engineer or competent architect would be required. Any holes would be cut in the middle third of the I-beam web. No holes are to be cut at all in the outer thirds of the beam. The hole may need to be reinforced. The specific holes should be approved by a design professional wherever they are to be cut, and they should be cut by a licensed welder.

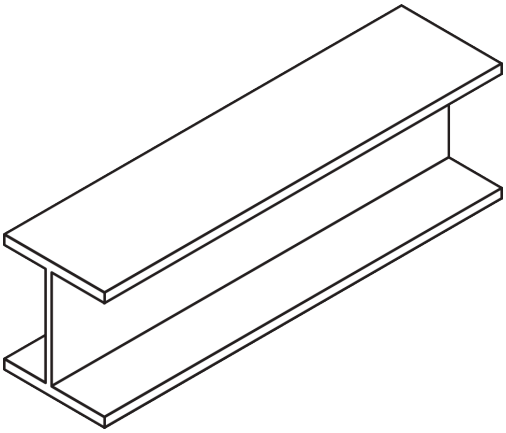


Figure 24 *Steel I-beam (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figure 25 shows an I-beam supporting a wood deck. Do not cut or notch either of these structural support components.

Figure 25 *Steel I-beam supporting a wood deck (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Penetrating Steel Wall Studs

Steel studs typically are supplied with a limited number of precut holes. Where precut holes are not useful, new holes can be cut with sheet metal snips or a hole-punch.

Piping penetrating steel stud walls that serve as fire separations will require firestopping. Pipe located within the wall may require isolation from the steel components. Sharp steel edges can physically damage the pipe, especially plastic piping such cross-link polyethylene (PEX). Copper piping needs to be isolated from contact with the steel studs to avoid damage that contact between dissimilar metals can cause. This can be accomplished by ***grommets*** or by wrapping with electrical tape. See Figures 26 and 27.

Concrete slab is a fire separation between upper and lower floors. Firestopping is required at all pipe penetrations.

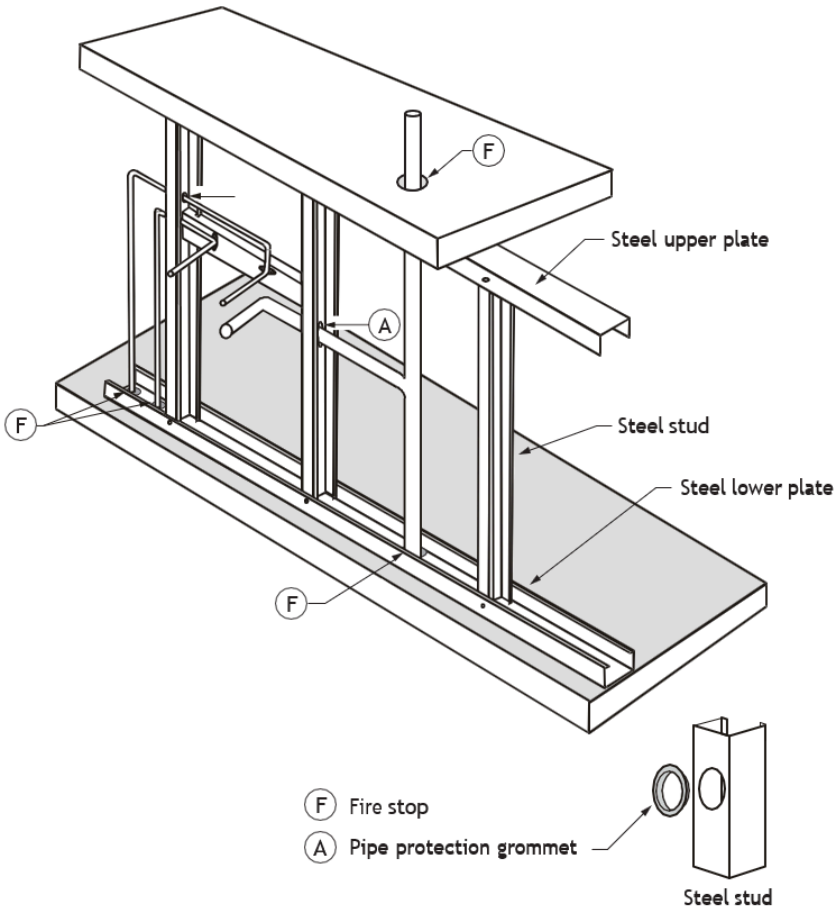


Figure 26 *Penetration of steel wall studs (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figure 27 *Plastic grommets (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Penetrating Concrete Walls and Concrete-block Walls

Piping penetrations of concrete or masonry walls may require insulation, waterproofing, firestopping or protective pipe wrap placed around the pipe penetration. These measures ensure the integrity of the wall being penetrated.

You must be aware of the location of the web portion and the hollow portion of a concrete masonry block wall. Any pipe passing through the wall will ideally penetrate the hollow portion of the concrete block and not the web.

Figures 28 shows a concrete block with pre-cut knock-outs which may be used to install a ***bond beam***.

When penetrating a concrete block wall after it has been constructed, you need to locate the hidden components before you drill. The concrete block wall cross-section in Figure 29 shows pipe sleeves, bond beam and hidden components. The bond beam ties together and strengthens the concrete block wall. It is located at the last or top course of blocks.

Figure 28 *Concrete block with bond beam pre-cuts (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

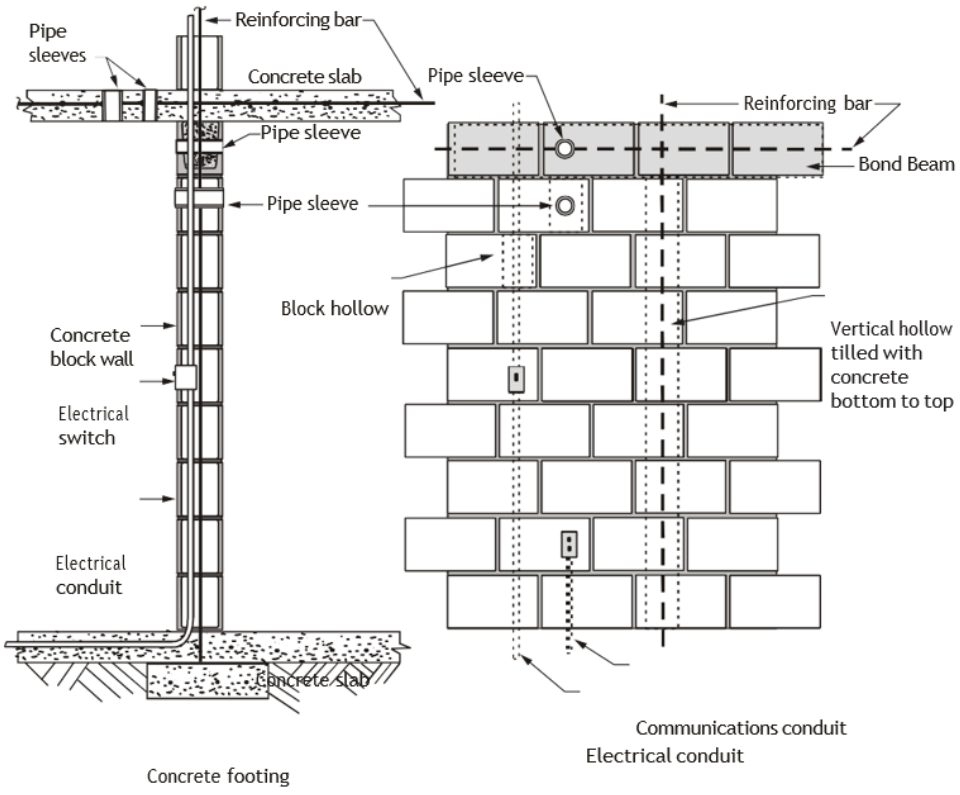


Figure 29 *Masonry concrete block wall with hidden components (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Concrete Construction Formwork

When you are working on a job site where there is concrete construction, you may be penetrating concrete walls, floors and roof structures with piping. Openings in a concrete structure for the purpose of installing pipe are usually cast into

the concrete by the use of pipe sleeves. This is done at the time of the concrete pour to avoid the expense of having to drill through the concrete after the concrete is cured.

Where holes need to be drilled in existing concrete, you need concrete drilling and breaking equipment and drill bits capable of cutting through ***rebar***. The mechanical contractor may have these tools. If not, they can be rented. Companies that specialize in concrete drilling/coring can also be contracted to perform this task.

Before drilling or breaking into an existing concrete wall, you need to do some investigation to locate hidden reinforcing bars, electrical conduit and communication cables buried in the concrete. To avoid contacting these hidden components, locate and review existing construction plans. The building owner or the local government building inspection authority may have original drawings. Look for electrical equipment mounted on a concrete wall or ceiling. The absence of surface-mounted conduit may indicate that conduit is buried in the concrete. Pipe-locating companies may have equipment to detect hidden components.

Figure 30 *Rebar, electrical conduit, pipes, and pipe sleeves ready to be buried in concrete* (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (*https://creativecommons.org/licenses/by-nc-sa/4.0/*)

Figure 31 shows a cross section of a concrete construction. Notice the hidden structural components and the use of pipe sleeves to penetrate the slab.

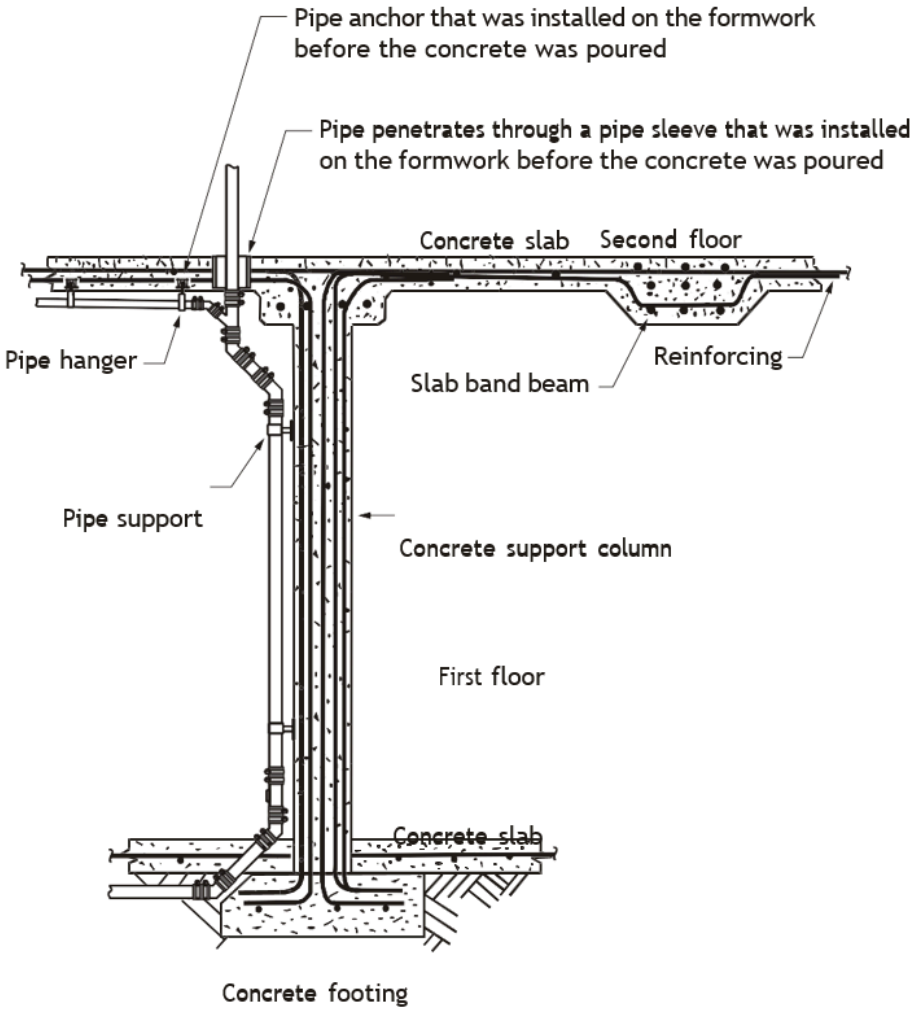


Figure 31 *Cross-section of basic structural components (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figure 32 *Pipe anchors (concrete hanger inserts) installed before the concrete is poured (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figures 33 and 34 give an idea of the work environment in buildings with concrete structural components. Figure 33 shows the formwork being installed in preparation for the first-floor concrete slab. The ***teleposts (telescopic)*** support the formwork and the weight when the slab is poured. After the concrete has cured the post will be systematically removed in stages. The photo in Figure 34 was taken from above the posts. You would install pipe sleeves on the deck before the concrete is poured.

Figure 33 *First floor formwork (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

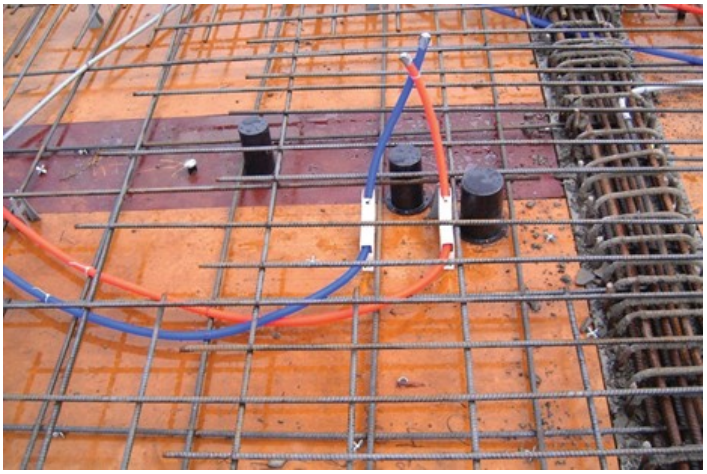
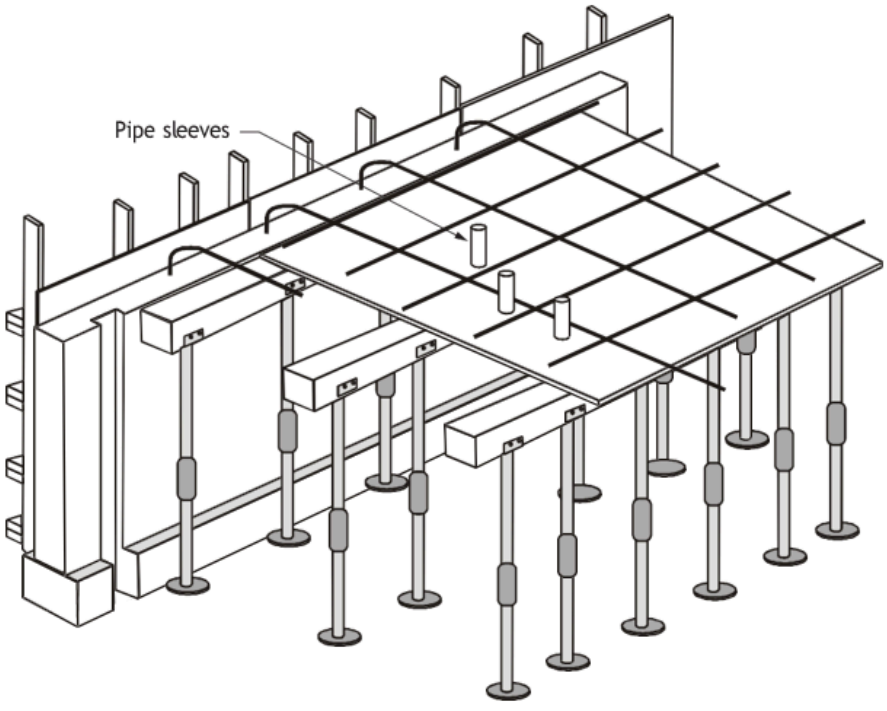


Figure 34 *Formwork from above jack posts (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figure 35 shows formwork for a foundation and the installation of pipe sleeves and ***block-outs.*** You would have located these sleeves and block-outs during this stage of construction.



Partial installation of post jacks support and deck not complete. Addition beams and cross bracing not shown. Pipe sleeve, water lines enclosed in sleeves, electrical conduit, reinforcing bar are all being installed. Timing of installation and accurate placement of these components is critical.

Figure 35 *Partially complete formwork for a concrete slab, showing pipe sleeves (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

As an alternate method of reinforcing concrete slabs with rebar, ***post-tension slabs*** can be installed. Cracking due to shrinkage is reduced and cracks that occur will be held together under the tension of the slab. Cables are installed in a slab before the concrete is poured. One end is anchored while the other end protrudes out the other side of the slab. These are referred to as ***tendons***.

When the concrete has come to an appropriate strength, the cable will be stretched, cut off and grouted in place. Safety becomes an issue when ***coring*** or drill post-tension slabs. Cut tendons can cause structural damage and injury or death to workers. Locating tendons before coring is a one of the first steps when penetrating a post-tension slab. Small openings can be made using a coring machine. Large penetrations (ex. duct shafts) may require concrete sawing. Consult with a professional engineer before penetrating a post-tension slab.

Pipe Sleeves

A ***pipe sleeve*** is a hollow, cylindrical insert placed in a wall, floor, structural component or ***concrete formwork*** to allow a pipe to penetrate the structure.

Pipe sleeves are short pipes or tubes that act as a conduit for pipe that passes through walls, ceilings, floors, foundations, footings, and so on. Sleeves allow the pipe to move through the partition free of building weight, abrasion, or corrosion. In concrete construction a sleeve placed in formwork before a wall or floor is poured is sometimes referred to as a *can*. The process of installing these sleeves is often called ***canning***.

The sleeve should be positioned to reflect the orientation of the pipe that will pass through it. A vertically installed pipe will require the pipe sleeve to be positioned vertically (plumb) above the formwork deck.

The term *pipe sleeve* also refers to protective pipe or tubing that surrounds a pipe carrying the fluid to be used. The sleeve protects the internal pipe from damage. Pipe sleeves may be used in corrosive ground conditions, concrete slabs, and under traffic ways. The pipe sleeve will allow the pipe to move freely and maintain a seal at the same time.

Fabrication of Pipe Sleeves (Pipe Chases or Block-Outs)

Pipe sleeves can be fabricated on the job site from materials such as steel, cast iron or plastic pipe, or from sheet metal. Pipe sleeves can also be purchased from a manufacturer as an assembly with firestop components. Pipe sleeves should be strong enough to resist the crushing weight of the surrounding building structure. The pipe should not normally bear weight or place any strain on the structure, unless the sleeve or pipe is designed to do so.

Placement of Pipe Sleeves

Multiple pipes penetrating a sleeve can create issues with application of pipe insulation, maintenance of proper clearances between pipe and the application of firestopping—**avoid this practice!**

Pipe sleeves are ideally positioned so the pipe and the sleeve are centred with each other. The clearance around the pipe and the sleeve is referred to as the annular space. The annular clearance is often specified in the manufacturer's firestop installation requirements.

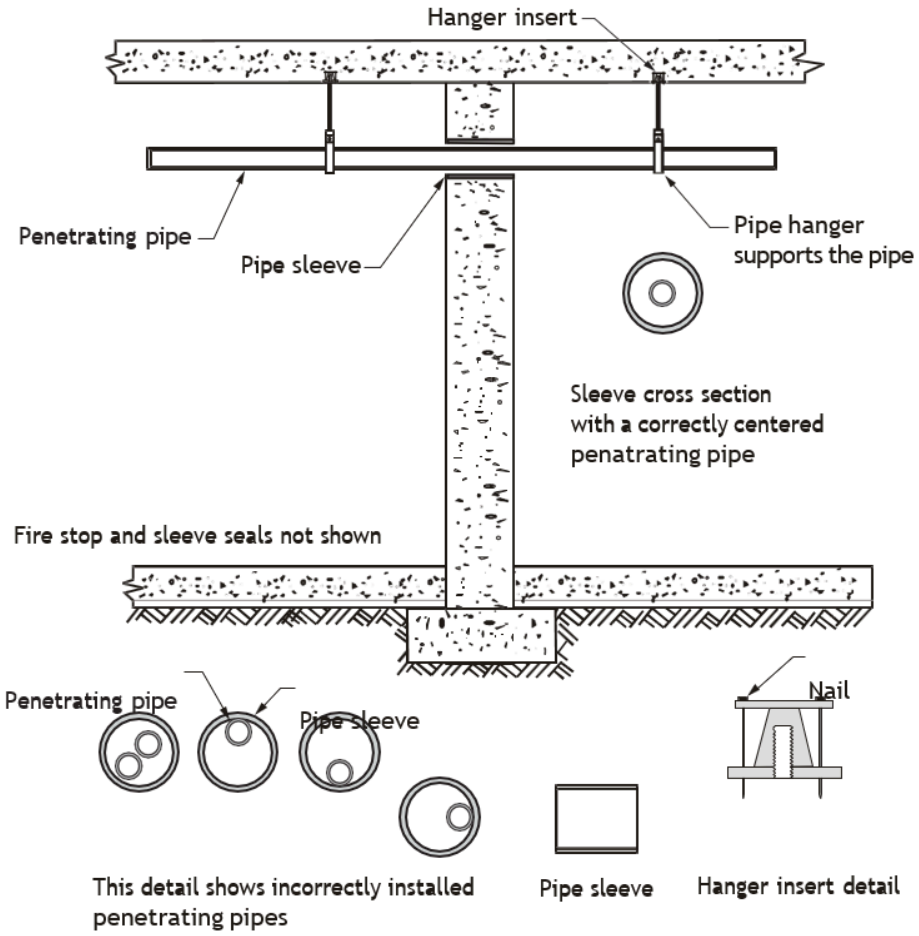


Figure 36 *Placement of pipe and pipe sleeve (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

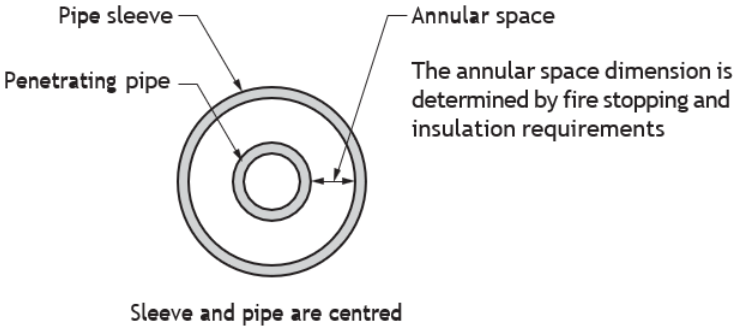


Figure 37 *Positioning of pipe within a pipe sleeve (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Timing of Sleeve Installation in Interior Walls

Often, interior framed walls are installed after the piping has been installed. Where needed, pipe sleeves would be slipped over the pipe as the pipe is being installed. When the wall is installed, the pipe sleeves are already on the pipe. The sleeve must be positioned to the centreline of the penetrating pipe. Pipe insulation or some other method could be used to centre the pipe sleeve at the time of the pipe installation. If you leave the centring of the pipe sleeve up to another trade, chances are it will not happen. You will be left to centre the sleeve later. If the installation of the wall has locked the sleeve into an off-centre position, you may have some difficulty trying to centre the sleeve.

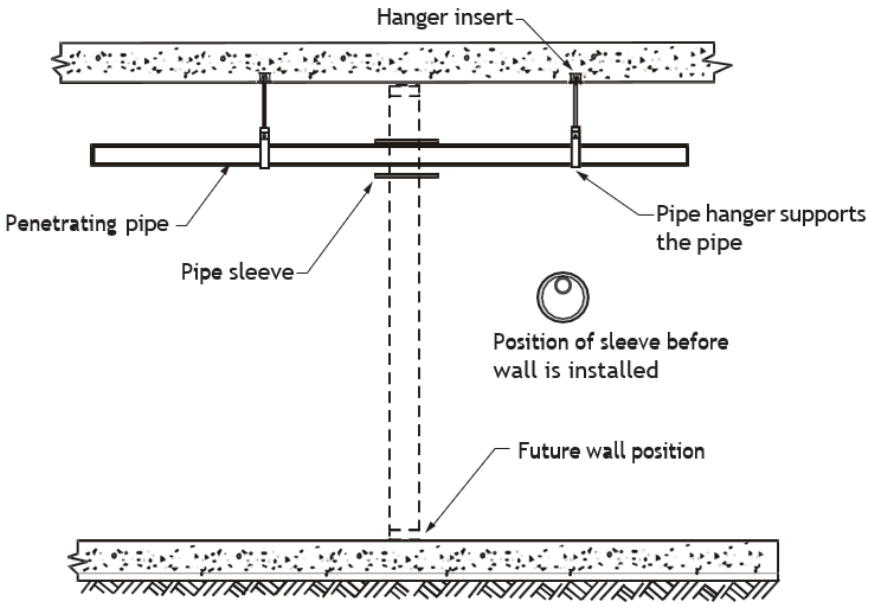


Figure 38 *Pre-positioning of pipe sleeve before wall is installed (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Sloped piping will require the sleeve to be sloped, or the sleeve must be sized large enough to allow the penetrating pipe to maintain slope through the sleeve.

Installing Sleeves in Deck Formwork (Canning)

Multi-storey, multi-unit office, and housing structures are often constructed with concrete floors and slabs for structural stability and load-bearing capacity. In these structures, a sleeve is a usually a length of pipe or tube that can be installed on or in concrete formwork before the concrete is poured. The sleeve provides an opening for pipe, conduit or communication cables after the concrete is cured.

Figure 39 shows examples of manufactured pipe sleeves that are installed during formwork for concrete structures. These sleeves are installed before the concrete is poured.

Figure 39 *Pipe sleeves (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Sizing of Pipe Sleeves

The diameter of a pipe sleeve depends on the following:

- External diameter of the penetrating pipe
- Allowances for expansion and contraction of the pipe
- Allowances for the application of pipe insulation
- Annular space required for firestopping components
- Water and or vapour penetration prevention
- Air movement, drafts

The length of the sleeve will depend on the thickness of the finished wall or floor. In some instances, the sleeve may extend beyond the thickness of the floor to prevent flooding on the surrounding floor. The sleeve may extend to accept a sealing boot (Figure 40).

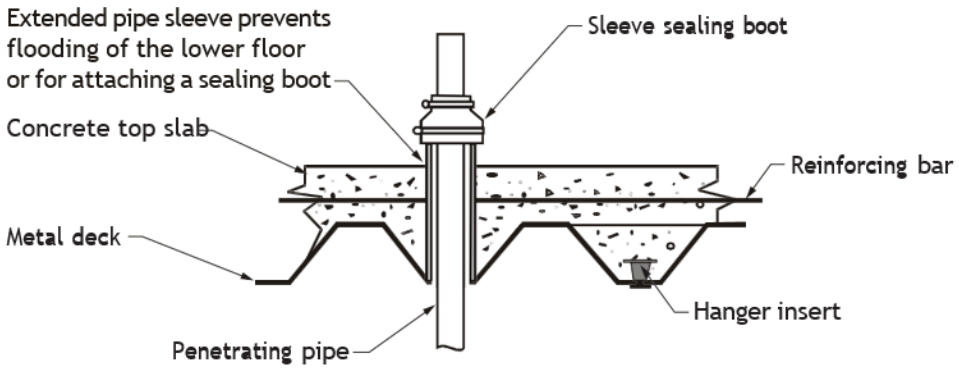


Figure 40 *Penetrating pipe with sleeve sealing boot (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Threaded inserts are installed on the formwork deck at the same time as the pipe sleeves. They remain solidly embedded in the concrete after it has cured. The inserts support pipes suspended from the underside of the concrete slab.

Timing of Installation of Pipe Sleeves

The timing of sleeve installation is important. Pipe sleeves are installed when the foundation formwork is being constructed, before concrete slabs or walls are poured. They are also installed during construction of walls, such as concrete block walls.

When the formwork for a concrete slab is completed, several trades will begin work on the deck. The best opportunity to install pipe sleeves is before the reinforcing bar is installed, when the deck is clear of obstructions.

Construction-site scheduling usually has deadlines for specific stages such as the pouring of the concrete. The trades must communicate and cooperate with each other while on the deck to ensure there is no conflict between the placement of the various components. This is an important time for the whole job. It is not a matter of first-come first-served.

Figure 41 *Pipe sleeves installed before reinforcing bar (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Positioning of Pipe Sleeves on Formwork

The correct positioning of pipe sleeves, block-outs and pipe support anchors is critical. Repositioning pipe sleeves after the concrete slab has set is costly and time consuming. Concrete walls and floors poured in place for multi-storey structures must be precisely positioned. Straight lines of pipe passing through a series of walls or floors will need pipe sleeves to line up perfectly from floor to floor or wall to wall. Bringing a pipe back into alignment can mean significant time and materials costs, so the alignment must be correct from the beginning.

Usually placement of a pipe sleeve (canning) would depend on the position of walls, structural beams and other building components. The sleeves are normally installed so that the penetrating pipe ends up in a wall. No walls are marked on the formwork deck. To be able to install the sleeve in the correct position, you will need to read the structure's blueprint and specifications first. The blueprint alone will not be enough to locate the position of a sleeve. You will need to talk to the job general supervisor or charge-hand. A reference mark or grid line should be established and marked on the deck. This reference mark can be used by the different trades to establish a baseline from which measurements can be established.

Once you have established the precise location of the sleeve, it can be attached to the deck. This measurement should be double-checked by the construction site supervisor. Laser-type levels are valuable assets for positioning sleeves and pipelines. String lines or chalk lines are used to establish a wall or other reference point on the deck; however, a caulk line does not last long in wet weather. The string line can be attached to the deck at one reference point, then stretched tight to another reference point on the deck.

Figure 42 shows a deck with string lines being used as a reference line to establish the position of the firestop pipe sleeves.

Figure 42 *String lines to locate sleeve positions (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Fastening Pipe Sleeves and Protection During the Concrete Pour

Field-cut pipe sleeves are anchored to the formwork deck using ***caddy clips***, which clip onto the sleeves (Figure 43). The pipe clips are positioned and securely nailed or screwed to the formwork. The clips can accommodate various sizes of pipe and wall thickness up to schedule 80.

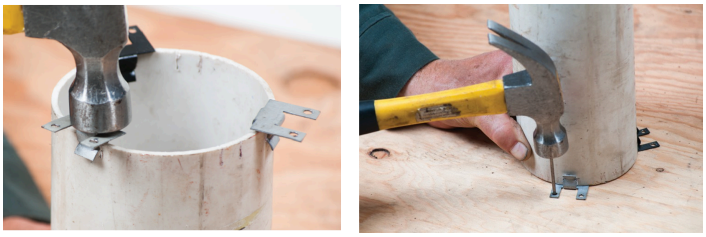


Figure 43 *Attaching pipe sleeves using caddy clips (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figure 44 *Caddy clips (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figures 45 and 46 illustrate working conditions and how the piping and pipe sleeves are protected and secured.

Figure 45 *Positioning water pipes before pouring concrete (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figure 46 *Pipe sleeve extensions used for thick concrete slabs (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Several turns of tightly applied duct tape can be used to attach a sleeve extension to an existing sleeve. The sleeve can be kept in a vertical position by attaching it to the reinforcing bar using tie wire.

During concrete pouring, activity on the slab deck can dislodge or damage pipe sleeves and hanger inserts. You must be present during the concrete pour to observe and be ready to make quick repairs or reposition and place any sleeves or hanger inserts that are disturbed. If this is not done promptly, the sleeve may not be suitable for use after the concrete has set.

Installing Pipe Penetrations After Concrete Has Set

Omitting a sleeve or incorrectly positioning it during the formwork leads to extra cost and wasted time because the concrete has to be drilled (cored) after the concrete has cured and the formwork has been stripped. Job profitability is jeopardized.

Normally you cannot simply break through a concrete slab or wall with jackhammer-type tools. Instead, the slab or wall will need to be cored with a rotary diamond-tipped core drill bit (Figure 47).

This type of drilling is usually done by specialized drilling companies using specialized concrete coring equipment. Electronic sensing equipment may be required to locate any hidden components before drilling.

Figure 47 *Diamond drill coring* (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (*https://creativecommons.org/licenses/by-nc-sa/4.0/*)

Sealing Around Sleeves

The openings created where pipes pass through walls and floors can cause problems by allowing water, smoke, fire, drafts, vapours, and sound to enter or pass freely within the structure. Pipe sleeves installed around the pipe may need to be sealed at one or both ends.

Pipe sleeves and the pipe seals installed in fire separations must be fire rated. The fire rating must be equal to the rating of the fire separation. Typically, a fire-rated seal will be made from graphite-impregnated (ethylene propylene-diene monomer). The pressure plates are made of steel. A silicone elastomer is used for penetration seals for temperature applications up to 204°C (400°F).

Pipe penetration seals are available in two types:

- Fixed penetration seals (Figure 48)
- Flexible penetration seals (Figure 48)

Fixed type seal

Pipe sleeve with flexible, watertight seal

Figure 48 *Pipe penetration seals (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Pipe ***sleeve seals*** provide positive seals around pipe sleeves above or below ground to keep out debris, water, and pests.

Sealants used between and around the pipe and sleeve include:

- Flexible caulking
- Masonry mortar
- Mechanical elastomer seals
- Quick-setting bonding cement mixtures
- Pipe wraps

Figure 49 shows various applications of pipe sleeve seals.

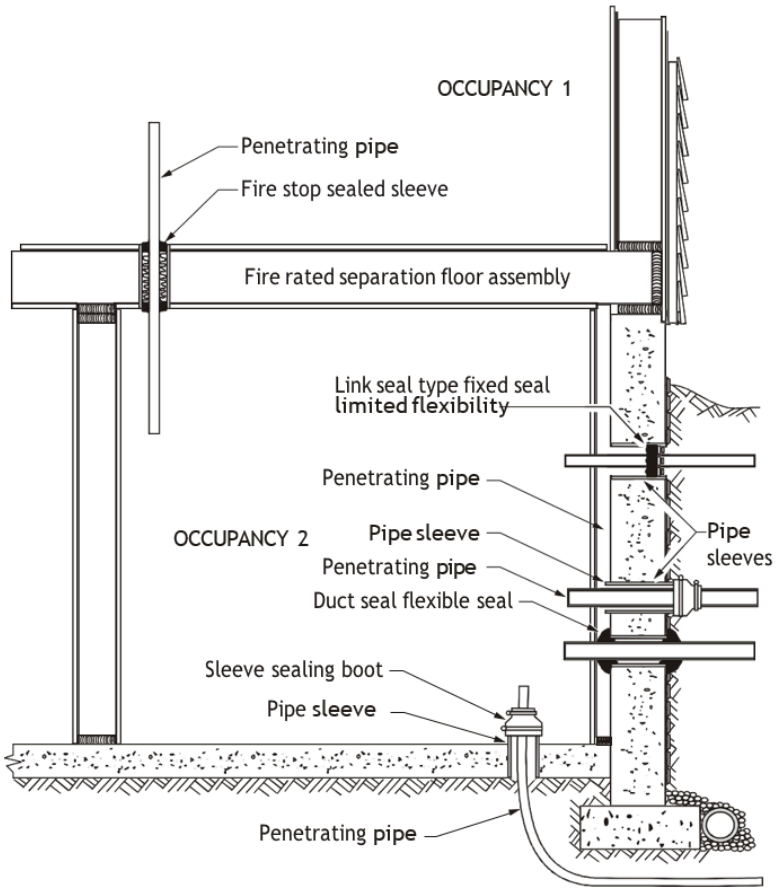


Figure 49 *shows various applications of pipe sleeve seals. (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Fixed Penetration Seals

Fixed penetration seals are suitable if flexibility is not needed. A fixed mechanical seal for general service can be made of EPDM (ethylene propylene-diene monomer), which is a synthetic rubber elastomer. Where the seal may come in contact with hydrocarbons, it may be made of nitrile. The pressure plates that hold the seal are generally made of glass-reinforced plastic

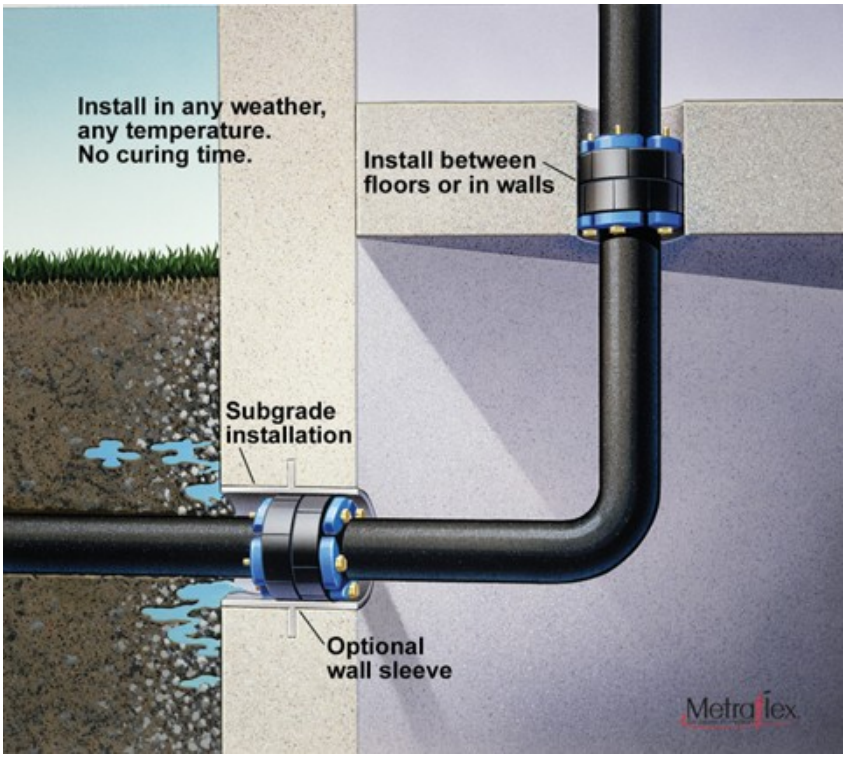


Figure 50 *Fixed penetration seal (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Flexible Penetration Seals

Flexible penetration seals are designed to close the pipe sleeve opening while allowing the pipe to move during operation. Flexible seals can absorb misalignments and angular penetrations.

Figure 51 shows a manufactured sleeve seal. This is a fast and economical way to seal a sleeve to a penetrating pipe. No other caulking is required.

Figure 51 *Flexible penetration sleeve seal (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figure 52 shows ***Pipetite sleeve boots*** designed specifically for sealing around tube-in-tube transitions. They provide good surface contact and eliminate the need for sealants, clamps or fasteners. Flexibility allows the pipes to move significantly without causing damage or breaking the seal. They also provide a finished look for exposed sleeves.

Figure 52 *Sleeve boots (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Sealing Below-Ground Pipe Penetrations and Isolating Groundwater

When pipes pass through foundations and slabs below ground level, unwanted moisture and vapour can enter the structure.

Problems caused by below-ground pipe penetration can include:

- Building and ground movement applying stress to the piping
- Moisture and water penetration
- Vapour penetration
- Expansion and contraction of piping and the foundation
- Corrosion of the piping

A properly placed pipe sleeve will help to avoid these problems. The pipe sleeve can allow some movement between the pipe and the foundation. The sleeve seal can reduce or prevent water penetration, and the application of a pipe wrap can prevent pipe corrosion and leakage through the penetration.

The methods of penetration and use of sleeves are supported by related codes and engineering practice. The following information is a summary only. Refer to each of the codes referenced for detailed requirements.

BC Plumbing Code Regulation

- Where piping passes through or under a wall it shall be installed so the wall does not bear on the pipe.

Gas Code Regulations

- Piping or tubing entering a building shall rise above grade before entry unless otherwise permitted by the authority having jurisdiction. (Gas piping should not enter the building from underground.)
- When gas piping is run in a sleeve, the sleeve shall be of such material and so installed as to protect the piping or tubing from damage and galvanic action.
- When gas piping or tubing passes through an exterior wall above ground, it shall be sealed watertight and the portion of piping that runs through the wall shall be sleeved or double wrapped with a waterproof wrap.

Fire Sprinkler Code

- Clearance shall be provided around all piping extending through walls, floors, platforms and foundations, including drains, fire department connections and other auxiliary piping.
- Unless other code requirements allow no clearance, where pipe passes through holes in platforms, foundations, walls or floors, the holes shall be sized such that the diameter of the holes is nominally 2 in. (50 mm) larger than the holes for pipe 1 in. (25 mm) nominal to 3 $\frac{1}{2}$ in. (90 mm) nominal, and 4 in. (100 mm) larger than the holes for pipe 4 in. (100 mm) nominal and larger.
- Where clearance is provided by a pipe sleeve, a nominal diameter 2 in. (50 mm) larger than the nominal diameter of the pipe shall be acceptable for pipe sizes 1 in. (25 mm) through 3 $\frac{1}{2}$ in. (90 mm), and the clearance provided by a pipe sleeve of nominal diameter 4 in. (100 mm) larger than the nominal diameter of the pipe shall be acceptable for pipe sizes 4 in. (100 mm) and larger.

Waterproof Pipe Wraps

When piping passes through a pipe sleeve, you must consider the type of materials the sleeve and the pipe are made from. For example, when a copper water line passes through a metal pipe sleeve, the following concerns arise:

- Contact between copper and a dissimilar metal
- Direct contact with the concrete

Contact between copper pipe and a steel pipe sleeve can result in damage to the copper pipe due to erosion caused by electrolysis. A plastic PVC or ABS sleeve can prevent damage caused when metal pipe contacts a pipe sleeve made of a dissimilar metal. Suitable pipe wraps can also be used.

Copper or any metal pipe that is going to be installed directly into concrete must be protected from contacting the concrete with a suitable pipe wrap or flexible continuous pipe sleeves.

Pipe wraps are mainly used to insulate, seal or protect piping from damage. Several manufacturers specialize in pipe wraps for specific jobs, including waterproofing, maintenance and sealing repairs. There are pipe wraps to suit just about any purpose, and there are many available for sealing and protecting pipe penetrations through concrete foundations.

Procedures for applying these products vary; therefore you should read and follow the manufacturer's installation procedures.

Following is a generic example of a manufacturer's instructions for applying waterproof pipe wrap sealant.

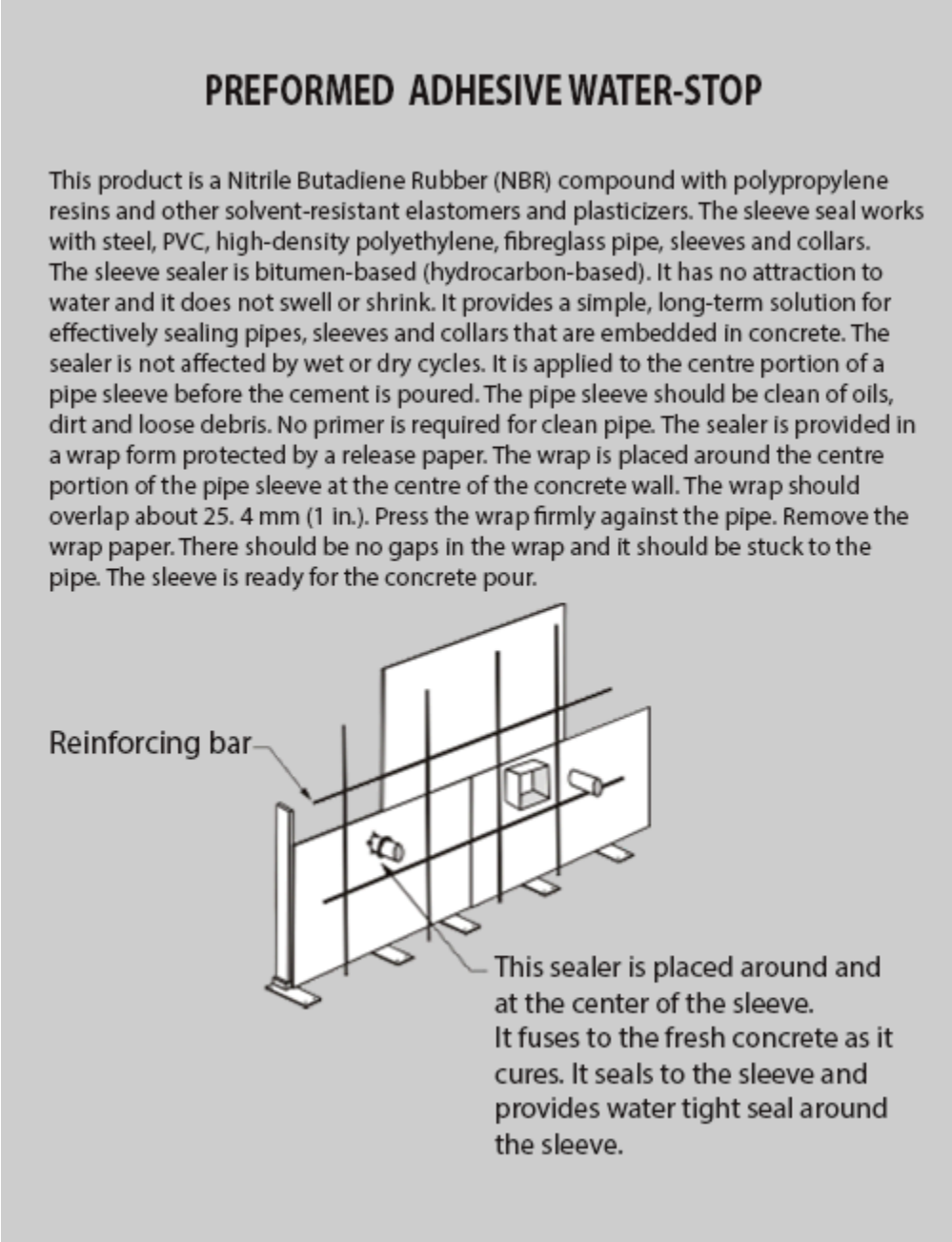


***Figure* 53** *Application of waterproof pipe wrap* (BC *Industry Training Authority*, 2019). CC BY-NC-SA 4.0 (*https://creativecommons.org/licenses/by-nc-sa/4.0/*)

Pipe Movement

The penetrating pipe is not likely to stay perfectly centred in the sleeve once ***backfill*** is placed over the pipe. The pipe can be pushed up against the sleeve wall. Any movement of the pipe against the sleeve can cause abrasions on the pipe. Continued movement caused by expansion and contraction or vibrations over time can cause the pipe wall to fail. The application of a pipe wrap is essential to prevent such damage.

Methods of keeping the pipe centred in a pipe sleeve include:

- Foam type insulation

Figure 54 PMR *(https://commons.wikimedia.org/wiki/File:PMR_63x5.8_125_file2.jpg) by Sönke Kraft aka Arnulf zu Linden (https://commons.wikimedia.org/wiki/User:Arnulf_zu_Linden) from Wikimedia Commons*

- Expanding spray foams

Figure 55 *Insulation (https://pixabay.com/photos/insulation-izolacja-pur-2389795/) by justynkalp (https://pixabay.com/users/justynkalp-3428771/?utm_source=link-attribution&utm_medium=referral&utm_campaign=image&utm_content=2389795) from Pixabay*

- Fibreglass pipe insulation

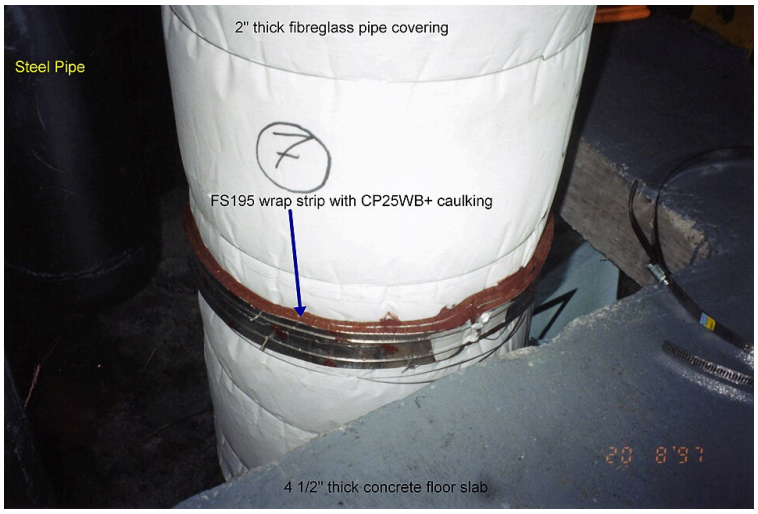


Figure 56 *Fiberglass pipe covering (https://commons.wikimedia.org/wiki/File:Fs195_cp25_fibreglass_pc.jpg) by Achim Hering (https://commons.wikimedia.org/wiki/User:Achim_Hering) from Wikimedia Commons*

- Fabricated centring devices within the sleeve
- Proper support of the pipe independent of the pipe sleeve penetration
- Firestopping

If no sleeve is used, you will need to consider the effect of contact between the copper pipe and concrete or masonry mortar. Direct burial of a copper water line in concrete will cause the copper to corrode.

Sealing Around Boxed-Out Openings

Pipe penetrations through concrete walls including foundations can be boxed out before the concrete is poured or broken out after the concrete is poured. These boxed-out or broken-out holes are usually rectangular or irregularly shaped. Sealing a pipe penetration through a large, irregularly shaped hole becomes a challenge. The chance of finding a supplier of a manufactured seal to fit the hole is slim. If you are working on a job site, there may be a set of specifications and drawings with instructions for how to seal the pipe penetrations. You may also need to research manufacturers that make a product that will do the job.

Two examples of such products are Synko-Flex and Hydro-Flex ***waterstops***, manufactured by the Henry Company (https://www.henry.com/commercial/products/waterstops/hydrophobic/synko-flex-waterstop/). These provide a watertight seal in reinforced construction cold joints, cast-in-place applications, and through-wall penetrations.

Compatibility of Sealants and Pipe Materials

Pipe sealants such as pipe wraps and coatings can react with the piping they are intended to protect. PE and PEX have been known to let petroleum-based products to leach through the pipe walls and contaminate the water inside the pipe. Waterproofing emulsions form release agents and should not be allowed to contact this plastic pipe.

Firestop system manufacturers test firestop sealants and other components for compatibility with specific types of pipe. The sealants may not be compatible with every type of pipe material they come in contact with. Check with the manufacturer to ensure that the pipe sealants and wraps, including firestop sealant, are compatible with the type of pipe material being used.

Self-Test D-4.1: Describe Factors Affecting Penetrations in Structures

Complete Self-Test 4.1 and check your answers.

If you are using a printed copy, please find Self-Test D-4.1 (#chapter-self-test-d-4-1-describe-factors-affecting-penetrations-in-structures) and Answer Key (#chapter-answer-key-self-test-d-4-1) in the Appendix at the end. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-pipingcomponents-bcplumbingapprl1.pressbooks.tru.ca/?p=2149#h5p-11 (https://d-pipingcomponents-bcplumbingapprl1.pressbooks.tru.ca/?p=2149#h5p-11)

References

BC Industry Training Authority. (2019). *Piping trades apprenticeship program: Use Tools and Equipment—Level 1 harmonized* [Binder]. Crown Publications, Queen's Printer for British Columbia. https://www.crownpub.bc.ca/Product/Details/7960000261_S

- Describe factors affecting penetrations in structures
- Plumber: Competency D-6 Penetrate Structures
- Steamfitter: Competency D-3 Penetrate Structures

Henry Company. (n.d.). *Synko-Flex waterstop*. https://www.henry.com/commercial/products/waterstops/hydrophobic/synko-flex-waterstop/

Province of British Columbia. (2025). *BC Building Code 2024*. Government of British Columbia. https://www2.gov.bc.ca/gov/content/industry/construction-industry/building-codes-standards/bc-codes/2024-bc-codes#2024

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- **Figure 22** Wood roof truss, (https://commons.wikimedia.org/wiki/File:Defense.gov_photo_essay_100713-A-5170O-167.jpg) by Sgt. Nicholas Olson of the United States Army (ID (https://commons.wikimedia.org/wiki/Commons:VIRIN) 100713-A-5170O-167 (http://www.defense.gov/dodcmsshare/photoessay/2010-07/hires_100713-A-5170O-167a.jpg)) from Wikimedia Commons, is in the public domain. (https://en.wikipedia.org/wiki/public_domain)
- **Figure 54** PMR 63×5.8 125 file2 (https://commons.wikimedia.org/wiki/File:PMR_63x5.8_125_file2.jpg) by Sönke Kraft [aka Arnulf zu Linden] from Wikimedia Commons is used under a CC BY-SA 3.0 (https://creativecommons.org/licenses/by-sa/3.0/deed.en) license.
- **Figure 55** Insulation (https://pixabay.com/photos/insulation-izolacja-pur-2389795/) by justynkalp from Pixabay is used under the Pixabay Content License (https://pixabay.com/service/license-summary/).
- **Figure 56** Fiberglass pipe covering [Fs195 cp25 fibreglass pc (https://commons.wikimedia.org/wiki/File:Fs195_cp25_fibreglass_pc.jpg)] by Achim Hering from Wikimedia Commons has been released into the public domain (https://en.wikipedia.org/wiki/en:public_domain) by its author.

D-4.2 Describe Acceptable Methods of Structure Penetration

In D-4.1 Describe Factors Affecting Penetrations in Structures (#chapter-d-4-1-describe-factors-affecting-penetrations-in-structures), you learned about methods for installing piping through structural components, including walls, floors, concrete foundations, and slabs. You should now be able to identify fire separations. Pipe often penetrates into or through, or is installed in, a fire separation. These pipe penetrations must be firestopped to ensure the integrity of the fire separation. In this section, you will learn to identify firestop materials and the various methods of firestopping pipe penetrations.

The spread of fire in a structure is a major concern. To prevent, stop, or slow down the spread of fire, building codes have included requirements regulating fire suppression, firewalls, fire separations, and firestops. Piping systems installed in the building often pass into or through firewalls, fire separations, and firestops. It is critical that the fire safety of the fire separation not be compromised by the piping systems.

Fire separations, firewalls, and firestops are integral parts of a building. It is important that the piping trade worker become familiar with these components and the installation of piping in, through, and around them. The building code has many regulations regarding fire separations that go far beyond the scope of this program. At Level 1, we will look at some of the basic applications of fire separations and the basic regulations regarding the installation of piping systems.

Firestopping Definitions

ablative: Resisting heat transfer by using the heat of the exposing fire to erode the material. The material, by sacrificing itself, protects the unexposed side from rapid temperature rise until it is spent. A typical example is a silicon-based firestop material.

active fire protection: Fire protection in which the equipment, components, or systems physically move to some extent when performing their design functions.

Examples of active fire-protection systems are:

- Fire sprinkler systems
- Fire suppression systems
- Fire detection systems

annular space: The space between a penetrating item and whatever surrounds it, such as the sides of an opening or a sleeve.

closure: A device or assembly for closing an opening through a fire separation or an exterior wall, such as a door, shutter, wired glass, or glass block. Includes all components such as hardware, closing devices, frames, and anchors.

compartmentalization: A method of building structure that divides the building into individual compartments for the purpose of limiting the spread of fire.

draft stop: A material intended to stop air movement and fire spread.

endothermic: A process or reaction that absorbs energy in the form of heat.

exothermic: A process or reaction that releases energy in the form of heat. The opposite of endothermic.

F rating: Abbreviation of *flame* or *fire* rating. Prevents flame transfer only.

FH rating: Abbreviation of *fire and hose* rating. Prevents passage of flame and fire hose stream.

FP rating: Abbreviation of *fire-protection rating*. The time in minutes or hours that a closure will withstand the passage of flame when exposed to fire under specified conditions of test and performance criteria, or as otherwise prescribed in the building code.

FR rating: Abbreviation of *fire-resistance rating*. The time in minutes or hours that a material or assembly of materials will withstand the passage of flame and the transmission of heat when exposed to fire under specified conditions of test and performance criteria, or as determined by extension or interpretation of information derived from or as prescribed in the building codes.

FT rating: Abbreviation of *fire and temperature* rating. Prevents transfer of flame and high temperatures.

fireblock: A material, component or system installed in a concealed space in a building to restrict the spread of fire, and often smoke, in that concealed space or from that concealed space to an adjacent space.

firestop backing: An approved material such as mineral wool or a foam-backing rod to keep the firestop caulking in place while the firestop material sets.

fire stopping: (sometimes referred to as *firestop*, *fire-block* or *draft stop*) A material, component or system, and its means of support, used to fill gaps between fire separations and other construction assemblies, or used around items that wholly or partially penetrate fire separations, to restrict the spread of fire and often smoke, thus maintaining the integrity of a fire separation.

FTH rating: Abbreviation of *fire, temperature and hose*. Prevents passage of flame, temperature and fire hose stream.

fire compartment: An enclosed space in a building that is separated from all other parts of the building by an enclosing construction that provides a fire separation having a required fire-resistance rating.

fire damper: A closure consisting of a damper installed in an air-distribution system or in a wall or floor assembly, which is normally held open but is designed to close automatically in the event of a fire in order to maintain the integrity of the fire separation.

fire detector: A device that detects a fire condition and automatically initiates an electrical signal to actuate an alert signal or alarm signal. Includes heat detectors and smoke detectors.

fire load: As applied to an occupancy, the combustible contents of a room or floor area expressed as the average weight of combustible materials per unit area from which the potential heat liberation may be calculated based on the calorific value of the materials. Includes the furnishings, finished floor, wall and ceiling finishes, trim, and temporary and movable partitions.

fire-retardant treated wood: Wood or a wood product that has had its surface-burning characteristics, such as flame spread, rate of fuel contribution, and density of smoke developed, reduced by impregnation with fire-retardant chemicals.

firestop flap: A device that operates to close off a duct opening in a horizontal assembly that is required to have a fire-resistance rating and to incorporate protective ceiling membranes.

flame-spread rating: An index or classification indicating the extent of spread-of-flame on the surface of a material or an assembly of materials as determined in a standard fire test as prescribed in the NBCC.

intumescent: A substance that swells as a result of heat exposure, thus increasing in volume and decreasing in density. An intumescent is typically used in passive fire protection. (firestop)

listed firestop system: A specific construction consisting of materials, any penetrating items and their means of support that has met the requirements for an F, FT, FH and/or FTH rating when tested in a fire resistance.

monolithic: A large section of concrete floor construction completed in a single concrete pour.

passive fire protection: Fire protection that attempts to contain fires or slow the spread of fire by dividing the building structure into compartments separated by fire-resistant wall assemblies, floor assemblies and doors. These are designed to keep fires, high temperatures and flue gases within the compartment where the fire originated.

penetrant: Something that penetrates; for example, the mechanical, electrical or structural items that pass through an opening in a wall or floor, such as pipes, conduits, cables, ducting, etc.

Building Code and Fire Code

The building code and fire code each contain provisions that deal with the safety of persons in buildings in the event of a fire and the protection of buildings from the effects of fire. The fire code also applies to other operations besides buildings, such as tank farms and storage yards.

The building code and the fire code have been developed as complementary to one another. This minimizes the possibility of containing conflicting provisions. The building code covers the fire safety and fire-protection features that are required to be incorporated in a building at the time of its original construction. The fire code includes intumescent materials provisions for the ongoing maintenance and use of the fire safety and fire-protection features incorporated into buildings.

The building code sets out technical provisions for the design and construction of new buildings. The code also applies to the alteration, change of use, and demolition of existing buildings. Where piping systems are installed, the provisions of the building code must be complied with, including those for the penetration of structural components. As a piping trade worker, you must become familiar with the code regulations as they relate to your trade.

It is expected that buildings comply with both the building code and the fire code. At some point during your career you will need to reference these codes in some detail.

As you proceed through your training you will learn more about reading, interpreting, and applying code regulations related to your specific piping trade.

Manufacturers' Literature

Manufacturers' specifications and job site and construction specifications must be followed. The installation of firestop systems and the penetration of piping through structural components often involve the manufacturer's design installation.

Your Responsibility

It is important that you follow the installation instructions, related code requirements, and construction specifications. Failure to follow the manufacturers' instructions usually releases them from the responsibility for their product. Responsibility would then transfer to you, the installer, when the product fails to do its job.

Simply put, you are installing pipe and equipment in buildings. In the process, you are drilling holes and cutting into or through structural members, many of which are fire separations. You can effectively destroy the fire-resistance rating of a passive fire-protection system. It is your responsibility to ensure that the penetration of structural components of a building does not compromise the fire rating by ensuring the use of approved firestopping methods.

The following examples of manufacturers' drawings and specifications are for illustration purposes only. On the job, you must use the drawings and specification supplied directly from the manufacturer.

Review the examples carefully. Pay close attention to the individual components and how to interpret the important notes provided.

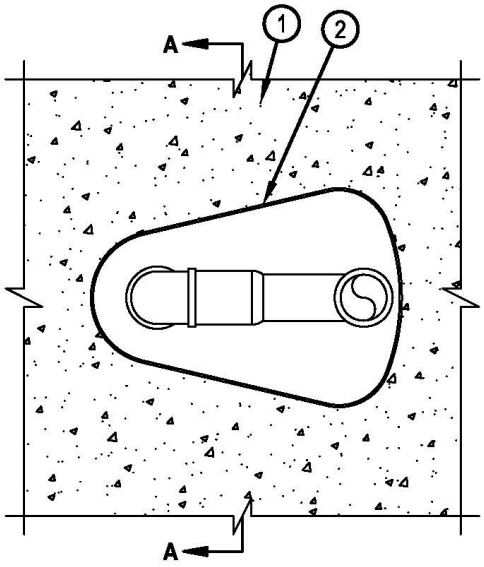
Classified by
Underwriters Laboratories, Inc.
to CAN/ULC-S115

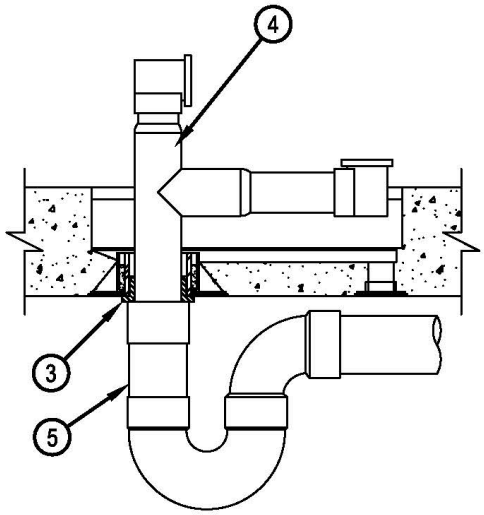
System No. F-A-1003

F Rating -- 2 Hr
FT Rating -- 0 Hr
FH Rating -- 0 Hr
FTH Rating -- 0 Hr

CANADA ONLY

FA 1003





SECTION A-A

System tested with a pressure differential of 50 Pa between the exposed and the unexposed surfaces with the higher pressure on the exposed side.

1. Floor Assembly – Min 114 mm (4-1/2 in.) thick reinforced lightweight or normal weight 1600-2400 kg/cu m (100-150 pcf) concrete.
2. Firestop Device*- Tub Box – Nom 216 by 305 by 51 mm (8-1/2 by 12 by 2 in.) deep acrylonitrile butadiene styrene (ABS) tub box with adjustable legs and intumescent coupling. Cast in place firestop device attached to form and permanently embedded during concrete placement or grouted in concrete assembly in accordance with accompanying installation instructions. Min concrete thickness of 51 mm (2 in.) shall be maintained below tub box.

   HILTI CONSTRUCTION CHEMICALS, DIV OF HILTI INC -- CP 681 Tub Box Kit
3. Tub Box Seal -- Elastomeric tub box seal (supplied with tub box kit) sized to accommodate 38 mm (1-1/2 in.) brass waste/overflow fitting. Seal seated from bottom within device coupling.
4. Waste/Overflow Fitting -- Nom 38 mm (1-1/2 in.) diam brass waste/overflow fitting installed through device coupling and seal.
5. Drain Piping -- Nom 51 mm (2 in.) diam Schedule 40 polyvinyl chloride (PVC) cemented together and secured to waste/overflow fitting with a compression coupling. Drain piping rigidly supported away from tub box with suitable hangers.

5A. Alternate Drain Piping -- (Optional - Not Shown) - Nom 51 mm (2 in.) diam cast iron P trap secured to PVC waste/overflow fitting with a compression coupling. Drain piping rigidly supported away from tub box with suitable hangers.

*Bearing the UL Classification Mark

Hilti Firestop Systems

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Underwriters Laboratories, Inc.
September 09, 2005

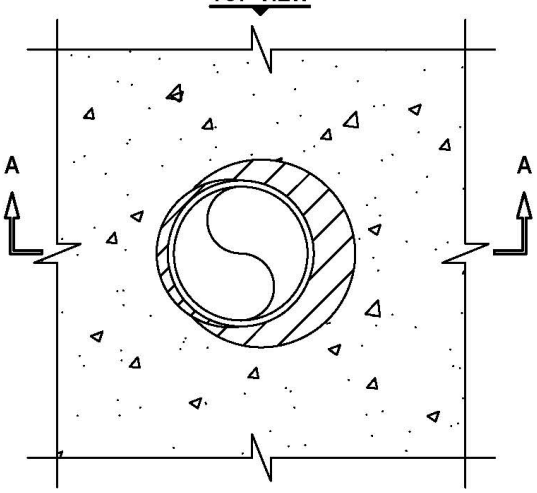
UL/cUL SYSTEM NO. C-AJ-1435

METAL PIPE THORUGH CONCRETE FLOOR/WALL OR BLOCK WALL

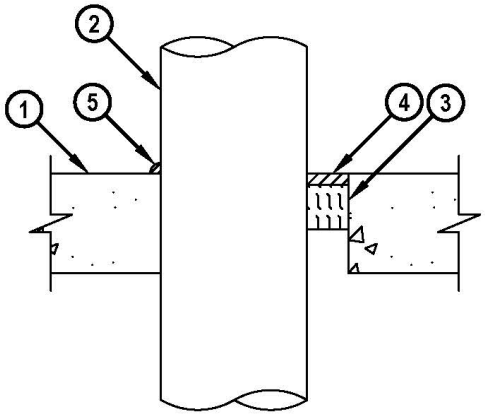
F-RATING = 2-HR.
T-RATING = 0-HR.
L-RATING AT AMBIENT = LESS THAN 1 CFM/SQ. FT.
L-RATING AT 400°F = LESS THAN 1 CFM/SQ. FT.

CAJ1435c.081110

TOP VIEW



SECTION A-A



1. CONCRETE FLOOR OR WALL ASSEMBLY (2-HR. FIRE-RATING) :
   A. LIGHTWEIGHT OR NORMAL WEIGHT CONCRETE FLOOR OR WALL (MINIMUM 4-1/2" THICK).
   B. ANY UL/cUL CLASSIFIED CONCRETE BLOCK WALL.
2. PENETRATING ITEM TO BE ONE OF THE FOLLOWING :
   A. MAXIMUM 30" NOMINAL DIAMETER STEEL PIPE (SCHEDULE 10 OR HEAVIER).
   B. MAXIMUM 30" NOMINAL DIAMETER CAST OR DUCTILE IRON PIPE.
   C. MAXIMUM 6" NOMINAL DIAMETER COPPER PIPE.
   D. MAXIMUM 6" NOMINAL DIAMETER STEEL CONDUIT.
   E. MAXIMUM 4" NOMINAL DIAMETER EMT.
3. MINIMUM 2" THICKNESS MINERAL WOOL (MIN. 4 PCF DENSITY) TIGHTLY PACKED.
4. MINIMUM 1/2" DEPTH HILTI CP 606 FLEXIBLE FIRESTOP SEALANT.
5. MINIMUM 1/2" BEAD HILTI CP 606 FLEXIBLE FIRESTOP SEALANT AT POINT OF CONTACT.

NOTES : 1. MAXIMUM DIAMETER OF OPENING = 31-7/8".
2. ANNULAR SPACE = MINIMUM 0", MAXIMUM 1-7/8".
3. MINIMUM 1/2" DEPTH HILTI CP 606 FLEXIBLE FIRESTOP SEALANT IS REQUIRED ON BOTH SIDES OF A WALL ASSEMBLY.

Hilti Firestop Systems	HILTI, Inc. Tulsa, Oklahoma USA (800) 879-8000	Sheet 1 of 1 Scale 5/32" = 1" Date Aug. 11, 2010	Drawing No. CAJ 1435c

Saving Lives through Innovation and Education

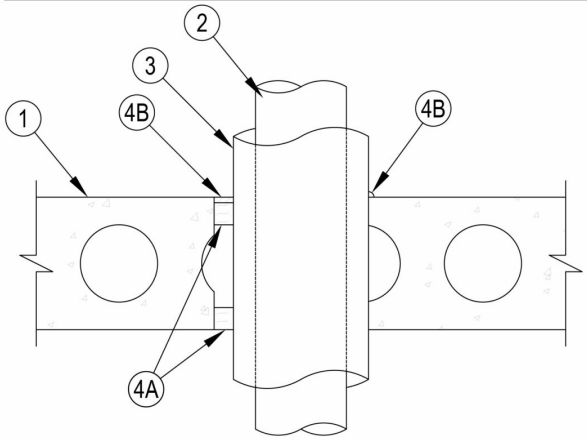
Deck and Bulkhead Penetration

CBJ 5013

Classified by
Underwriters Laboratories, Inc.
to UL 1479 and CAN/ULC-S115

System No. C-BJ-5013

ANSI/UL1479 (ASTM E814)	CAN/ULC S115
F Rating - 2 Hr	F Rating - 2 Hr
T Rating - 1 Hr	FT Rating - 1 Hr
	FH Rating - 2 Hr
	FTH Rating - 1 HR



1. Floor Assembly — Min 8 in. (203 mm) thick reinforced lightweight or normal weight (100-150 pcf or 1600-2400 kg/m3) concrete. Floor assembly may also be constructed of any 8 in. (203 mm) thick UL Classified hollow-core Precast Concrete Units*. Max diameter of opening is 7 in. (178 mm).
   See Precast Concrete Units CFTV) category in the Fire Resistance Directory for names of manufacturers.
2. Through Penetrants — One metallic pipe or tube to be installed concentrically or eccentrically within the firestop system. Annular space between pipe or tube and edge of opening to be min 0 in. (point contact) to max 7/8 in. (22 mm). Pipe or tube to be rigidly supported on both sides of floor-ceiling assembly. The following types and sizes of metallic pipes or tubes may be used:
   A. Steel Pipe — Nom 4 in. (102 mm) diam (or smaller) Schedule 10 (or heavier) steel pipe.
   B. Copper Tubing — Nom 4 in. (102 mm) diam (or smaller) Type L (or heavier) copper tubing.
   C. Copper Pipe — Nom 4 in. (102 mm) diam (or smaller) Regular (or heavier) copper pipe.
3. Pipe Covering Materials* — Nom 1 in. (25 mm) thick hollow cylindrical heavy density (min 3.5 pcf or 56 kg/m3) glass fiber units jacketed on the outside with an all service jacket. Longitudinal joints sealed with metal fasteners or factory-applied self-sealing lap tape. Transverse joints secured with metal fasteners or with butt tape supplied with the product. The annular space shall be min 0 in. (point contact to max 7/8 in. (22 mm).
   See Pipe and Equipment Covering - Materials - (BRGU) category in the Building Materials Directory for names of manufacturers. Any pipe covering material meeting the above specifications and bearing the UL Classification Marking with a Flame Spread of 25 or less and a Smoke Developed Index of 50m or less may be used.
4. Firestop System — The firestop system shall consist of the following:
   A. Packing Material — Min 1 in. (25 mm) thickness of 4 pcf (64 kg/m3) mineral wool insulation tightly packed into the opening as a permanent form. Packing material to be installed flush with the bottom surface of floor assembly and recessed from the top surface of the assembly to accommodate the required thickness of fill material.
   B. Fill, Void or Cavity Materials*-Sealant — Min 1/4 in. (6 mm) thickness of fill material applied within the annulus, flush with top surface of floor. An additional 1/4 in. (6 mm) bead shall be installed at penetrant/concrete interface on top surface of floor.
   HILTI CONSTRUCTION CHEMICALS, DIV OF HILTI INC — FS-ONE Sealant or FS-ONE MAX Intumescent Sealant.

* Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.

Hilti Firestop Systems

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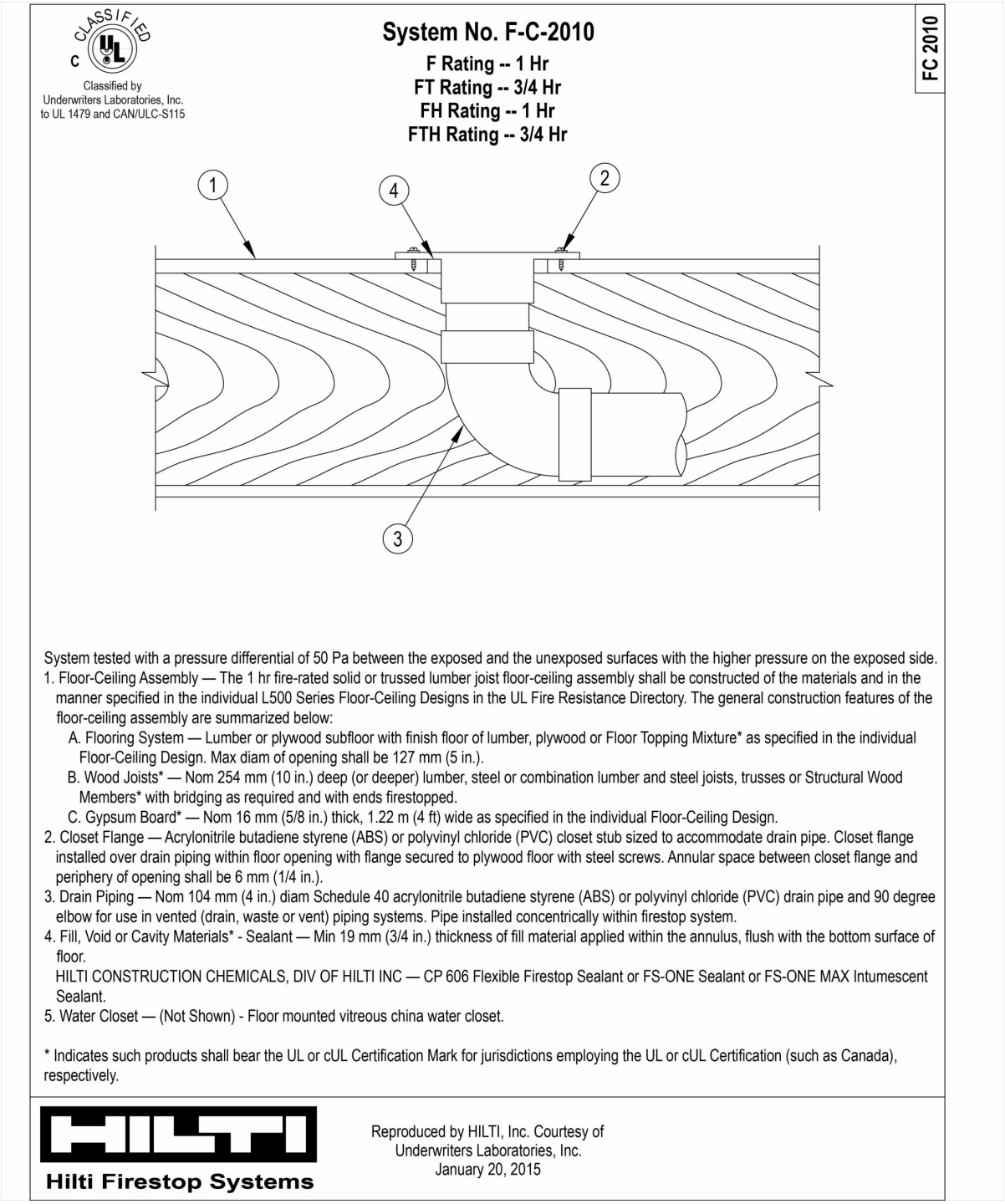
Underwriters Laboratories, Inc.
January 16, 2015

To interpret this manufacturer's data sheet you might want to review the definitions of F, FT, FH and FTH ratings.



System No. F-C-2010

F Rating -- 1 Hr
FT Rating -- 3/4 Hr
FH Rating -- 1 Hr
FTH Rating -- 3/4 Hr

FC 2010

Classified by
Underwriters Laboratories, Inc.
to UL 1479 and CAN/ULC-S115

System tested with a pressure differential of 50 Pa between the exposed and the unexposed surfaces with the higher pressure on the exposed side.

1. Floor-Ceiling Assembly — The 1 hr fire-rated solid or trussed lumber joist floor-ceiling assembly shall be constructed of the materials and in the manner specified in the individual L500 Series Floor-Ceiling Designs in the UL Fire Resistance Directory. The general construction features of the floor-ceiling assembly are summarized below:
   A. Flooring System — Lumber or plywood subfloor with finish floor of lumber, plywood or Floor Topping Mixture* as specified in the individual Floor-Ceiling Design. Max diam of opening shall be 127 mm (5 in.).
   B. Wood Joists* — Nom 254 mm (10 in.) deep (or deeper) lumber, steel or combination lumber and steel joists, trusses or Structural Wood Members* with bridging as required and with ends firestopped.
   C. Gypsum Board* — Nom 16 mm (5/8 in.) thick, 1.22 m (4 ft) wide as specified in the individual Floor-Ceiling Design.
2. Closet Flange — Acrylonitrile butadiene styrene (ABS) or polyvinyl chloride (PVC) closet stub sized to accommodate drain pipe. Closet flange installed over drain piping within floor opening with flange secured to plywood floor with steel screws. Annular space between closet flange and periphery of opening shall be 6 mm (1/4 in.).
3. Drain Piping — Nom 104 mm (4 in.) diam Schedule 40 acrylonitrile butadiene styrene (ABS) or polyvinyl chloride (PVC) drain pipe and 90 degree elbow for use in vented (drain, waste or vent) piping systems. Pipe installed concentrically within firestop system.
4. Fill, Void or Cavity Materials* - Sealant — Min 19 mm (3/4 in.) thickness of fill material applied within the annulus, flush with the bottom surface of floor.
   HILTI CONSTRUCTION CHEMICALS, DIV OF HILTI INC — CP 606 Flexible Firestop Sealant or FS-ONE Sealant or FS-ONE MAX Intumescent Sealant.
5. Water Closet — (Not Shown) - Floor mounted vitreous china water closet.

* Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.

Hilti Firestop Systems

Reproduced by HILTI, Inc. Courtesy of
Underwriters Laboratories, Inc.
January 20, 2015

The final line appears at the bottom of each page of the manufacturer's specification sheet.

Conflicts between documents can occur, so consultation between code officials, the building design engineers, and the manufacturer's representative will be required.

Firestops

Firestops are a passive fire-protection system consisting of various components used to seal openings and joints in fire resistance-rated wall and/or floor assemblies, based on fire testing and certification listings.

Unprotected openings in fire separations void the fire-resistance ratings of the fire separations. Firestops are designed to restore fire-resistance ratings by impeding the spread of fire through the opening by filling the openings with fire-resistant materials. A firestop's fire-resistance rating will be the same as that of the assembly it is used in.

The objectives of a firestop system are to:

- Prevent the spread of fire, smoke, and hot gases through a building by containing them in the compartment of origin.
- Maintain the integrity of escape routes from a building.
- Reduce loss of or damage to property from the effects of fire and smoke.
- Maintain pressure differential between compartments and ventilation channels.

Many elements combine together to provide fire protection in a building. Some of the components of a fire-protection system may include the following:

- Constructing the building of non-combustible materials.
- Firewalls may be provided to divide a building into a number of smaller buildings.
- Fire separations may be provided at the following locations:
  - ▸ at floors levels
  - ▸ between suites
  - ▸ between suites and public corridors
  - ▸ at roof/ceiling level
  - ▸ around exit stairs
  - ▸ around service and elevator shafts
  - ▸ around other rooms requiring protection
  - ▸ at exterior walls for spatial separation purposes and to support the structural system of the building
- Firestopping using cast-in-place construction or firestop systems to seal openings where they pass through fire separations.
- Concealed space barriers (fire-blocks), built in the concealed spaces within walls and at floor levels.
- Fire alarm, detection and suppression systems, fire sprinkler systems.

Firestop Ratings

Firestops are tested for a number of criteria to establish a fire rating. The ratings are as follows:

F rating: The minimum rating required for all firestops. The F rating required is the same as a closure, which is one level below the fire-resistance rating required for the fire separation.

An F rating is required for all fire stops involving combustible drain, waste and vent pipe. The firestop F rating required is the same as the fire-resistance rating for the fire separation. The pipe must also meet a pressure differential of 50 Pa (0.01 psi) on the fire-exposed side during the test. This pressure simulates the pressures that occur during a fire condition.

FT rating: the FT rating is required for all firestops in horizontal fire separations above storage garages classified as separate buildings and firewalls.

The firestop FT rating is the same as the fire-resistance rating for the fire separation. The rating test also requires the firestop to limit the rise in temperature on the unexposed surface of the fire separation to less than 181°C (358°F) above ambient room temperature. This temperature-rise component makes obtaining an FT rating more difficult.

Cast iron, steel, and copper pipes may need firestop systems that require these pipes to be insulated.

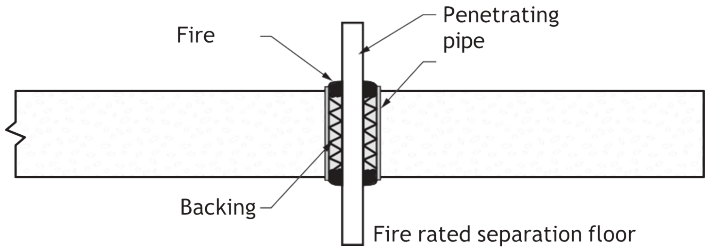


Figure 1 *Typical parts of a firestop (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Firestop Configurations

Through-Penetration Firestops

Through-penetration firestops are those that are employed when a penetrating item passes entirely through a fire separation. Such an opening creates the opportunity for fire and smoke to spread directly from one fire compartment to another. A through-penetration firestop system consists of a fire-rated wall or floor, a penetrating item (pipe, cable, conduit, etc.) and the firestop material.

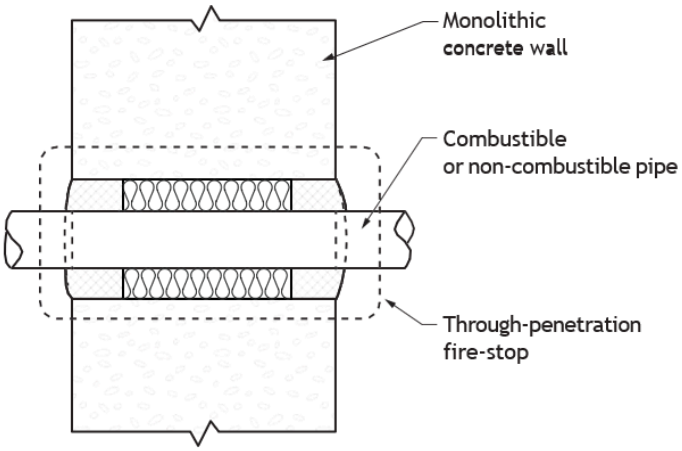


Figure 2 *Example of a through-penetration firestop (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Membrane-Penetration Firestops

Membrane-penetration firestops are those that are employed when a penetrating item passes through only one membrane of a fire-rated assembly (made up of multiple materials) but does not pass through the entire assembly.

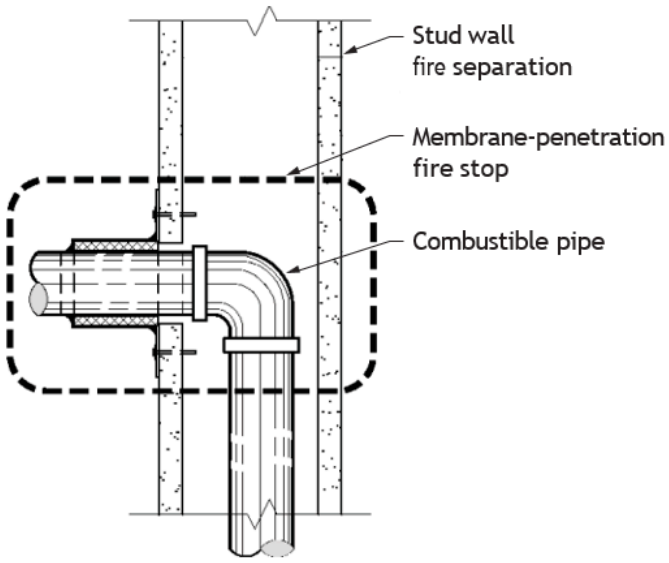


Figure 3 *Example of a membrane-penetration firestop (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Types of Firestops

There are various types of firestops, including:

- Collars
- Pillows
- Caulking
- Sealants
- Mortars
- Mineral wool
- Foams
- Putties
- Fire-blocks
- Composite sheets and boards

Firestop Collars

Firestop collars are devices used to provide effective firestopping for plastic pipes. They typically consist of a steel or plastic canister, filled with a predetermined amount of ***intumescent material*** (material that expands upon exposure to excessive heat).

During a fire scenario, as the plastic pipe begins to soften, the intumescent material expands to several times its original volume, helping crush the plastic pipe and fill the void, thereby providing an effective seal against the passage of flames and hot gases.

Traditionally, fire collars for use on PVC pipes were supplied in size increments to match the common pipe sizes, namely 40, 50, 65, 80, 100 and in some cases 150 mm nominal diameter. In recent times, to cater for other plastic pipe sizes, where the outer diameter of the plastic pipe varies and to reduce model numbers and stock holdings, many proprietary fire collars can be used on more than one size and type of plastic pipe.

Fire collars designs consist of the following generic types:

- Retrofit or surface-mounted collars
- Cast-in-place floor slab collars
- Wall collars
- Ceiling collars
- Wraps

Retrofit or Surface-Mounted Collars

Retrofit or surface-mounted collars are usually fixed to the underside of a floor slab or to both sides of a wall, after the plastic pipe has been placed through the fire-resistant barrier. Retrofit collars are easy to identify during subsequent maintenance or inspection regimes.

Figure 4 *Retrofit wall collars (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

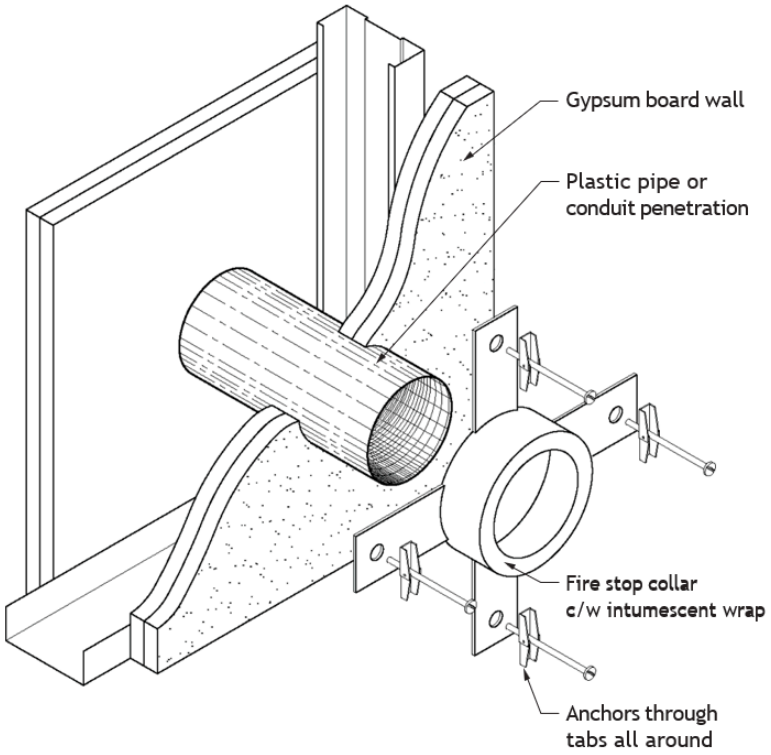


Figure 5 *Retrofit fire collar installation (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Hilti Firestop Collar

Hilti firestop collars are used on combustible pipes up to 4 in. in diameter in penetrations through firewalls and floors. They are suitable for use with the following pipe materials: PVC, CPVC, ABS, PVDF and FRPP (fibreglass-reinforced pipe).

Ceiling collars are collars fire-tested and used for breaches in fire-resistant ceilings where special temperature-rise requirements are called for.

Figure 6 *Hilti firestop collar (Courtesy of Hilti) Used with permission.*

Cast-in-Place Floor Slab Collars

For this fire protection used for pipes penetrating concrete floor slabs, the collar is cast in place around the pipe.

Figure 7 *Cast-in-place sleeve collar (Courtesy of Hilti) Used with permission.*

Wall collars are cast into the wall upon pipe penetration.

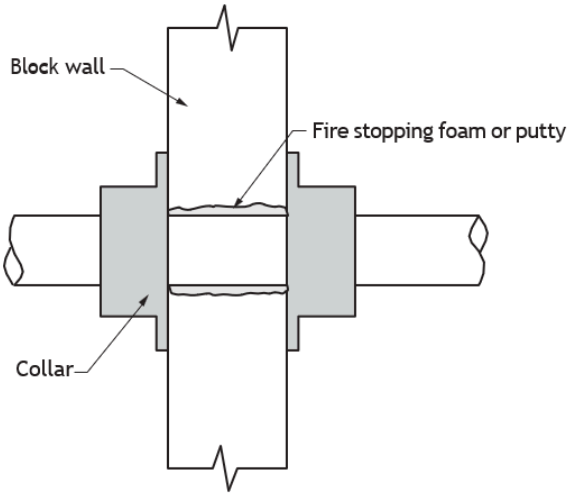


Figure 8 *Collars for wall application (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Wraps are effectively fire collars without the outer casings or canisters. They typically consist of a pre-manufactured quantity of intumescent material. Because there is no canister, they are typically limited to concrete or masonry openings, where the fire-resistant barrier provides the necessary constraints to prevent the intumescent from expanding anywhere except into the opening as the pipe softens.

Figure 9 *Firestop wrap (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Blocks, Pillows and Bags

Fire-resistant pillows were originally developed as a temporary form of firestopping and were used extensively during construction of telephone exchanges. They consist of an outer covering and an infill material, just like the pillows we sleep on. The conventional fire pillow consists of a fire-retardant cotton cover (typically coloured for ease of

recognition), with a mineral-fibre infill material. These pillows must be packed firmly into openings to ensure that there are no gaps that would allow the passage of flames and hot gases. They are often used together with sealants to ensure that the integrity of an opening's fire separation is maintained.

Figure 10 *Fire-resistant pillows* (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (*https://creativecommons.org/licenses/by-nc-sa/4.0/*)

Types of fire-resistant pillows include:

- Rock-wool batts with intumescent resin inside plastic bags
- Vermiculite with intumescent graphite inside fibre bags
- Intumescent foam rubber

Pillows may present an opportunity for vandalism if they are not properly secured. Repairs must conform to the original certification listing.

Figure 11 illustrates the placement of firestop pillows. Always refer to the manufacturer's instructions and the authority having jurisdiction.

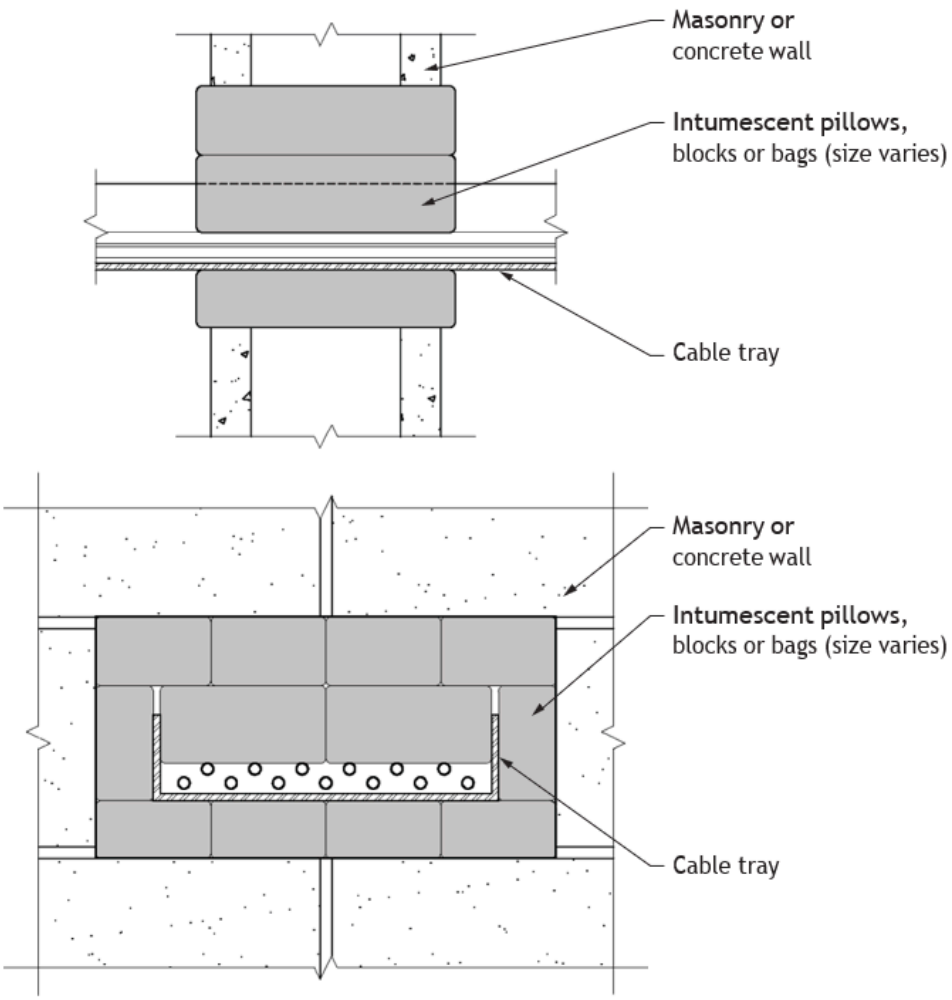


Figure 11 *Placement of firestop pillows, blocks or bags (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Firestop Sealants

Sealants are compounds typically applied by caulking from a plastic cartridge, sausage or bulk container into an opening by way of a caulking gun. They come in different chemical formulations, of which the following are more common generic types:

- Acrylic (water-based or latex)
- Polyurethane
- Silicone
- Hybrids of acrylic, polyurethane and silicone

Many of the sealants used for firestopping purposes contain intumescent additives that allow them to expand to many times their original volume during fire conditions (exposure to extreme heat). This is not a mandatory design attribute.

The uses of the different generic types of sealants depend on many factors, which include but are not limited to:

- Flexibility
- Availability
- Tack-free time
- Adhesion to substrates
- Requirement for surface preparation
- Resistance to water
- Resistance to UV
- Design life
- Ease of cleaning of equipment after use
- Aesthetics
- Cost

Caulks and sealants are often used for single and multiple penetrations in an opening because they are adaptable to more complex and unusual penetrations and openings. Caulks are normally applied around a penetrating item in an opening with a caulking gun to form a seal. A sealant is a similar material to a caulk that is applied with a trowel or putty knife or is sprayed on. Caulks and sealants can possess intumescent or endothermic properties, depending on the specific material used. Caulks are used to seal the annular space around a penetration (e.g., pipe, cable, duct), or to cover a mineral fibre or similar material used in a construction joint.

Figure 12 *Latex firestop sealant installation (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Firestop Foams and Foam Blocks

Fire-stop foams are similar to caulks but expand during installation to fill openings in fire-rated assemblies. Foam fire-stop systems are typically used for small or medium-sized openings, often where an opening is difficult to reach. Some foam products are used with a packing or damming material. When using a foam, check the manufacturer's technical literature, as some foam remains liquid for several minutes before foaming occurs. In this situation, damming or packing is necessary.

Figure 13 *Firestop brick based on a two-component polyurethane foam (Courtesy of Hilti) Used with permission.*

Figure 14 *Spray filler foam (Courtesy of Hilti) Used with permission.*

Fire-Resistant Foams

Fire-resistant foams are specially formulated and modified foams that are fitted into linear gaps under compression and provide a fire rating in their own right. They may be used in conjunction with standard non-rated sealant in some jurisdictions.

Firestop Mortars

Mortars are powders that are mixed with water to form a compound that can be poured or towelled into an opening. When set, they form a homogeneous and usually lightweight barrier. They are similar to concrete but are free of the cracking, fissuring and spalling seen in concrete under fire conditions.

Fire-resistant mortars are usually much lighter when cured than conventional concrete and can be readily drilled through to form openings for additional cables or other penetrations over the life of the opening. They do not typically require any additional steel reinforcing and are not typically load-bearing.

Fire-stop mortars, including quick-setting compounds, are most typically used to firestop large openings in walls and floors that are required to have a fire-resistance rating.

Many proprietary fire-resistant mortars have red or blue dye additives to make them easier to recognize as a fire-resistant material in the field. This is similar to the coloured fire-resistant plasterboard and other building boards. This trend is encouraged.

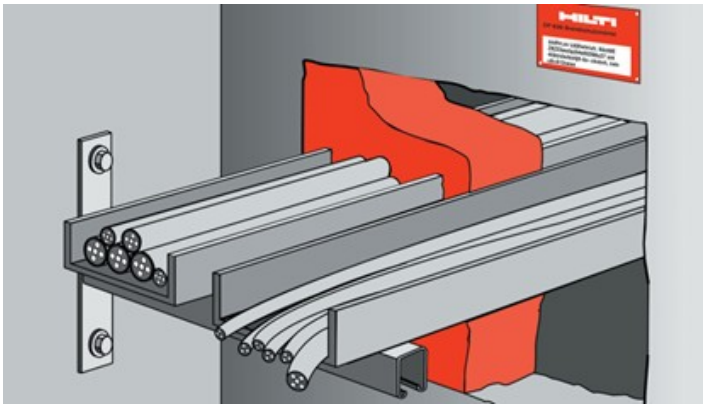


Figure 15 *Application of firestop mortar (Courtesy of Hilti) Used with permission.*

Figure 16
Quick-setting mortar in package (Courtesy of Hilti) Used with permission.

Coatings and Sprays

Coatings and sprays are sprayed or brushed on, usually over mineral wool insulation that has been tightly compressed. The mineral wool holds the spray in place or dams it and helps to block heat transmission. Sprays and coatings consist of intumescent or ablative materials.

Because they are quicker to apply, coatings and sprays are often used instead of caulks in applications such as covering construction joint firestop systems. When dry, most coatings or sprays form a flexible seal that can withstand some movement and water penetration.

Mineral Wool and Backboards

Mineral wool is made of fibres of natural or synthetic minerals or metal oxides such as fibreglass, ceramic and rock

or stone. These materials can break down under very high heat, but they do provide sufficient fire resistance to be commonly used as passive fire protection. While bacteria can grow in wet mineral wool, rats and mice do not find these materials appetizing.

Figure 17 *Mineral wool batts (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Safety Precautions When Handling Mineral Fibre

You must take safety precautions when you handle mineral wool or other fibre products. The fibres can float in the air and be inhaled, irritating the eyes, skin and respiratory tract. Prolonged exposure could lead to long-term effects. Mineral wool is considered a possible carcinogen to humans, similar to asbestos. This effect may depend upon the fibre structure, chemical composition and persistence within the body.

Firestop Putties

Putties are normally installed as firestops in similar situations as caulks and sealants. Putties are fire-stop materials that are mouldable. They can be pressed manually into an opening in a fire-rated assembly. Putties may possess either intumescent or endothermic reaction properties.

Putties are sometimes used to create a fire-stop envelope over electrical boxes embedded in stud walls. Putties are mouldable, so are easy to install near obstructions, bent pipes and close running pipes, where collars cannot be installed. They also provide ease of entry as they remain pliable and reusable for years. Putty is available in tubes or as strips premeasured to fit around most schedule 40 plastic pipes.

Figure 18 *Firestop putty (Courtesy of Hilti) Used with permission.*

Composite Sheets and Boards

Composite sheets and boards consist of panels sandwiched around an intumescent material. They are typically cut to fit closely around penetrating items and are fastened to the fire separation.

Caulk or putty is provided to seal the opening around the penetrating item. They are commonly used for openings that are too large to be sealed by caulks or putties alone. Figure 19 shows a general application of a composite sheet. Always consult the manufacturer's instructions and authority having jurisdiction.

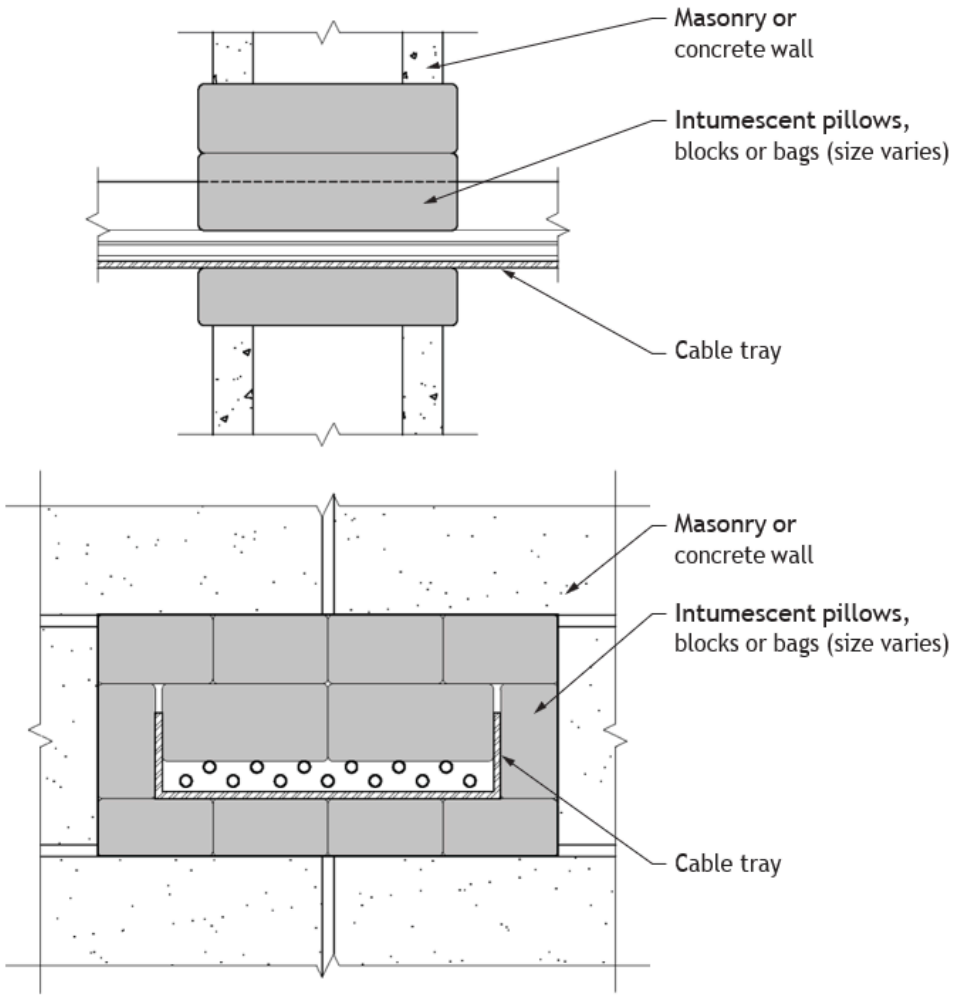


Figure 19 *Composite sheet firestop (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Generic Firestop Materials

There are a number of generic materials that may be used as part of a firestop system. ***Fibre insulations***, which may be generic materials, are commonly used in many fire-stop systems. The specific types of insulations used for these applications include mineral wool, ceramic fibre and, in some cases, glass fibre. For all fire-stop systems, the appropriate type of insulation must be used. When using these insulation materials in firestop systems, it is important to ensure that the thicknesses and densities meet those of the manufacturer's directions and that any compression requirements are closely followed.

Mineral wool is a mineral-fibre insulation processed from rock or slag. It is often used to fill spaces where its compressibility and resilience are needed to address structural movement in fire-stop systems. It is commonly used as an insulating material in many systems as well as for building-perimeter fire stops. Mineral wool begins to melt at approximately 1100°C (2000°F).

Note: The term***mineral-fibre*** is used to describe a family of fibre insulation products that includes glass fibre.

Cerami-fibre is a space-age, high-temperature insulation product commonly used in the refractory industry. Ceramic fibre products are available in blanket or board form. Ceramic fibres are also incorporated into mastics to create a hard, non-flexible fire stop that can withstand high temperatures. The major advantage of ceramic-fibre blanket or board products is their ability to withstand high temperatures. Ceramic fibre begins to melt at approximately 1800°C (3270°F). On the other hand, fibres from these products are possible carcinogens, so users should wear appropriate protective clothing and masks.

Glass-fibre is a mineral fibre insulation made of glass fibres rather than rock or slag. Some fire-stop systems incorporate glass fibre insulation as a forming or packing material. The maximum temperature-resisting capabilities of glass fibre insulation are typically less than those of rock, slag or ceramic fibre insulations.

Fire Dampers

Fire dampers are devices used specifically for firestopping where ducts penetrate through fire-resisting barriers. The conventional fire damper is a gravity mechanical device consisting of metal pivoted dampers. The dampers are held in the open position by a ***fusible link***. The fusible link melts during a fire and the dampers close tight, providing a barrier to the passage of hot flames and gases.

Figure 20 *Fire damper with fusible link (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Insulated Pipe Penetrations

Piping is often insulated for various reasons, including reducing heat loss and heat gain. Pipe insulations may or may not be fire rated. You must ensure that the correct fire-stop system is selected for the type of insulation being used when pipe passes through a fire separation. Firestops must be designed to account for the impact of they have on the insulation around the pipe while at the same time maintaining the fire rating of the assembly.

Different arrangements for firestops are required for different types of pipe insulation and pipe materials. Firestops for such insulated pipes are currently available for both non-combustible and combustible pipes.

In Figure 21, the fire stop must be able to seal the opening either at the outer surface of the insulation or at the non-combustible pipe if the insulation can be damaged by fire.

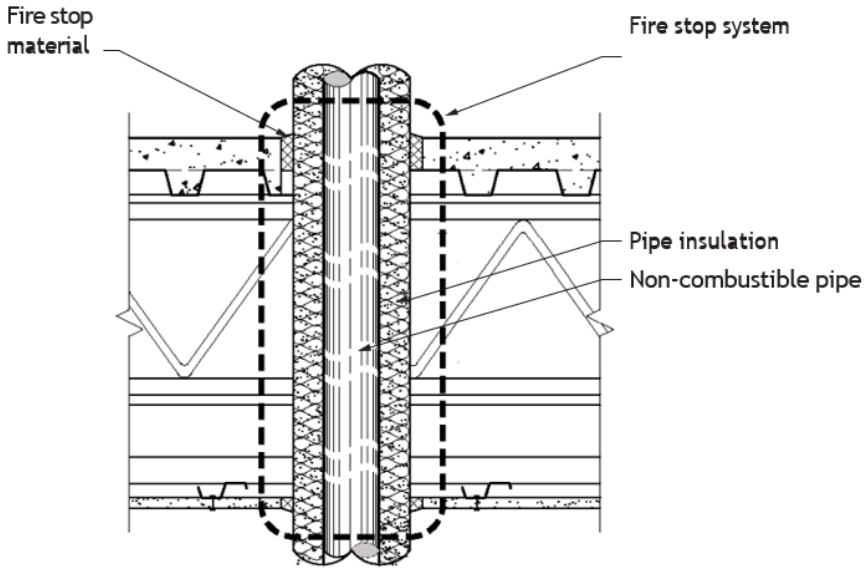


Figure 21 *Firestop in non-combustible pipe penetration through metal-supported concrete deck (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

In Figure 22, the firestop must be able to seal the opening in such a way that the void created by the fire-damaged combustible pipe is also sealed when the combustible pipe collapses from the heat of fire.

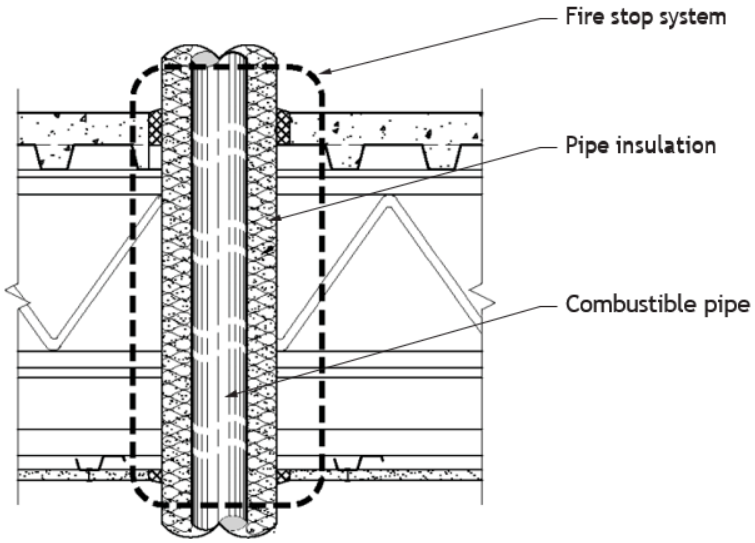


Figure 22 *Fire stop in combustible pipe penetration of metal-supported concrete deck (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Pipe Penetrations Through Monolithic Concrete Floor Assemblies

The difference between an F rating and an FT rating requirement depends upon the type of pipe used. In Figure 23, F-rating-only combustible pipe will not conduct heat, so no insulation is needed for an FT rating.

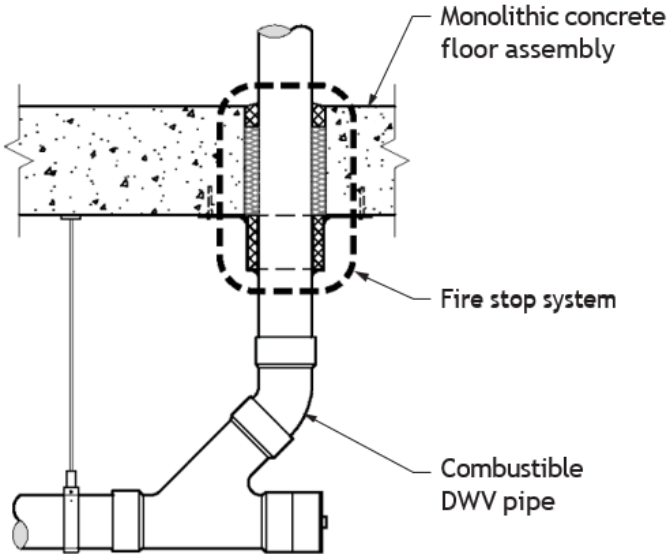


Figure 23 *Combustible pipe penetration through monolithic concrete slab (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figure 24 shows insulation placed on the pipe below the slab. This insulation is fire rated and forms part of the firestop assembly. An *FT (temperature transmission) rating* is required for this non-combustible penetration. The insulation limits the metal pipe from conducting heat from a fire in an area below the slab, such as a parking garage, into the floor above. The specifications for this application and manufacturer's installations must be followed. Consult the local authority having jurisdiction before using this arrangement.

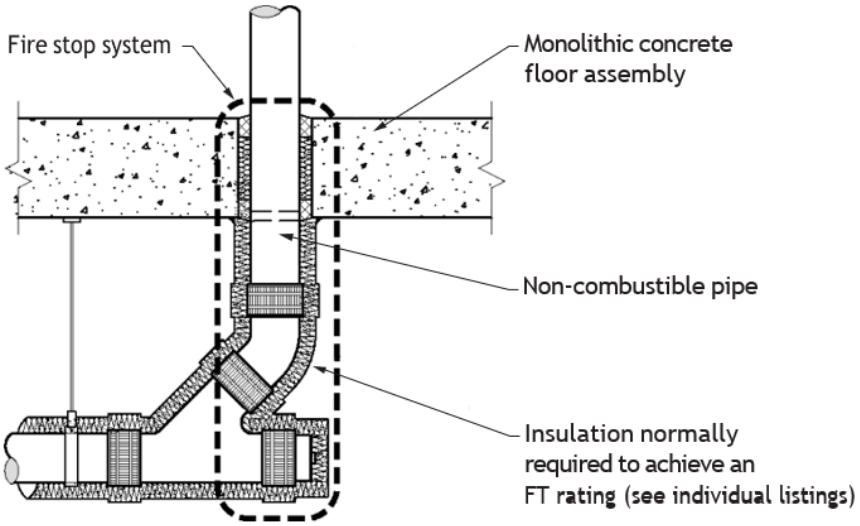


Figure 24 *Non-combustible pipe penetration through monolithic concrete slab (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Floor Penetrations for Toilets Above Monolithic Concrete Floor Assemblies

DWV piping for toilets may pass through a monolithic concrete floor assembly from a parking garage to a wood-framed residence area (Figure 26). This situation would require firestop solutions similar to those in Figure 25. The parking garage is a classified as a separate building. The extent to which a non-combustible pipe would need to be insulated for an FT rating is dictated by the listed firestop system installation requirements. If combustible pipe is used, a listed firestop system rated for combustible pipe would be required.

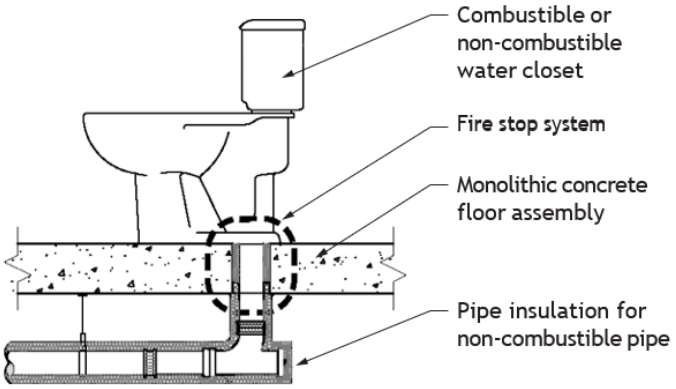


Figure 25 *Penetration for toilet in a wood-frame area above a monolithic concrete floor, for FT rating (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

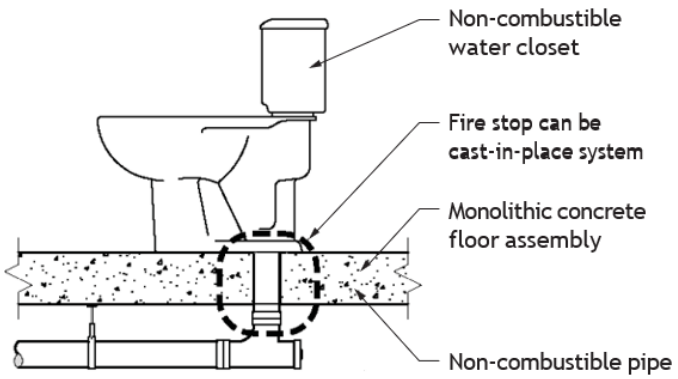


Figure 26 *Penetration for toilet above a monolithic concrete slab for F rating only* (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (*https://creativecommons.org/licenses/by-nc-sa/4.0/*)

Where the parking garage is part of the building above it, the penetration through the monolithic concrete floor assembly using combustible pipe is permitted by the national building code. The water closet must be non-combustible. For such combustible pipe penetrations, a listed firestop system with an F rating would be required. For non-combustible pipe, the national building code would not require a listed fire-stop system if the pipe were cast in place. A listed firestop system with an F rating could also be used instead of casting the pipe in place.

Floor Penetrations for Toilets Above Wood Sleeper Floors on Monolithic Concrete Floor Assemblies

When a wood sleeper floor system is installed above a monolithic concrete floor assembly, a somewhat different arrangement of firestops may be required, depending on whether a parking garage is considered a separate building or not. There are several available options.

Figure 27 illustrates one option when a non-combustible pipe penetrates an assembly that requires an FT rating. The insulation will cover the pipe for a specified distance from the firestop to ensure that the FT rating is achieved. The pipe is not cast in place, so a firestop system is also used to attain an F rating. Inside the dashed line, you can see the firestop system required. When using this type of wood sleeper floor system, you may be required to subdivide the area of the wood sleeper floor.

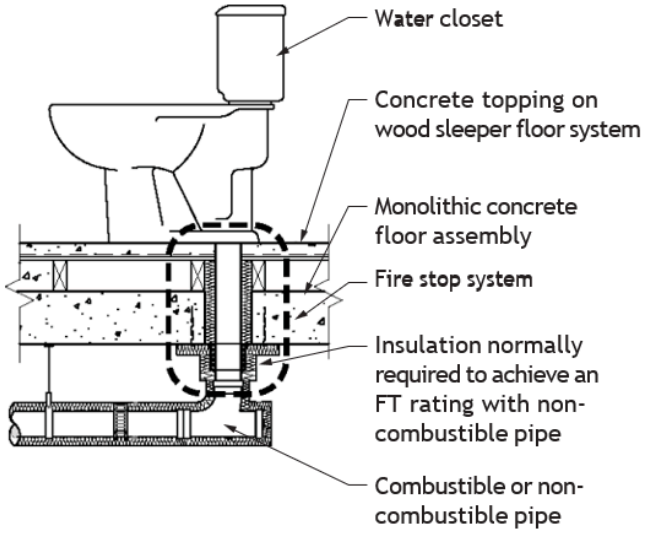


Figure 27 *Penetration for toilet on wood sleeper floor system above a monolithic concrete slab for an F or FT rating (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Recall the definitions of the following terms:

F Rating: A firestop system that remains in the opening during the fire test for the rating period (for example, $\frac{3}{4}$ hour, 1 hour, etc.), without permitting the passage of flame through the opening or any flaming on any element on the unexposed side of the firestop system. F ratings may be at the level of a fire-protection rating or fire-resistance rating, depending on the type of service penetration being protected.

FT Rating: A firestop system that remains in the opening during the fire test, without permitting the passage of flame through the opening or any flaming on any element on the unexposed side of the firestop system. It also limits the temperature rise on the unexposed surface to less than 181oC (358oF) above ambient room temperature.

Monolithic Concrete Floor Penetrations for Tubs and Showers

Figure 28 illustrates an arrangement where a monolithic concrete floor is penetrated by piping for a tub or shower. The left side shows a combustible pipe penetration, and the right side shows a non-combustible pipe penetration.

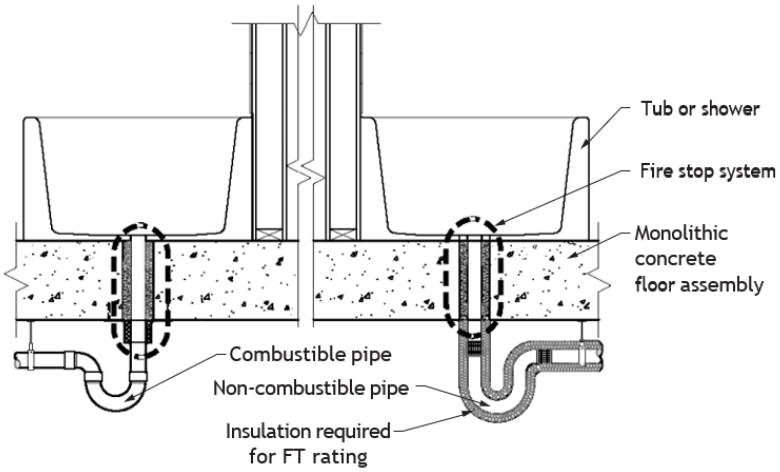


Figure 28 *Pipe penetration for a tub or shower above a monolithic concrete slab for F or FT ratings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figure 28 illustrates a plumbing penetration through a slab where the parking garage is a separate building or where the parking garage and the floors above are considered to be in the same building. If non-combustible pipe penetrates an assembly and the fire stop is required to have an FT rating, insulation may be required to cover the pipe for a specified distance to and from the fire stop to achieve the FT rating.

Pipe Penetrations Through Monolithic Concrete Slab or Masonry Walls

Figures 29 to 31 show pipe penetrations through a monolithic concrete or masonry wall fire separation and firewall.

When penetrating a firewall, piping must be designed in such a manner that its collapse will not cause the collapse of the firewall. Any fire stop must take that requirement into account. As well, any pipe penetration of a firewall must be provided with a fire stop with an FT rating not less than the fire-resistance rating of the firewall. Recall that an FT rating requires the non-combustible pipe to be insulated for a specified distance on both sides of the firewall. The distance for the insulation is specified in the listed firestop system design. This insulation could also extend equally on both sides of the firewall.

When penetrating a monolithic concrete or masonry wall that is a fire separation, only an F rating is required.

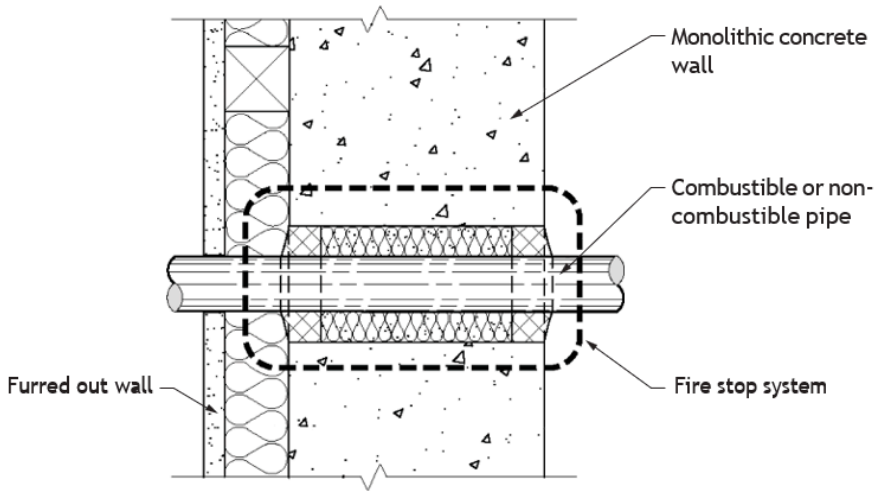


Figure 29 *Penetration of pipe through monolithic concrete wall assembly (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

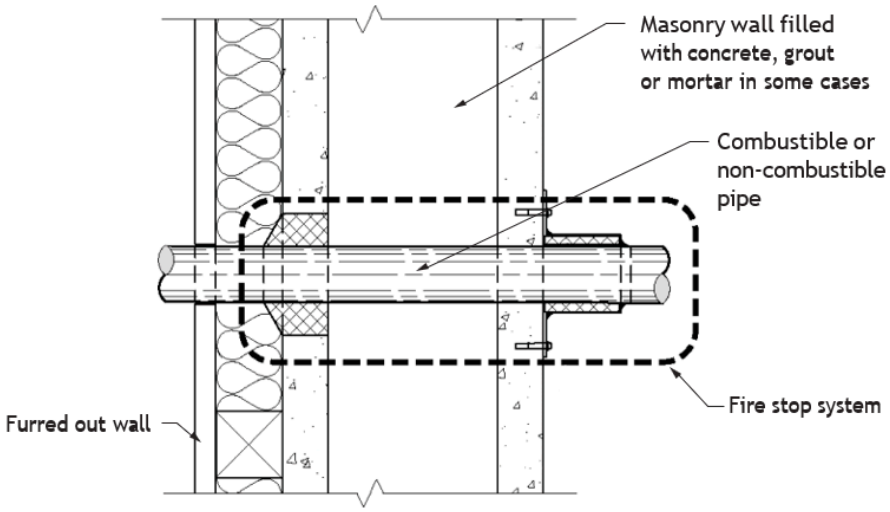


Figure 30 *Penetration of pipe through wall assembly without using a sleeve (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

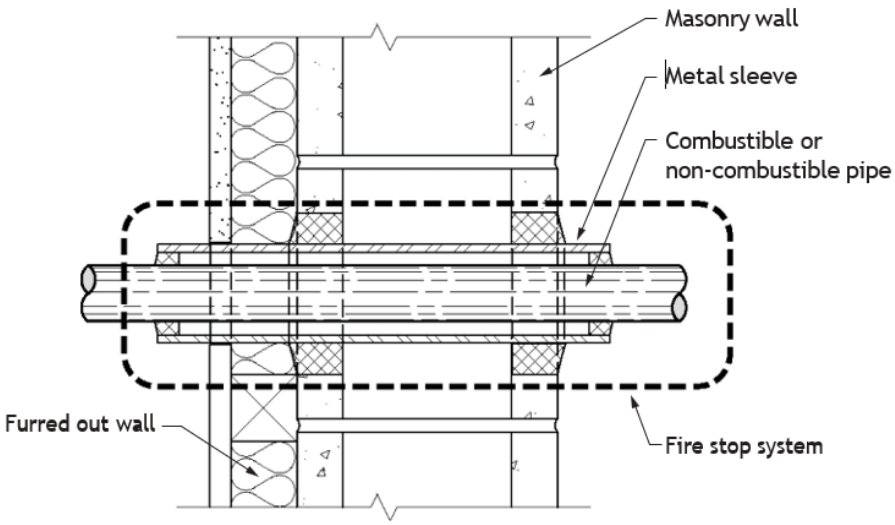


Figure 31 *Penetration of pipe through wall assembly using a sleeve (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Pipe Penetrations Through Wood-Framed Fire-Separation Assemblies

Figure 32 shows an example of piping arrangement and firestopping locations through a framed floor assembly. When penetrating a fire-rated framed floor assembly, firestops are required at the ceiling membrane and at the floor level. Follow the manufacturer's firestop directions, the job specifications and building code requirements. The building code will determine the appropriate use of non-combustible piping when penetrating horizontal fire separations.

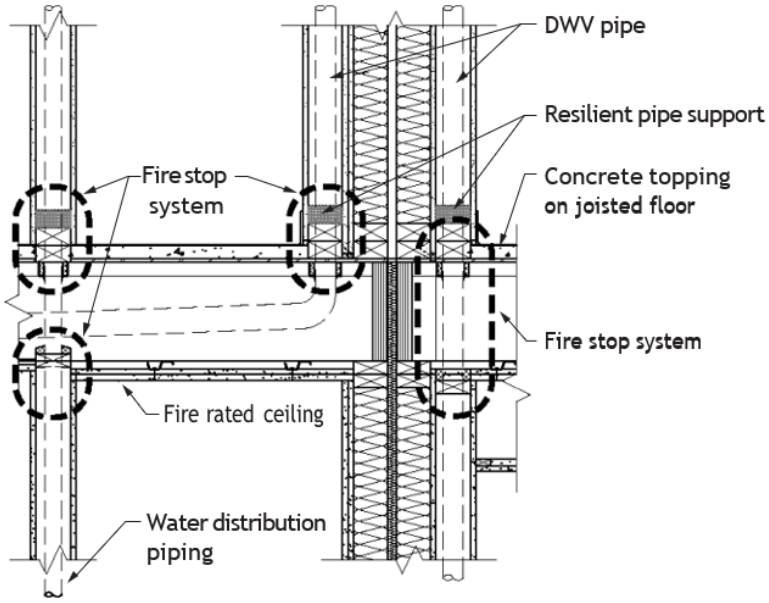


Figure 32 *Firestop locations for pipe penetration through a framed floor assembly (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Combustible Sprinkler Pipe

Figure 33 shows an example of how combustible sprinkler piping is permitted to penetrate a horizontal fire separation. No fire stop is required at the lower, non-fire-rated ceiling.

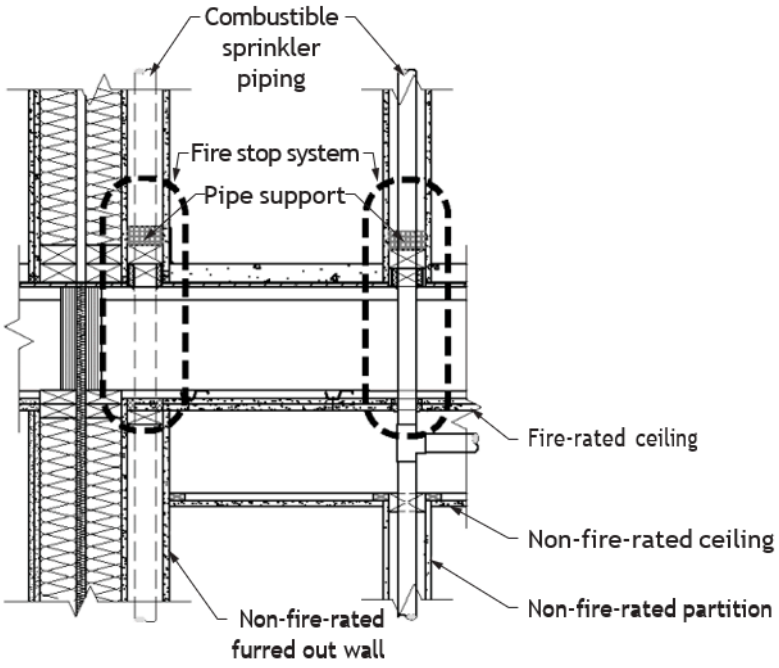


Figure 33 *Penetration of combustible sprinkler piping through a framed floor assembly (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Where combustible or non-combustible sprinkler piping penetrates a fire-rated ceiling membrane and leads directly to a sprinkler (Figure 34), that penetration should be tightly fitted and covered with an escutcheon on the room side. Changes to the installed sprinkler with a fire stop in the annular space between the pipe and the ceiling could impede sprinkler operation. Fire stops are often not provided at this ceiling penetration as they may potentially interfere with the distribution pattern of the sprinkler spray if the sprinkler position moves as a result of fire-stop intumescent action.

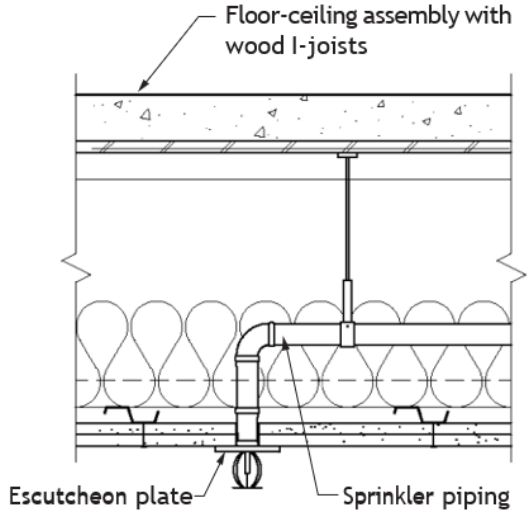


Figure 34 *Penetration of sprinkler piping through ceiling membrane of fire-rated assembly (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

If used, firestops selected for this application in Figure 35 should not deform under fire temperatures. Contact the manufacturer of the sprinkler to determine if firestops can be used in this application.

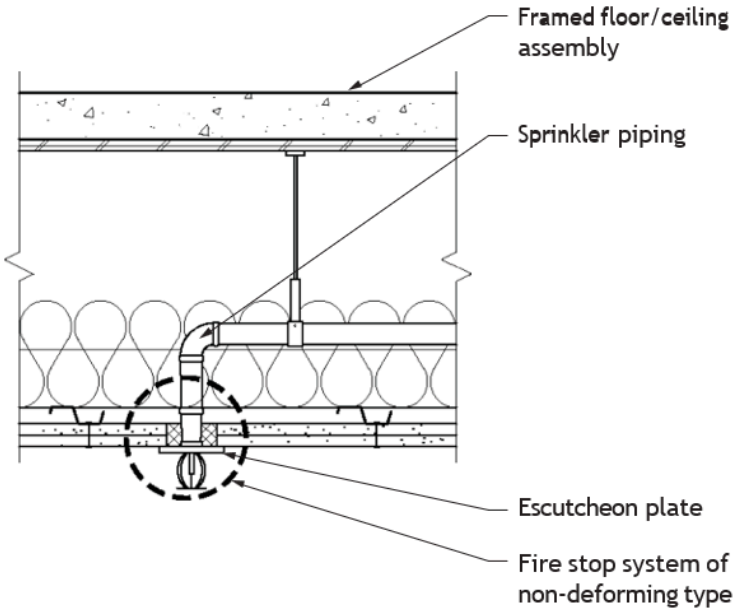


Figure 35 *Penetration of sprinkler piping through ceiling membrane of fire-rated assembly with a firestop (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Pipe Penetrations Through Framed Floor Fire-Separation Assemblies

Figure 36 shows two water-closet piping arrangements and fire-stop locations.

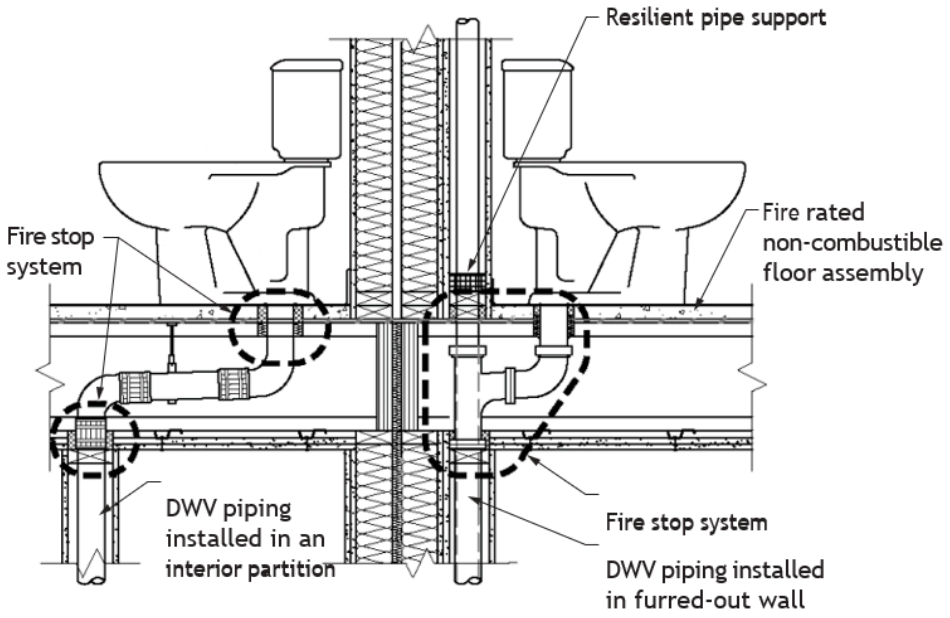


Figure 36 *Penetration of DWV pipe for toilet through a framed floor assembly (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Note: Piping configurations in these illustrations may not be correct to plumbing code requirements. Drawings are not for plumbing design purposes.

Pipe Penetrations Through Framed Floor Assemblies for Tubs And Showers

Figure 37 shows two bathtub piping arrangements and firestop locations.

Typically the waste and overflow drain opening in the floors is cut rectangular. The firestop board here would be cut to fit tight to the shape of the drain assembly. ***Gypsum board***, cement board, plywood or ***oriented strand board (OSB)*** may be acceptable to the authority having jurisdiction. The exact board product may be specified for the listed firestop system. Since moisture could be an issue here, a water-resistant board may be required.

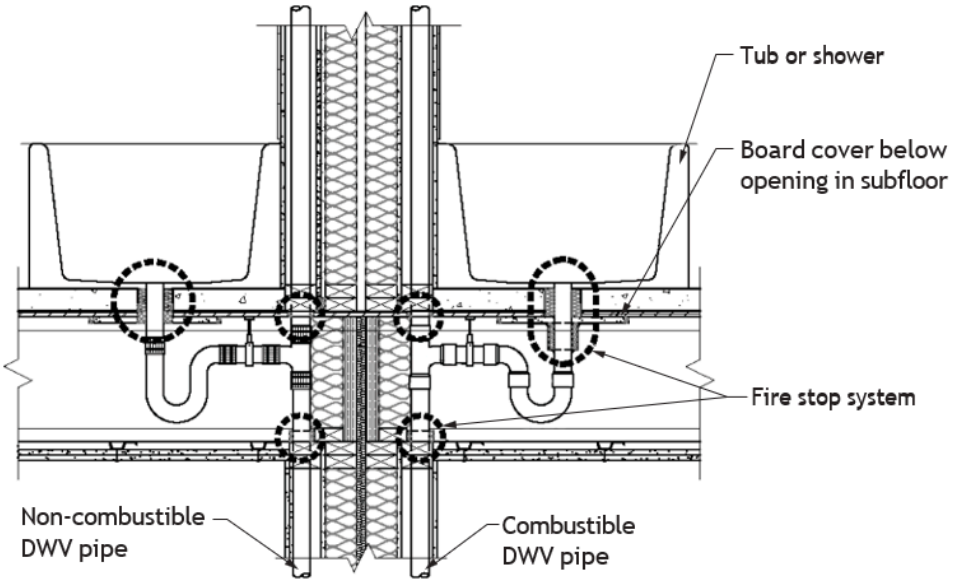


Figure 37 *Penetration of pipe for tubs or showers through a framed floor assembly (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Pipe Penetrations Through Framed Walls

Figure 38 shows piping installed in a framed wall and the location of firestops. Firestops are required at the location where the pipe penetrates the wall membrane and at the point where it penetrates the wall bottom plate or track.

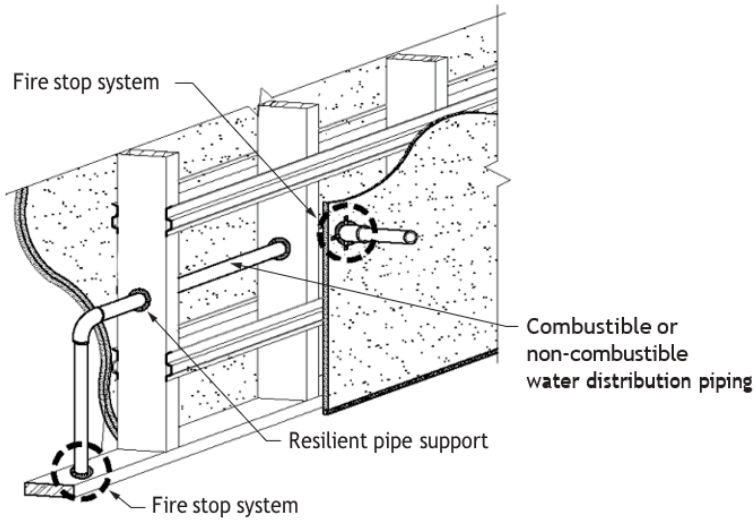


Figure 38 *Penetration of water supply pipe through membrane of wall assembly (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figures 39 and 40 show pipe penetrations through framed-stud fire separations. Firestops are required at both membranes since interior fire separations are rated from both sides. In Figure 40, an FT rating would require insulation on both sides of the separation.

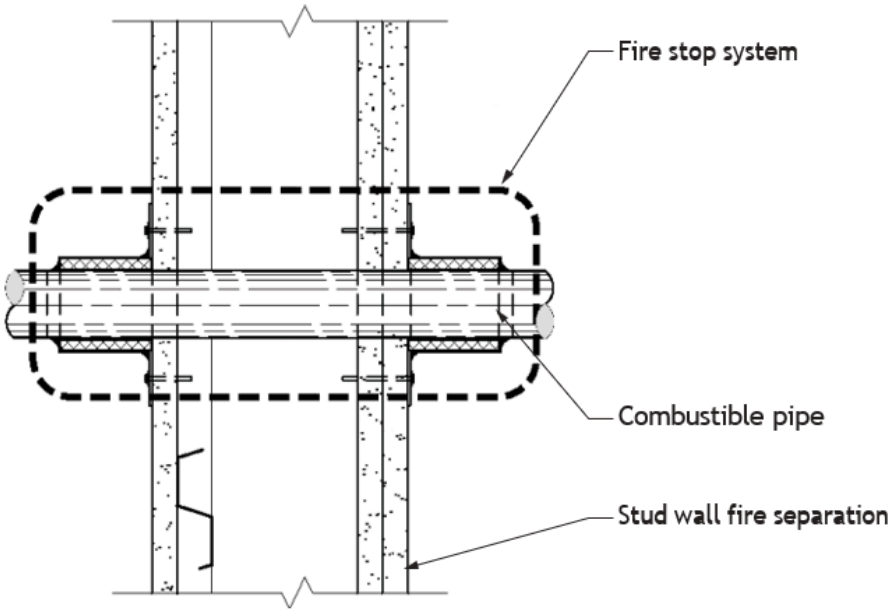


Figure 39 *Penetration of a combustible pipe through an interior fire-rated wall assembly (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Note: The use of retrofit fire stops on both sides of the fire separation.

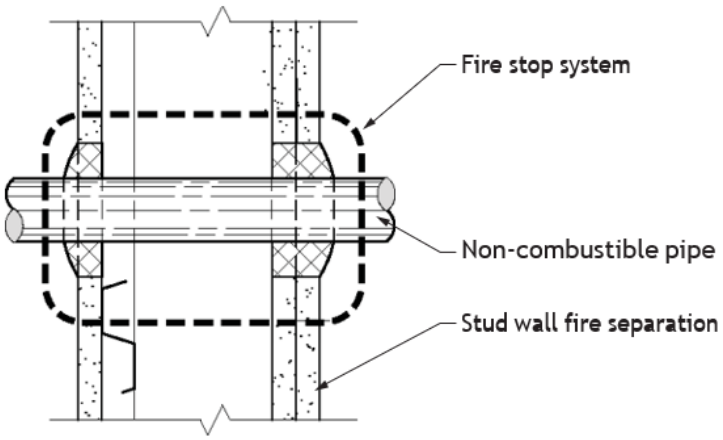


Figure 40 *Penetration of a non-combustible pipe through an interior fire-rated wall assembly (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figure 41 shows combustible pipe and firestop locations installed in a furred-out wall outside of the fire-separation shaft. Vertical combustible piping is not permitted in a vertical fire-separation shaft. Fire stops are required at the top

and bottom penetrations of the furred-out wall. (Only the bottom plate firestop is shown.) Fire stops may not be required at the furred-out wall penetrations since the wall chase is not a fire-rated wall. If the pipe were located in a vertical fire-separation shaft, it would need to be non-combustible and listed firestop systems would have to be provided at the wall penetrations.

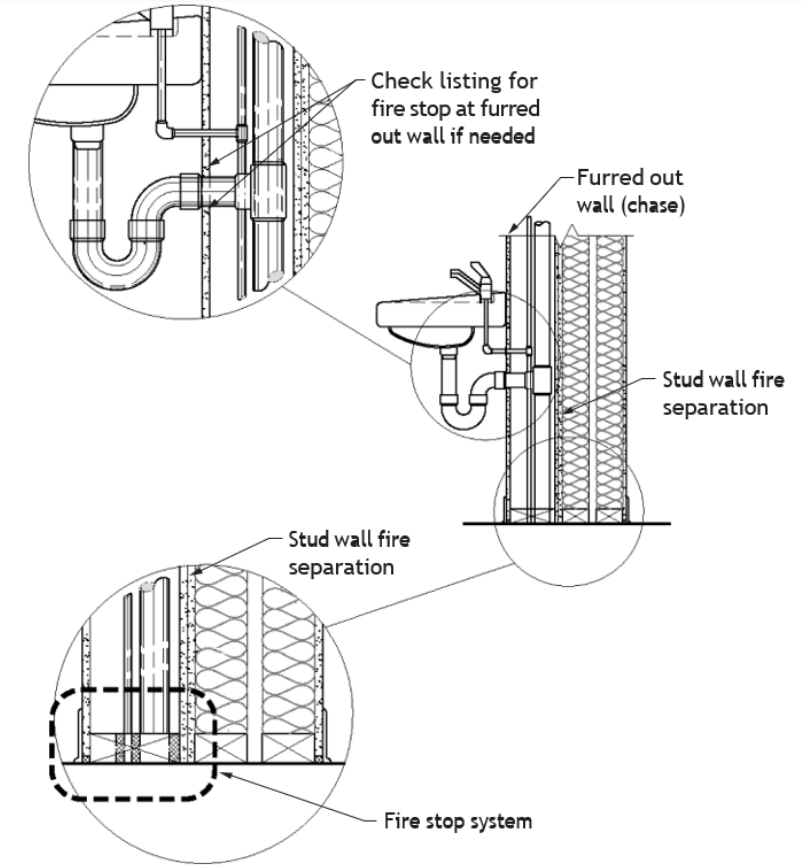


Figure 41 *Combustible piping in a furred-out wall (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figure 42 shows a pipe penetration through a fire-rated membrane and the location of the firestops. Note that some listed fire-stop systems require the DWV piping to be located only inside a fire-rated wall, so care must be taken to ensure that walls are fire-rated where these firestops are used. Details are provided in the literature for the listed fire-stop system.

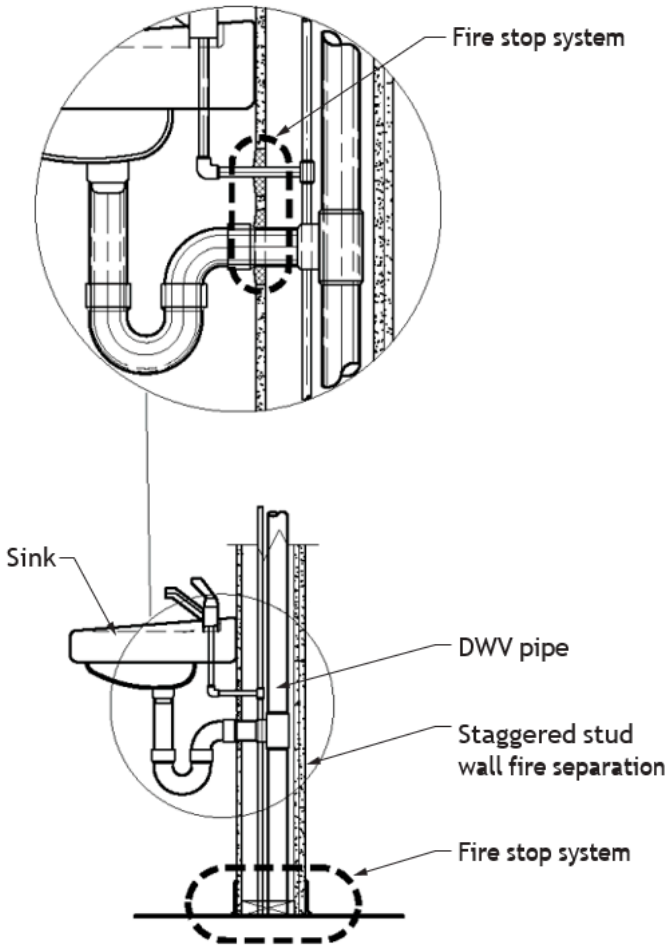


Figure 42 *Penetration of a pipe through a fire-rated wall assembly (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Pipe Penetrations for Laundry Rooms

Figure 43 shows a pipe penetration through a fire-rated membrane and the location of the firestops for a laundry tray. The difficulty for firestopping is at the clothes-washer hose connecting to the drainage pipe inside the wall. Follow the instructions for the listed firestop system used. You should be aware whether the firestop system requires the washer drain piping to be located only inside a fire-rated separation.

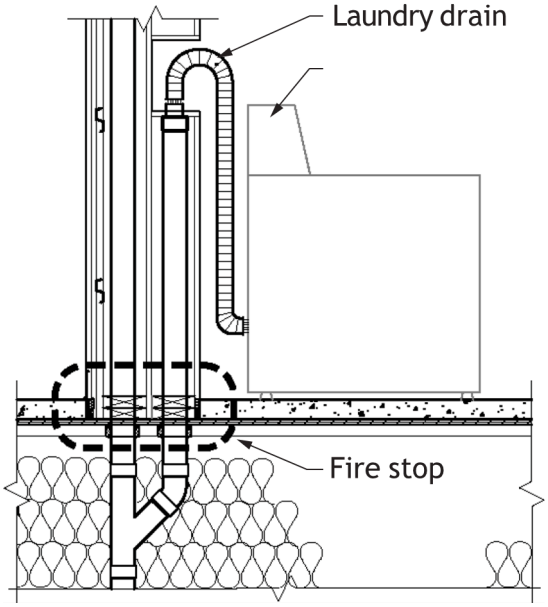


Figure 43 *Penetration of a drainpipe through a furred-out wall assembly* (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (*https://creativecommons.org/licenses/by-nc-sa/4.0/*)

Note: Piping configuration may not be correct to plumbing code requirements. Drawings are not for plumbing design purposes.

Multiple Pipe Penetrations Through Framed Stud Walls

Figure 44 shows a framed opening in a fire-separation stud wall. The framed opening should provide the same fire rating as the fire separation. Refer to the details for the listed firestop system selected. Recall the spacing requirements for multiple penetrations discussed earlier.

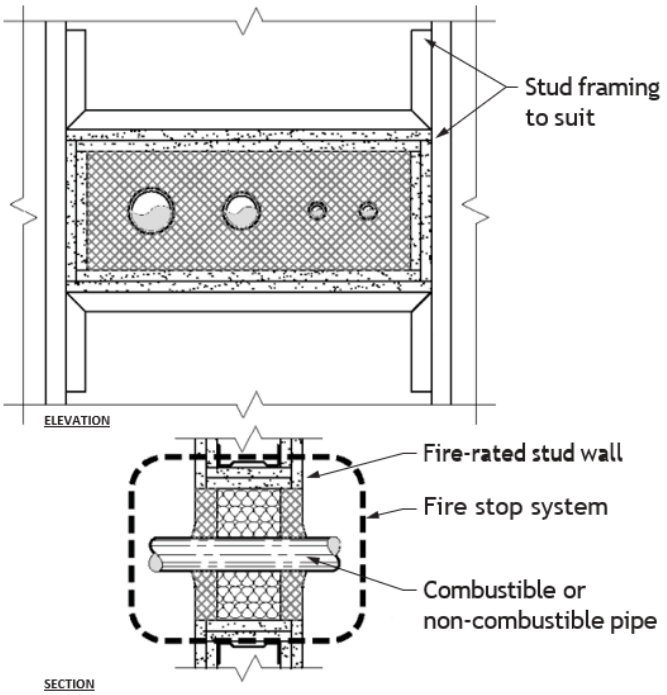


Figure 44 *Multiple pipe penetrations through a fire-rated stud wall* (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (*https://creativecommons.org/licenses/by-nc-sa/4.0/*)

Multiple penetrations through a fire separation should be spread out to the greatest extent possible to achieve best practice. Where multiple penetration openings are needed through a gypsum board wall, many installations will require a frame around the larger openings to support the listed fire-stop system and the penetrating item. An alternative to using individual listed firestop systems, each with its penetrating item(s), is to use a specifically listed fire-stop system for multiple penetrations— especially if the penetrations must be close together.

Sometimes, openings may contain combinations of penetrating items, such as both pipes and cables. When these situations occur, select a listed firestop system design that accommodates the assembly construction materials and the various penetrating items to ensure the integrity of the fire-stop system.

Pipe Penetrations Through Framed Roof Spaces

Figure 45 shows a combustible or non-combustible plumbing vent pipe penetrating a fire-rated ceiling into an attic space. Firestopping is required, as shown. Many buildings are required to have fire-rated roof assemblies. Where these fire-rated roof assemblies are present, pipe penetrations into the concealed roof space must be equipped with firestops at the fire-rated membrane ceiling level. Firestops for sprinkler piping, except those connecting to a sprinkler head, must be installed in the same manner as shown in Figure 45.

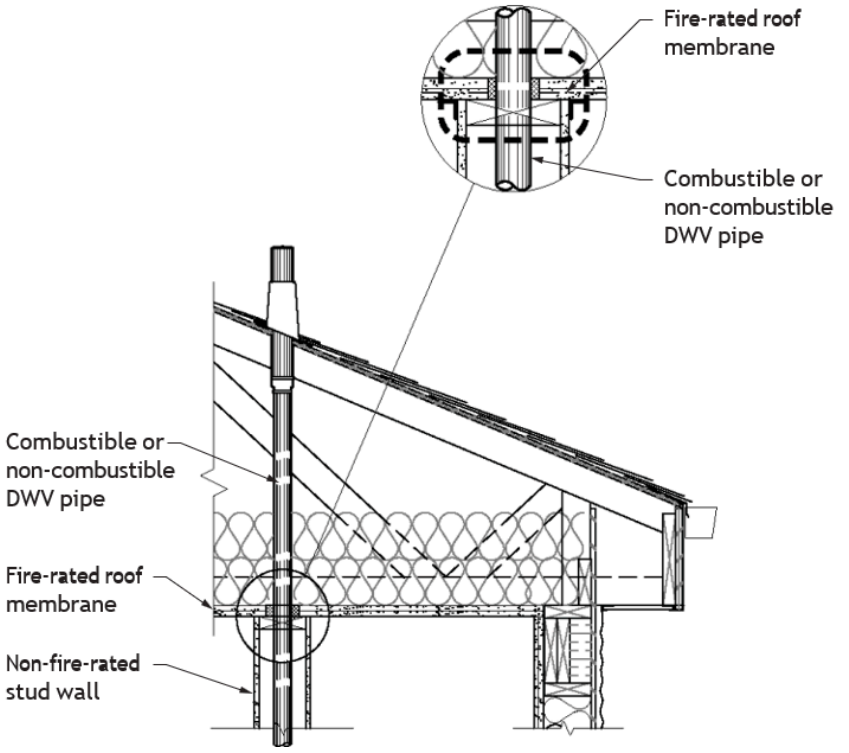


Figure 45 *Penetration of a pipe through a fire-rated ceiling membrane (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Transitions Between Combustible and Non-Combustible Pipe

Sometimes both combustible and non-combustible pipes are used in the same structure. The transitions from combustible pipe to non-combustible pipe must be made in the right location to ensure the fire-protection integrity of the structure (Figure 46). The building code allows combustible DWV pipe to penetrate a horizontal fire separation if it leads directly from a non-combustible water closet through a concrete floor slab. The building code also permits combustible DWV piping to penetrate a fire separation, provided it is equipped with a listed firestop system tested with a 50 Pa (0.01 psi) pressure differential and the pipe is not located in a vertical shaft. Before applying the above arrangement, discuss the application with the authority having jurisdiction in your location. Interpretation of the code may differ in some jurisdictions.

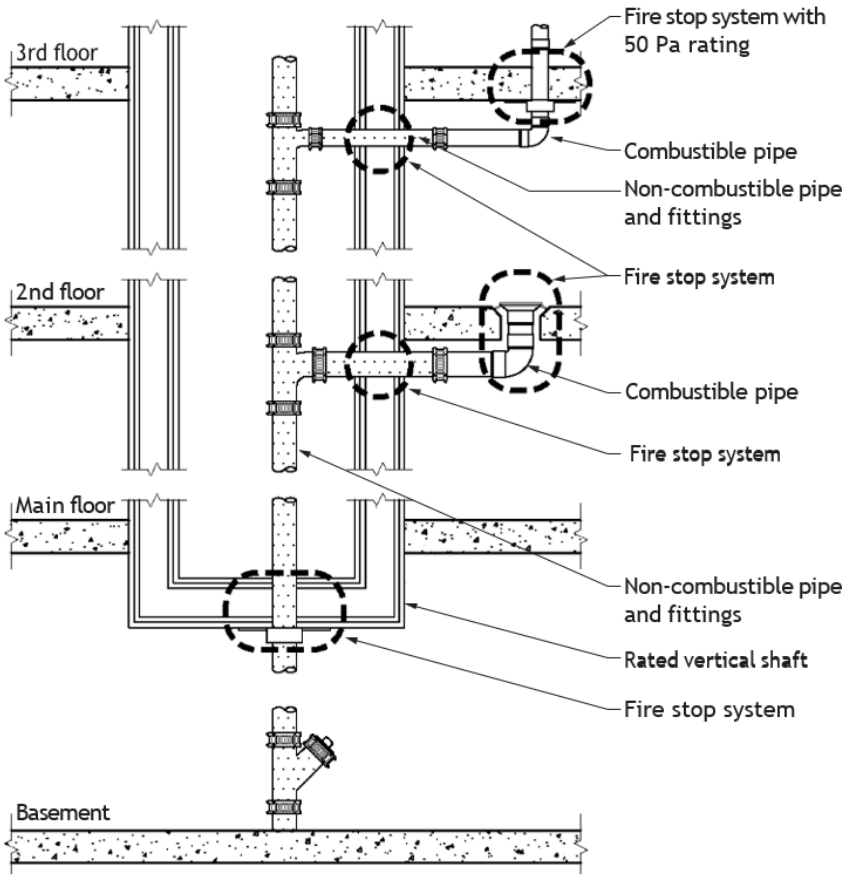


Figure 46 *Piping transition locations and required locations of firestops in a vertical fire-separation shaft (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Note: In both horizontal pipe arrangements, the pipe penetrating the wall of the vertical shaft and the pipe in the shaft itself are non-combustible. A vertical fire-separation shaft passes through several stories. Vertical chase is located within a single storey.

Figure 47 shows combustible DWV piping installed in a vertical chase, as allowed by the building code. The combustible DWV pipe is allowed to penetrate a vertical fire separation, provided that the combustible pipe is not located in a vertical shaft. The vertical run of pipe is located in a chase inside a wall and not in a vertical shaft. The type of firestop chosen will depend on whether or not the wall is fire-rated.

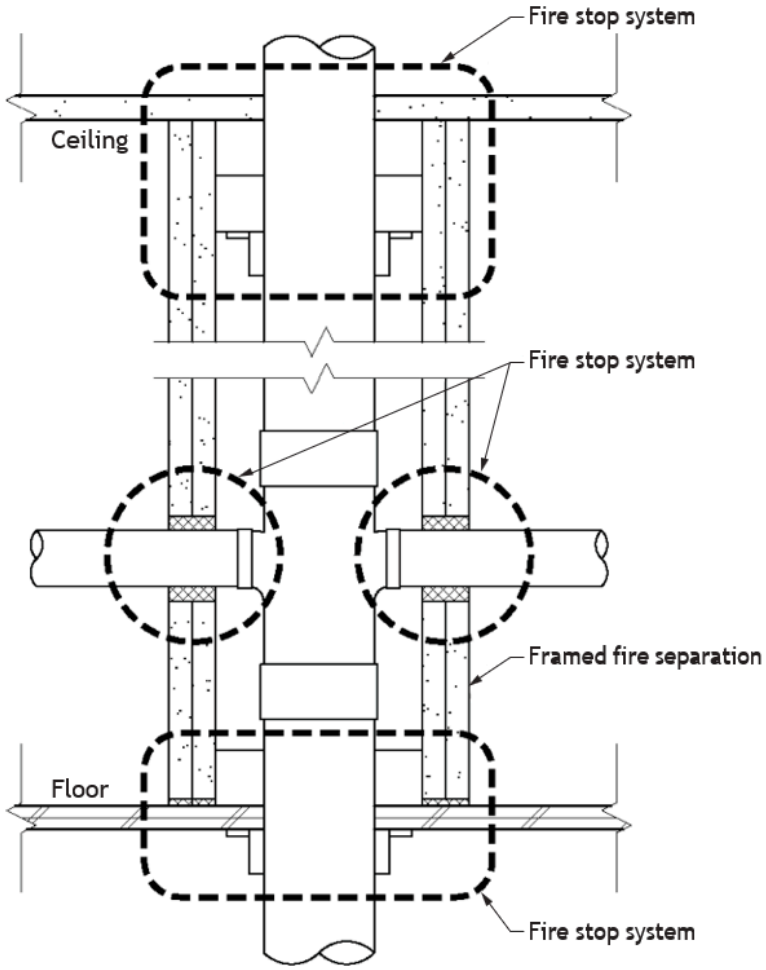


Figure 47 *Combustible DWV pipe penetrating a vertical fire chase separation (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

The combustible pipe is located in a chase inside a fire-rated wall and not in a vertical shaft.

Figure 48 shows combustible DWV pipe installed in a parking garage and passing up through a concrete slab. The firestopping required is as shown. The location of the transition is not clear. Opinions vary on this application. Some firestops may require a minimum distance above the slab before the pipe transition can occur. There are numerous other possible variations of combustible/ non-combustible pipe transitions that can occur in a plumbing system, including those for water pipes. Consult the local authority having jurisdiction before beginning any installations involving such transitions.

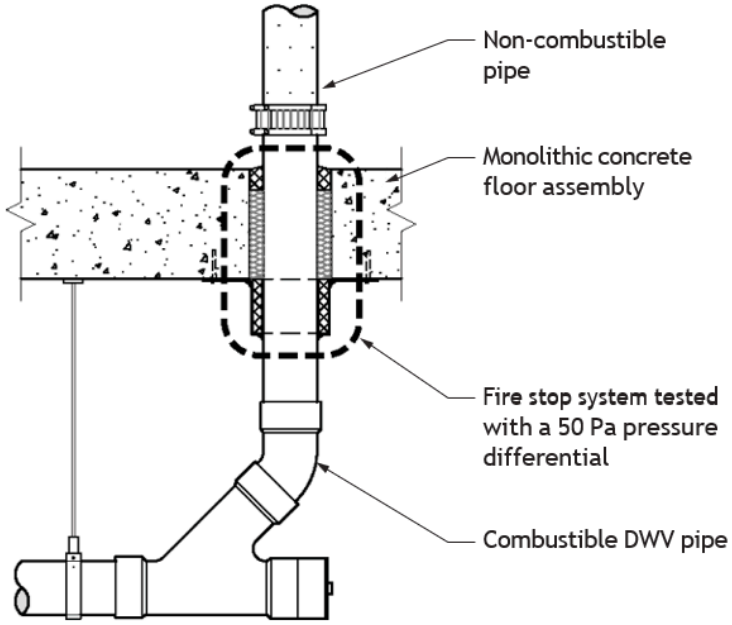


Figure 48 *Transition from combustible pipe in the parking garage below the slab, to non-combustible pipe above the slab (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Maintenance of Firestop Systems

Fire-stop systems require regular inspection and testing to ensure that the components will inhibit fire spread as intended. Moving parts must be adjusted and lubricated.

Labelling Firestop Assemblies

Where practical, all firestopping systems should be labelled for identification purposes to assist with ongoing maintenance, inspection and testing (Figure 49). In some jurisdictions, this is a requirement.

Figure 49 *Fire stop label (Courtesy of Hilti) Used with permission.*

Manufacturer's Installation Instructions

Manufacturers supply installation instructions specific to their product. The instructions typically include photographs or drawings to demonstrate the correct installation methods. Technical data sheets are usually supplied with the installation instructions. These list the important limitations relating to the fire-stopping product, such as:

- Fire-resistant barrier types
- Maximum opening sizes
- Compatible penetrating services
- Surface or other preparation
- Fixing details

Manufacturers and suppliers should provide adequate instruction on the correct installation of their products in line with the as-tested specimens. Adequately detailed installation instructions should ensure that the product is installed correctly.

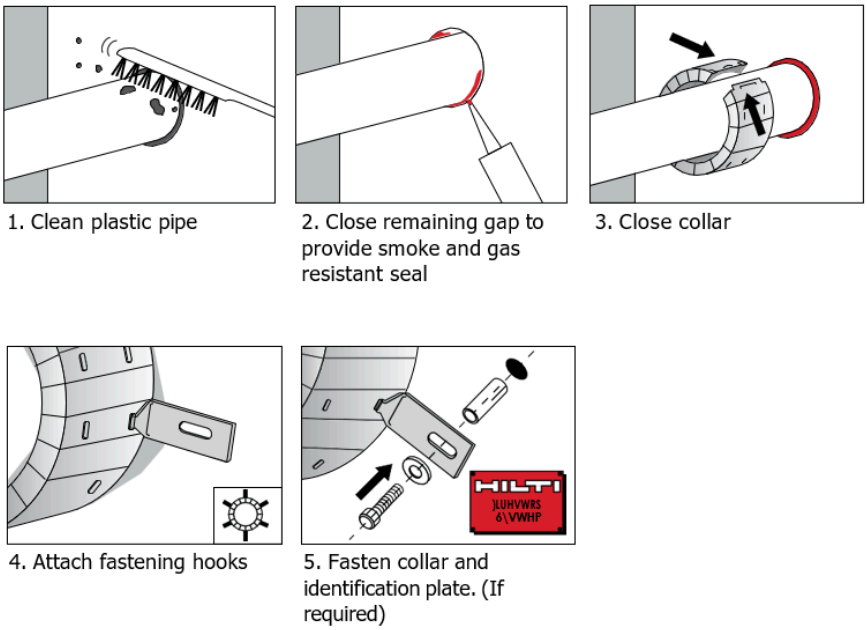


Figure 50 *Typical installation instruction diagrams (Courtesy of Hilti) Used with permission.*

Examples of Firestop Applications

Figure 51 shows piping passing through a concrete block firewall.

Figure 51 *Fire stop in concrete (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Figure 52 shows the underside of a concrete slab above an underground parking garage. The garage is considered a separate building from the floor above.

Figure 52 *Firestop in parking garage ceiling (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

In Figure 52, the single grey combustible plastic pipe on the right does not require insulation for the FT rating. A firestop sleeve that was precast into the concrete slab is visible where the plastic pipe penetrates the slab. The two steel non-combustible pipes on the left are insulated back a specified distance from their fire stop to provide the FT rating. Although not visible, these pipes also have a firestop sleeve precast into the slab.

Figure 53 shows an example of a pipe passing through a concrete slab next to two unused fire stops. Notice the firestop material (putty) used to plug the unused firestop sleeves. Also note the use of a fire-stop collar on the plastic pipe on the left.

The hole for the plastic pipe on the left was cored after the slab had been poured, so a retrofit collar was used. The intumescent collar will expand to fill the hole if the plastic melts. Insulation for FT rating on plastic is not required, as the plastic pipe will not conduct heat in the way steel pipe would.

The two unused sleeves may have been placed incorrectly before the concrete pour. The tops of these unused fire-stop sleeves will also be plugged.

Figure 53 *Fire-stop application* (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (*https://creativecommons.org/licenses/by-nc-sa/4.0/*)

In Figure 54, notice the putty used as firestop material.

Figure 54 *Pipe passing through a drywalled steel stud wall* (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (*https://creativecommons.org/licenses/by-nc-sa/4.0/*)

In Figure 55, insulation provides an FT rating. The importance of accurately placing the sleeves before the slab is poured is clear here. The extra cost of coring the slab reduces the profit margin, and the error in sleeve placement is there for everybody to see.

Figure 55 *Insulated water pipe passing through the underside of a concrete slab in an underground parking lot* (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (*https://creativecommons.org/licenses/by-nc-sa/4.0/*)

In Figure 56, the plastic ABS DWV pipe on the left is boxed out, so it can be used outside of the fire separation.

Figure 56 *Gypsum board used in fire-blocking* (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (*https://creativecommons.org/licenses/by-nc-sa/4.0/*)

Ventilation Vapour Barriers and Moisture Penetration

Moisture and ventilation are important considerations in construction. As air moves into and out of buildings, temperature and pressure differences can occur with the building. Moisture in the air can condense on cold surfaces inside rooms or walls and over time can cause superficial and structural damage and pose a risk to the health of the occupants.

To prevent moisture problems and provide good air quality, buildings today employ heating systems, ventilation system and often air-conditioning systems. Many buildings employ construction methods involving the use of moisture barriers, vapour barriers and rain-screen technology. All of these construction methods strive to maintain an energy-efficient and comfortable environment within the structure.

Mechanical system installers, including the plumbing and pipe trades, must ensure that the piping they install does not jeopardize the efficiency of vapour or moisture barriers and rain-screen technology. Just as for firestopping practices, any piping penetration of vapour and moisture barriers, including rain-screen systems, must maintain the integrity of these systems.

Piping to exterior hose faucets and gas service will penetrate the house wrap. The penetrations must be sealed to prevent moisture penetration. Exterior grade flexible caulking is used to seal around any pipe penetration. The caulking should not react with the piping, such as cross-link polyethylene (PEX) piping. A protective wrap may be needed on the pipe before applying the caulking.

Water pipes exiting an exterior wall that incorporates rain-screen technology must meet these requirements:

- It must be sloped down and the penetration must be sealed. There is no regulation regarding the degree of slope.
- The pipe should be held secure to the structure to withstand the strains applied during use.

Figure 57 *Exterior wall assembly with rain-screen (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (https://creativecommons.org/licenses/by-nc-sa/4.0/)*

Summary

You should now be better equipped to deal with piping penetrations and firestopping. Review the following learning outcomes. Upon completion of this section, you will be able to:

- Install piping systems in structures using various acceptable methods of structure penetrations without jeopardizing the structural integrities of the building.
- Describe acceptable installation methods of structural penetration and read and interpret the related manufacturer's specifications, code regulations and job specifications.

If you feel confident that you have met these outcomes along with the individual topic objectives you are ready to move on. If you do not feel confident, find the time to review the material again.

Self-Test 4.2 Describe Acceptable Methods of Structure Penetration

Complete Self-Test 4.2 and check your answers.

If you are using a printed copy, please find Self-Test D-4.2 (#chapter-self-test-d-4-2-describe-acceptable-methods-of-structure-penetration) and Answer Key (#chapter-answer-key-self-test-d-4-2) in the Appendix at the end. If you prefer, you can scan the QR code with your digital device to go directly to the interactive Self-Test.

An interactive H5P element has been excluded from this version of the text. You can view it online here: https://d-pipingcomponents-bcplumbingapprl1.pressbooks.tru.ca/?p=2154#h5p-12 (https://d-pipingcomponents-bcplumbingapprl1.pressbooks.tru.ca/?p=2154#h5p-12)

References

BC Industry Training Authority. (2019). *Piping trades apprenticeship program: Use Tools and Equipment—Level 1 harmonized* [Binder]. Crown Publications, Queen's Printer for British Columbia. https://www.crownpub.bc.ca/Product/Details/7960000261_S

- Describe factors affecting penetrations in structures
- Plumber: Competency D-6 Penetrate Structures
- Steamfitter: Competency D-3 Penetrate Structures

Hilti Canada. (n.d.). *Hilti Canada.* https://www.hilti.ca/

Hilti Canada. (n.d.). *Firestop collars, wraps and bandages*. https://www.hilti.ca/c/CLS_FIRESTOP_PROTECTION_7131/CLS_FIRESTOP_COLLARS_WRAPS_BANDAGES_7131

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- The following figures are courtesy of Hilti Canada (https://www.hilti.ca/) and are used with permission:
  - **Figure 6** Hilti firestop collar
  - **Figure 7** Cast-in-place sleeve collar
  - **Figure 13** Firestop brick based on a two-component polyurethane foam
  - **Figure 14** Spray filler foam
  - **Figure 15** Application of firestop mortar
  - **Figure 16** Quick-setting mortar in package
  - **Figure 18** Firestop putty
  - **Figure 49** Fire stop label
  - **Figure 50** Typical installation instruction diagrams

Self-Test D-4.1 Describe Factors Affecting Penetrations in Structures

Complete Self-Test D-4.1 and check your answers.

1. What word is defined as the ability of a structural component to perform its designed purpose?
    1. Strength
    2. Agility
    3. Malleability
    4. Integrity
2. What words define a structural construction assembly that acts against the spread of fire?
    1. Fire separation
    2. Fire hose
    3. Fire extinguisher
    4. Fire sprinkler
3. What section of a wood laminated I-beam can be cut?
    1. End of the flange
    2. Centre of the flange
    3. Centre of the beam web
    4. Within 300 mm (12 in.) of the beam end

Figure 1 *Wood I-Beam*

4. What structural wood-frame component cannot be drilled, notched or altered?
    1. Stud
    2. Truss
    3. Joist
    4. Beam
5. What structural hidden component is used in a concrete block wall to tie together and strengthen the wall?
    1. Tie wire
    2. Grade beams
    3. Bond beam
    4. Snap ties
6. What devices are installed before a concrete deck slab is poured?
    1. Pipe hangers
    2. Grid stakes
    3. Cast iron drainage fittings
    4. Concrete inserts for hangers
7. What is the name of a reference point for locating sleeves when canning a formwork deck in preparation for the concrete pour?
    1. Grid line
    2. Datum point
    3. Slab band line
    4. Reinforcing bar line
8. What word describes the space between the inside wall of a pipe sleeve and the outside wall of the penetrating

pipe?

1. Annual
2. Annular
3. Gap
4. Root

9. What premise service piping cannot enter the building from underground?

1. Water
2. Gas
3. Electrical
4. Storm-water

10. What is used to cut a hole for a pipe penetration in a structural concrete slab above a parking garage?

1. Diamond drill coring
2. Jackhammer
3. Cutting torch
4. Laser coring

11. What criteria are used to size a pipe sleeve?

1. Liner pipe expansion and internal sleeve diameter
2. Thickness of penetrating pipe wall and firestop diameter
3. Internal diameter of penetrating pipe and insulation thickness
4. External diameter of penetrating pipe and insulation thickness

12. When should you install pipe sleeves during the construction of the formwork of a concrete slab?

1. Before the formwork is complete
2. Before the reinforcing bar and conduit are installed
3. After all reinforcing and conduit have been installed
4. During the pour of the concrete slab

13. What is the minimum width of undamaged wood in the top plate of a wood stud wall that is permitted without additional reinforcement?

1. 25 mm (1 in.)
2. 40 mm (1 ½ in.)
3. 50 mm (2 in.)
4. 75 mm (3 in.)

14. What is the minimum total undamaged dimension of a notched wood stud in a load-bearing wall that is permitted without additional reinforcement?

1. 1 ½ in. (40 mm)
2. One-quarter the depth of the stud
3. One-third the depth of the stud
4. Two-thirds the depth of the stud

Answer Key: Self-Test D-4.1 (#chapter-answer-key-self-test-d-4-1) is on the next page.

Answer Key: Self-Test D-4.1

1. d. Integrity
2. a. Fire separation
3. c. Centre of the beam web
4. b. Truss
5. c. Bond beam
6. d. Concrete inserts for hangers
7. a. Grid line
8. b. Annular
9. b. Gas
10. a. Diamond drill coring
11. d. External diameter of penetrating pipe and insulation thickness
12. b. Before the reinforcing bar and conduit are installed
13. c. 50 mm (2 in.)
14. d. Two-thirds the depth of the stud

Self-Test D-4.2 Describe Acceptable Methods of Structure Penetration

Complete Self-Test D-4.2 and check your answers.

1. What name defines a substance that swells as a result of heat exposure?
    a. Intumescent
    b. Exothermic
    c. Endothermic
    d. Active fire-protection expansive
2. What word defines the space between a penetrating item and whatever surrounds it, such as the sides of an opening or a sleeve?
    a. Void
    b. Granular
    c. Annular
    d. Sealant
3. What abbreviation defines fire prevention rating for a firestop with a flame transfer and high temperature rating?
    a. F
    b. FR
    c. FP
    d. FT
4. What type of fire prevention system is a firestopping system?
    a. Active
    b. Passive
    c. Aggressive
    d. Preventive
5. What fire rating is required for a firestop located in a horizontal fire separation above a parking garage classified as a separate building?
    a. F only
    b. FT
    c. FR
    d. FP
6. What is the design application of the firestop collar shown here?
    a. Wall and ceiling installation
    b. Installation after the concrete is poured
    c. Installation requiring an FT rating of four hours
    d. Installation before the concrete is poured
7. What type of penetration is one where the fire stop is used for a penetrating item that passes through only one membrane of a fire-rated assembly?
    a. Membrane
    b. Through
    c. One side penetration

Figure 1 *Hilti firestop collar*

d. Partial separation fire stop

8. What type of fire stop consists of a steel or plastic canister, filled with a predetermined amount of intumescent that expands to many times its original volume, helping crush plastic pipe and fill the void?
    a. Mineral wool
    b. Firestop collar
    c. Surface-mounted collar
    d. Composite sheet board
9. What type of fire stop is often used for single and multiple penetrations in an opening because it is adaptable to more complex and unusual penetrations and openings?
    a. Caulking
    b. Collar
    c. Pillow
    d. Foam blocks
10. What fire rating is required for non-combustible pipe penetration through a monolithic concrete slab between separate occupancies?
    a. F
    b. FT
    c. FR
    d. FP
11. What additional protection is required, besides the firestop, for a non-combustible pipe penetration through a monolithic concrete slab between separate occupancies such as a parking garage and the occupancy above?
    a. Insulation placed on the pipe below the slab
    b. Insulation placed on the pipe above the slab
    c. Insulation placed on the pipe above and below the slab
    d. Firestop collar place above and below the slab
12. What is required for a non-combustible sprinkler pipe that penetrates a fire-rated ceiling membrane and is connected directly to a sprinkler head?
    a. Collar
    b. Intumescent putty
    c. Silicone caulking
    d. Tightly fitted escutcheon
13. What is required for a non-combustible pipe penetration passing through an FT-rated firewall?
    a. Fire collar on one side of the wall
    b. Insulation placed on the pipe on one side of the wall
    c. Insulation placed on the pipe on both sides of the wall
    d. Firestop pillows placed on both sides of the wall
14. What is required for a water pipe exiting an exterior wall that incorporates rain-screen technology?
    a. Sloped down in the direction of flow and the penetration sealed
    b. Sloped down opposite the direction of flow and the penetration not sealed
    c. Sloped up in the direction of flow and the penetration not sealed
    d. Installed with no slope and the penetration left open to ventilate the air space

Answer Key: Self-Test D-4.2 (#chapter-answer-key-self-test-d-4-2) is on the next page.

Answer Key: Self-Test D-4.2

1. a. Intumescent
2. c. Annular
3. d. FT
4. b. Passive
5. b. FT
6. d. Installation before the concrete is poured
7. a. Membrane
8. b. Fire-stop collar
9. a. Caulking
10. b. FT
11. a. Insulation placed on the pipe below the slab
12. d. Tightly fitted escutcheon
13. c. Insulation placed on the pipe on both sides of the wall
14. a. Sloped down in the direction of flow and the penetration sealed

Version History

This page provides a record of changes made to this learning resource, Plumbing Apprenticeship Level 1, Block D (https://d-pipingcomponents-bcplumbingapprl1.pressbooks.tru.ca/). Each update increases the version number by 0.1. The most recent version is reflected in the exported files for this resource.

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Table 1: Version History Table

Version	Date	Change	Details

Plumbing Apprenticeship & Trade Resources in BC

A successful career in plumbing requires a strong foundation of skills, knowledge, and workplace safety awareness. Below are key resources to support plumbing apprentices in BC, including educational pathways, trade certifications, workplace safety guidelines, and mental health and wellness support.

Plumbing Apprenticeship & Certification Resources

- **SkilledTradesBC – Plumbing Apprenticeship (https://skilledtradesbc.ca/plumber)** — Overview of plumbing training, certification requirements, and apprenticeship pathways in British Columbia.
- **Red Seal Program – Plumber (https://www.red-seal.ca/eng/trades/plumbers/overview.shtml)** — National certification program with exam prep guides and trade mobility information.
- **BC Building Codes & Standards (https://www.bccodes.ca/)** — Official building and plumbing codes for British Columbia.

Workplace Safety & Regulations

- **WorkSafeBC (https://www.worksafebc.com/en)** — Essential safety resources for plumbers, including:
  - Health & Safety – WorkSafeBC (https://www.worksafebc.com/en/health-safety)
  - Report Unsafe Working Conditions (https://www.worksafebc.com/en/contact-us/departments-and-services/health-safety-prevention)
  - Report a Workplace Injury or Disease (https://www.worksafebc.com/en/claims/report-workplace-injury-illness)
  - Submit a Notice of Project Form (https://www.worksafebc.com/en/for-employers/just-for-you/submit-notice-project)
  - Get Health and Safety Resources (Videos, Posters, Publications, and More) (https://www.worksafebc.com/en/resources-health-safety)
  - Search the OHS Regulations (and Related Materials) (https://www.worksafebc.com/en/law-policy/occupational-health-safety/searchable-ohs-regulation)
  - Conduct an Incident Investigation (https://www.worksafebc.com/en/health-safety/create-manage/incident-investigations/conducting-employer-investigation)
- **CCOHS: OHS Answers Fact Sheets – Plumber (https://www.ccohs.ca/oshanswers/occup_workplace/plumber.html)** — Safety guidelines and best practices for plumbers in various work environments.

Financial Supports

- **Financial Support (SkilledTradesBC)** (https://skilledtradesbc.ca/financial-support) — Information about grants, tax credits, Canada apprentice loans, employment insurance, and the Indigenous Skills and Employment Training

(ISET) program.
- **StudentAidBC (https://studentaidbc.ca/)** — Complete post-secondary education through student loans, grants, and scholarships. There is also programs that help with loan repayment.
- **WorkBC (Government of BC)** (https://www.workbc.ca/find-loans-and-grants/students-and-adult-learners/services-apprentices-and-employers) — Services for apprentices and employers.

Mental Health & Wellness Support

- **HealthLink BC – Mental Health and Substance Use** (https://www.healthlinkbc.ca/mental-health-and-substance-use) — HealthLink BC resources for mental health and wellness support.
- **Here2Talk** (https://here2talk.ca/) — Free and confidential counseling services available to all post-secondary students registered at a BC school.
- **Help Starts Here** (https://helpstartshere.gov.bc.ca/) — A database with over 2,500 listings of services related to mental health and substance use supports.
- **Hope for Wellness Helpline** (https://www.hopeforwellness.ca/) — 24/7 online chat and phone line with experienced and culturally competent counselors available to all Indigenous people in Canada.
    - First Nations Health Authority Mental Health Supports Info Sheet [PDF] (https://www.fnha.ca/Documents/FNHA-mental-health-and-wellness-supports-for-indigenous-people.pdf) by First Nations health Authority — List of culturally safe services for Indigenous people.
- **HeretoHelp – BC** (https://www.heretohelp.bc.ca/) — Mental health resources, including videos, articles, and support services in BC.
- **BC Construction Industry Rehabilitation Plan** (https://www.constructionrehabplan.com/) — Mental health and substance use services for CLRA and BCBT members and their families.
- **Virtual Mental Health Supports (Government of BC)** (https://www2.gov.bc.ca/gov/content/health/managing-your-health/mental-health-substance-use/virtual-mental-health-supports) — Virtual services are available for British Columbians who are experiencing anxiety, depression, or other mental health challenges.

Crisis Support

- **Interior Crisis Line Network** — Call 1-888-353-2273 (tel:+1-888-353-2273) for 24/7 emotional support, crisis intervention, and community resource information.
- **Talk Suicide Chat Service** (https://talksuicide.ca/) — An alternative if calling is difficult; available for crisis intervention.
- **310Mental Health Support** — Call 250-310-6789 (tel:+1-250-310-6789) for emotional support, information, and resources specific to mental health.
- **1-800-SUICIDE** — Call 1-800-784-2433 (tel:+1-800-784-2433) if you are experiencing feelings of distress or despair, including thoughts of suicide.
- **Opioid Treatment Access Line** — Call 1-833-804-8111 (tel:+1-833-804-8111) between 9 am and 4 pm to connect with a doctor, nurse, or healthcare worker who can prescribe opioid treatment medication that same day.
- **KUU-US Crisis Response Service** — Call 1-800-588-8717 (tel:+1-800-588-8717) for culturally-aware crisis support for Indigenous peoples in BC.
- **Alcohol and Drug Information and Referral Service** — Call 1-800-663-1441 (tel:+1-800-663-1441) to find resources and support.

Emergency Services — For life-threatening situations, call 911 or visit your nearest emergency department.