

Block D: Piping and Components



Plumbing Apprenticeship Program Level 1 Series

Block D: Piping and Components

BC Plumbing Apprenticeship, Level 1

SKILLEDTRADESBC

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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-bcplumbingapprli.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-bcplumbingapprli.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-bcplumbingapprli.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-bcplumbingapprli.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.

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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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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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- Camosun College
- Trades Training BC

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(<https://skilledtradesbc.ca/>)

To order printed copies of Program Outlines or learning resources (where available) for BC Trades, contact:

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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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References

- 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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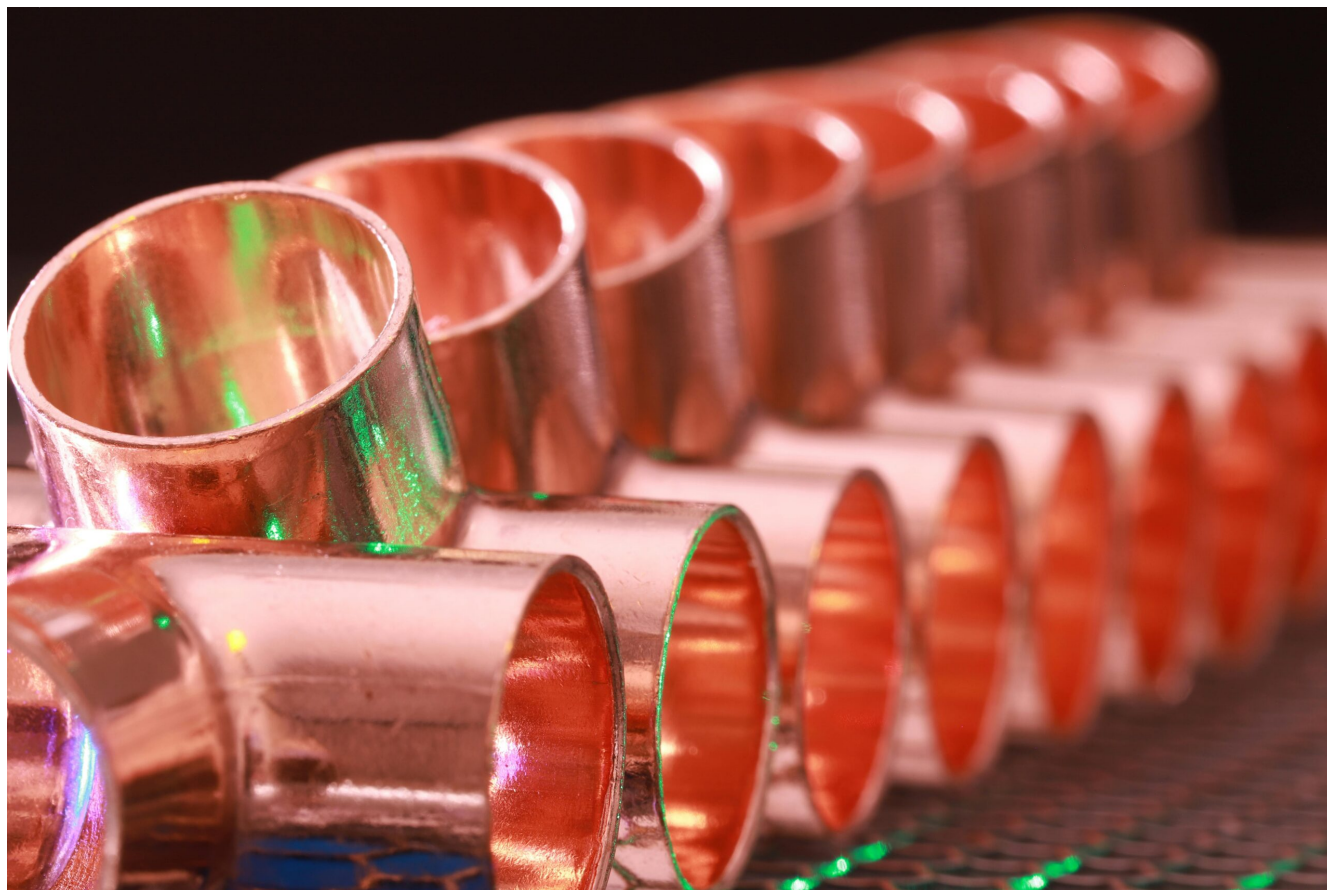
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PART III

D-3 INSTALL FITTINGS

Plumber Apprenticeship Program – Level 1



Copper plumbing fittings arranged in a row, showcasing metallic texture and industrial detail. (<https://www.pexels.com/photo/copper-plumbing-fitting-28169591/>) (Nic Wood/Pexels) Pexels license (<https://www.pexels.com/license/>)

D-3 Install Fittings Introduction

Pipe fittings are essential components used to connect, direct, and control the flow of piping systems in the trades. In this section, you will learn how to visually identify common fittings, understand their purpose, and interpret the abbreviations used to describe them. You will also explore different connection methods and develop the skills needed to select appropriate fittings for various applications. Building a strong understanding of fittings terminology and use is a key step toward working safely and effectively in the pipe trades.

Learning Objectives

After completing this section, you will be able to:

- Visually identify and name common types of pipe fittings
- Interpret and write common abbreviations used in the pipe trades
- Describe fittings used in the pipe trades.
- Describe connection methods of fittings.
- Select fittings.
- Compile a basic, *readable, logically ordered* materials list using the basic procedures outlined in this section.

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



Resources

You may be required to reference publications and videos available online at the WorkSafeBC (<https://www.worksafebc.com/en>) website.

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**.

- **adapter fitting:** A fitting used to connect pipes with different connection types. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **branch:** The pipe that connects off the main run of a fitting. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **bushing:** A fitting used to reduce the size of a pipe opening, usually with threaded ends. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **cap:** A fitting used to close the end of a pipe with internal threads. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **cleanout:** An access point in a pipe system used to remove blockages. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **coupling:** A short fitting used to join two pipes in a straight line. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **dwv fittings:** Fittings used to carry drainage, waste, and vent fluids by gravity. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **elastomeric:** A material that is flexible and rubber-like, able to stretch and return to its original shape. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **elbow:** A fitting used to change the direction of a pipe. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **full-face gasket:** A gasket that covers the entire face of a flange, including the bolt holes, to provide a complete seal between two flanged surfaces. (Section D-3.2 (#chapter-d-3-2-section-2))
- **gasket:** (Sometimes referred to as a *compression type fitting* or *connection*); A flat sealing material placed between two surfaces to prevent leaks when they are joined together. (Section D-3.2 (#chapter-d-3-2-section-2))
- **hub end:** The end of a fitting that receives another pipe or fitting. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **materials list:** A list of materials needed to complete a job, used to communicate with suppliers or plan work on site. (Section D-3.3 (#chapter-d-3-3-select-fittings))
- **materials takeoff (materials takeoff list):** A detailed list of materials and quantities required for a job, often used for estimating costs and planning. (Section D-3.3 (#chapter-d-3-3-select-fittings))
- **packing:** A sealing material made of flexible (pliable) materials that provides a dynamic seal between a moving part and a stationary part, such as around a valve stem to prevent leaks. Common types include graphite packing. (Section D-3.2 (#chapter-d-3-2-section-2))
- **plug:** A fitting with external threads used to seal the end of a pipe. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **plumber's putty:** A soft, moldable sealing compound used to create watertight seals around fixtures such as sinks and drains. (Section D-3.2 (#chapter-d-3-2-section-2))
- **pressure fittings:** Fittings designed to carry fluids under pressure. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))

- **reducing fitting:** A fitting used to connect pipes of different sizes. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **run:** The straight-through portion of a fitting. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **sanitary tee (san tee):** A fitting used in drainage systems to connect pipes at a 90-degree angle with a curved path for smooth flow. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **sealant:** A material used to fill gaps and create a watertight or airtight seal between surfaces. (Section D-3.2 (#chapter-d-3-2-section-2))
- **side inlet fitting:** A fitting with an additional connection on the side. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **silicone caulking:** A flexible sealant and adhesive compound used to fill gaps and create a watertight seal around fixtures, joints, and surfaces, often containing mildew-resistant chemicals. (Section D-3.2 (#chapter-d-3-2-section-2))
- **solvent cement:** A chemical adhesive used to join plastic pipes by softening and fusing the surfaces together to form a permanent bond. (Section D-3.2 (#chapter-d-3-2-section-2))
- **spigot end:** The end of a pipe or fitting that fits into a hub end. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **street elbow:** An elbow with male threads on one end and female threads on the other. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **tee:** A fitting that connects three pipes. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **teflon thread compound:** A type of thread sealant that contains PTFE (Teflon) to help seal threaded connections, reduce friction, and prevent leaks. (Section D-3.2 (#chapter-d-3-2-section-2))
- **thread compound (pipe dope):** A paste applied to threaded pipe connections to seal gaps, prevent leaks, and make assembly easier. (Section D-3.2 (#chapter-d-3-2-section-2))
- **union:** A fitting that allows pipes to be easily connected and disconnected. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))
- **wye:** A fitting that connects pipes at an angle (usually 45°) for smoother flow. (Section D-3.1 (#chapter-ch-3-install-fittings-3-1))

D-3.1 Describe Fittings Used in the Pipe Trades

Fittings Terminology

The terminology used to identify fittings may include all or some of the following information:

- Fitting size
- Material the fitting is made from (e.g. cast iron, copper, ABS, etc.)
- Intended use for the fitting (pressure or drainage, etc.)
- Basic shape of the fitting (tee, elbow, wye, etc.)
- Joint type (soldered, threaded, solvent cement, etc.)

As you proceed through this section, you will learn to use all of these characteristics to identify and name fittings.

Abbreviations Used to Identify Fittings

Abbreviations are used throughout the industry to reduce the amount of writing needed to identify fittings. Pipe tradespersons use abbreviations when compiling **material takeoff lists**. Abbreviations may vary depending on the manufacturer and local practices. These differences can cause errors when interpreting a material list. If you do not know the correct abbreviation, write out the full word.

Incorrect use of an abbreviation may result in a wrong fitting being priced and shipped to the job site. Abbreviations should be clearly written, and both the writer and the reader should be able to interpret the abbreviation correctly.

Table 1 lists some common abbreviations used in the pipe trades. You must memorize these common abbreviations, and be able to interpret and write them. Be aware that the table does not show all possible abbreviations.

Table 1: Common Pipe Fitting Abbreviations

Abbreviation	Meaning
Adpt	Adapter
Blk CI	Black cast iron (threaded pipe fittings)
Blk mal	Black malleable (threaded pipe and fittings not galvanized)
C×C	Copper by copper (pipe and fittings)
C×FIPT	Copper by female iron pipe thread
c/o	Clean out
CB	Cast brass; also catch basin
CI	Cast iron (pipe and fittings)
CSA	Canadian Standards Association. Note: All fittings and pipe used in the plumbing system must be CSA approved for the application for which they are used.
Dbl	Double (e.g. double wye)
90 degree ell	90 degree elbow
DWV	Drainage waste and vent fittings and pipe
Fit.C×FIPT	Fitting copper by female iron pipe thread
Galv	Galvanized (pipe and fittings with a zinc coating for corrosion resistance)
IPS	Iron pipe size
IPT	Internal pipe thread, or iron pipe thread
F or M	Female or male
FPT	Female pipe thread
FIPT	Female iron pipe thread
JIC	Joint Industry Conference
Mal	Malleable (pipe and fittings)
MJ	Mechanical joint clamp (pipe and fittings)
MIP, MPT, or MIPT	Male iron pipe, male pipe thread or male iron pipe thread

OPT	Outside pipe thread
RH or LH	RH = right hand; LH = left hand (used when identifying the location of the side outlet on a DWV fitting)
S	Solvent cement ABS and PVC socket fitting joint
SAE	Society of Automotive Engineers
San	Sanitary (drainage fittings)
Sch	Schedule (used to describe a steel pipe wall thickness)
SO	Side outlet (used to describe a tee with a side outlet connection)
SP	Spigot end
Tapt	tapped (refers to fitting openings that are threaded to accept MIP threads)
w/o	without (e.g. an ABS P trap w/o cleanout)
WB	Wingback
WC	Water closet
WOG	Water, oil, gas
SWOG	Steam, water, oil, gas
Wrot	Wrought
Wye	Y fitting

Abbreviations Exercise

Complete Table 2 from memory if possible. Then refer to Table 1 and other sources to check your answers and find any missing abbreviations.

Table 2: Abbreviations Exercise

Abbreviation	Meaning
ell	
	Adapter
	Black cast iron (threaded pipe fittings)
	Black malleable (threaded pipe and fittings, not galvanized)
C×C	
C×FIPT	
c/o	
	Cast iron (pipe and fittings)
CSA	
Dbl	Double (e.g. double wye)
DWV	
FIPT	
Galv	
IPS	
IPT	
FPT or FIPT	
	Malleable (pipe and fittings)
	Mechanical joint clamp (pipe and fittings)
OPT and MPT	

RH or LH	
MIPT	
SAE	
	Sanitary (drainage fittings)
	Schedule (used to describe a steel pipe wall thickness)
	Side outlet (used to describe a tee with a side outlet connection)
	Spigot end
Tap	
	without (e.g. an ABS P-trap w/o cleanout)
WC	
WB	
WOG	
	Wrought
	Y fitting

Types of Fitting Applications

Fittings are commonly separated into two basic application types:

- **Pressure fittings** (used to carry fluids under pressure)
- **DWV fittings** (used to carry fluids by gravity; drainage, waste, and venting)

Differences Between DWV and Pressure Fittings

Plumbing fittings are often identified by application and shape. There are four main differences between **DWV fittings** and **pressure fittings**. You should be able to note these differences and identify, from a selection of fittings, which fittings are for pressure applications and which fittings are for DWV applications.

The four main differences between pressure and DWV fittings are:

1. Pressure fittings have an abrupt turn **radius** at the **throat** of the fitting, while the DWV fitting has a gradual change in direction.
2. The socket end of pressure fittings are usually much deeper, providing greater joint strength than DWV fitting joints.
3. DWV fittings have a recessed interior surface. When the inside surfaces are aligned, flow is smoother and blockages are reduced. All DWV fittings have this recess.
4. Copper pressure fittings may have thicker walls than DWV fittings.

Test Yourself

You must be able to identify fittings correctly when making a *material takeoff list*. As you go through this module, cover the fitting descriptions and write out the correct identification of each fitting. Remember, one of your objectives is to be able to visually name and identify pipe fittings.

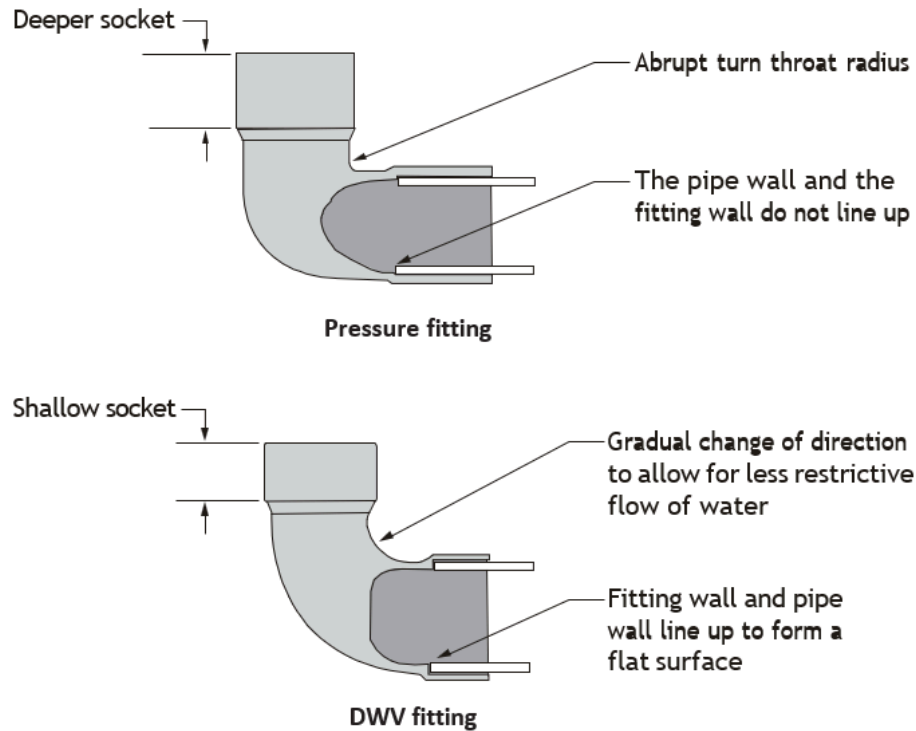


Figure 1 Differences between pressure fittings and DWV fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Fittings used for pressure applications should not be interchanged with those for drainage, waste, and vent purposes (DWV systems). Although the basic shapes and sizes may be the same, the specific design of each is different. An important feature to remember when you are trying to identify fittings is that DWV fittings have more gradual bends to direct the flow (Figure 2).

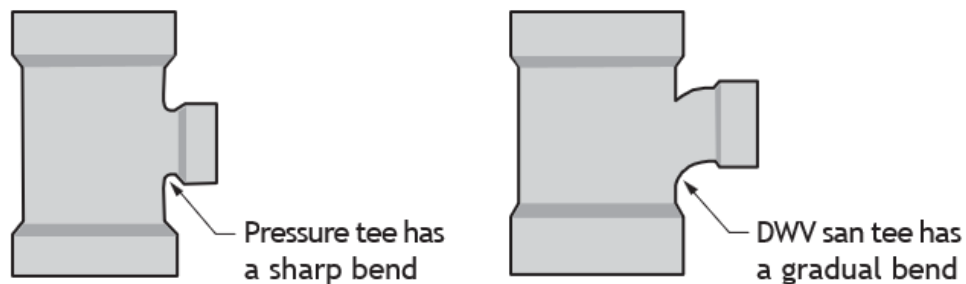


Figure 2 Pressure and DWV tees (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Basic Parts of Fittings

Pipe tradespersons must be able to identify the basic parts of fittings to measure and install them correctly. For example,

plumbing codes require that 4" diameter (10 cm) or less than 90 degree elbows have a **centreline** radius of not less than their diameter. To interpret the code, the pipe tradesperson must be able to identify where the radius and the centreline are located. Similarly, when installing pipe, tube, and fittings, a tradesperson must be able to identify the parts of fittings in order to accurately measure them.

The basic parts of a fitting include:

- Throat
- Radius
- **Hub end** (also referred to as the *socket* or *bell end*)
- **Spigot end** (the end of a fitting or pipe that has no hub: fits into the hub end of another fitting or pipe)
- Centreline (an imaginary line along the centre of pipes and fittings)
- **Face** (also referred to as front; generally used to refer to a flange face)
- Back (the back of the fitting)

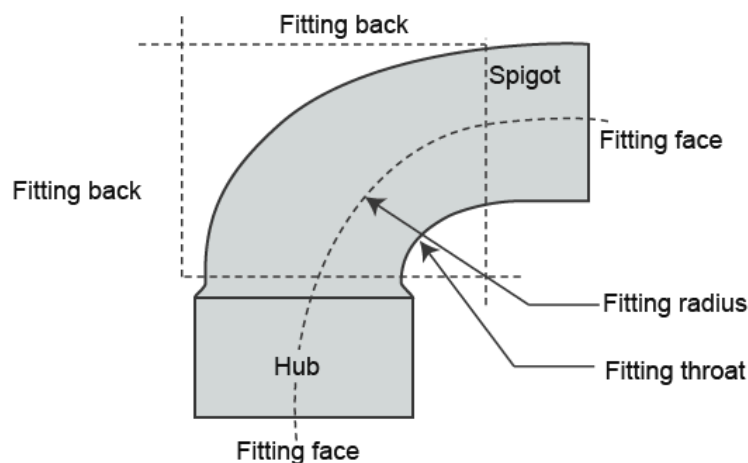


Figure 3 Parts of a 1 1/2" ABS hub x spigot 90 deg elbow (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Considerations When Selecting Fittings

Pressure Ratings

System pressure is an important factor when selecting fittings. Piping system pressures can vary from atmospheric pressure to several thousand kilopascals (kPa), or pounds per square inch (psi). Fittings must be designed and made from materials that can withstand these pressures. You will learn later how pressure ratings are also used when describing fittings.

Wrought (Wrot) Copper Compared to Cast Brass

Fittings for copper piping can be made of **wrought copper** or **cast brass**. Wrought copper fittings, sometimes referred to as *streamline fittings*, have the same colour, smooth texture and **malleability** as copper pipe. Cast brass fittings have a rougher texture and a brass-coloured appearance, and are not as malleable as copper. These differences may be a concern when selecting a fitting: cast brass fittings manufactured for use in DWV and potable water systems may not be suitable for high temperature **brazing**. Industrial-grade cast brass fittings can be used for high-temperature brazing.

Figure 4 shows wrought copper and cast brass fittings for various applications. Figure 5 show examples of copper and brass fittings.



Wrought copper DWV sanitary reducing tee
(Courtesy of NIBCO INC)



Cast brass DWV tapt sanitary reducing tee
(Courtesy of NIBCO INC)



**Copper pressure fitting has a deeper socket
for greater strength of the joint**
(Courtesy of NIBCO INC)



DWV fitting has a shallow socket
(Courtesy of NIBCO INC)

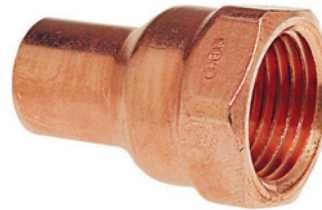


Cast brass DWV double tee C x C x C x C (Courtesy of NIBCO INC)

Figure 4 Various wrought copper and cast brass fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Flush brass bushing FIP, 3/4" up to 1 1/2" (Courtesy of NIBCO INC)



Wrought copper fitting adapter Ftg x FIP Wrot (Courtesy of NIBCO INC)



Copper 180 deg return bend (Courtesy of NIBCO INC)



Cast 90° Elbow Close Rough C x C (Courtesy of NIBCO INC)

Figure 5 Various copper and brass fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

A **wrought copper solder pressure female adapter** is used in residential and commercial systems such as potable water, air conditioning and refrigeration. Options also include cleaned and bagged for medical gas applications.

Malleable Iron vs Cast Iron Threaded Fittings

Table 3: Malleable Iron Compared to Cast Iron Threaded Fittings

Cast Iron	Malleable Iron
Cast iron fittings have a larger bead than <i>malleable iron fittings</i> . Recall that the term bead is used to describe thickening on a threaded fitting, to provide strength at the point of the thread connection. The thick bead is required for strength.	Malleable fittings resist cracking due to their malleability.
Cast iron fittings will crack if subjected to excessive stress, such as over-tightening.	Malleable iron fittings are stronger and will stretch rather than crack under normal installation. The size of the bead is therefore smaller than a cast iron fitting bead.
Cast iron fittings have a greater chance of containing sand holes produced at the time of manufacture.	Malleable iron fittings are typically used in gas piping systems.
Cast iron fittings can crack and are unsuitable for gas piping.	
Cast iron pattern threaded fittings may be used in hot water (hydronic) space heating systems.	



Mal iron 90 deg elbow



Cast iron 90 deg elbow

Figure 6 Malleable iron to cast iron bead comparison (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Both types of fittings are used in piping systems. Always check the job specifications and local codes to determine the correct application.

Threaded fittings are also available in brass for use in potable water systems, and forged steel for use in high-pressure fluid systems such as steam and hydraulic systems.

Types of Fittings

Figures 7 show examples of fittings in the three basic categories: elbows, tees, and specialty fittings. Notice that the size designations have not been included. Sizing identification will be included later in this section.

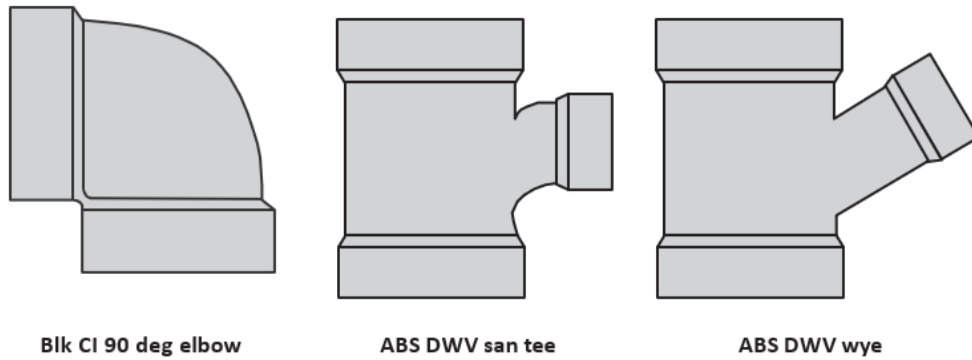


Figure 7 Three common fitting configurations (elbow, tee and wye) (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

- Elbows (bends)
- Tees, double tees (crosses), wyes, double wyes
- Specialty fittings (fittings that do not fit into the first two groups), including:
 - ▶ Couplings and unions
 - ▶ Adapters
 - ▶ Bushings and reducers
 - ▶ Caps, plugs and cleanouts
 - ▶ Traps and continuous waste fittings



Cast iron fittings



Malleable iron fittings

Figure 8 Various threaded fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Elbows

Pipe tradespersons use the term **elbow** to describe fittings that change the direction of a pipeline.

Common angles include:

- 22½°
- 45°
- 60°
- 90°

Other angles can be obtained from the manufacturer, or in some cases the elbow may be fabricated on the job site. Fabrication of fittings is more closely related to the job of a steamfitter. Plumbers would normally purchase elbows with the standard changes of direction. Experienced pipe tradespersons can correctly identify the angle of a fitting just by looking at it.

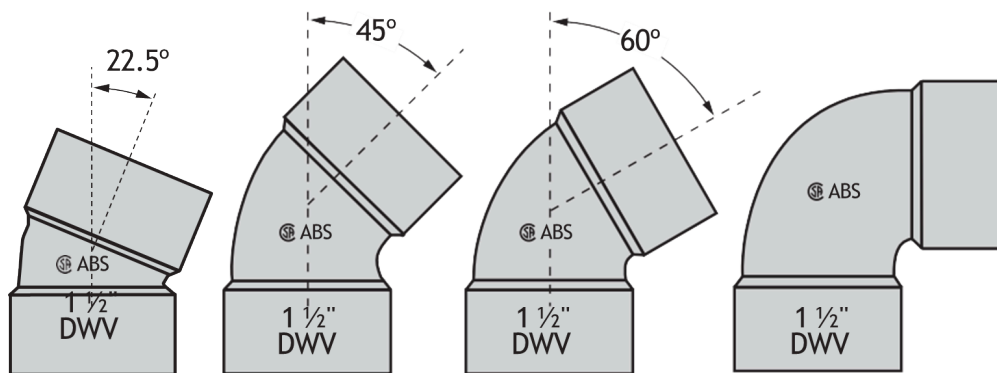


Figure 9 Elbows (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Standard radius elbows and long radius elbows are also manufactured. **Long radius** can also be referred to as *long sweep*.

Manufacturers sometimes use the terms **short radius**, **long radius** and **standard turn** to describe the different radii of their elbows. Some elbows are available with a 180 degrees change of direction. These are called **return bends**.

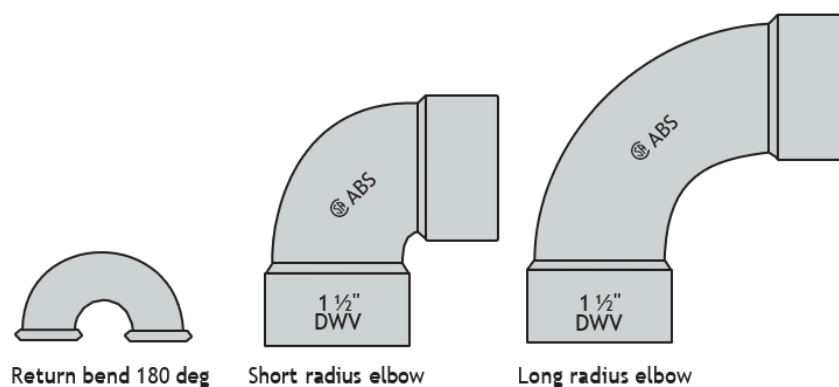


Figure 10 Bend and elbows (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Fittings often include printing that indicates the size, use, and type of material from which the fittings are made. Also notice the Canadian Standards Association (CSA) stamp of approval.

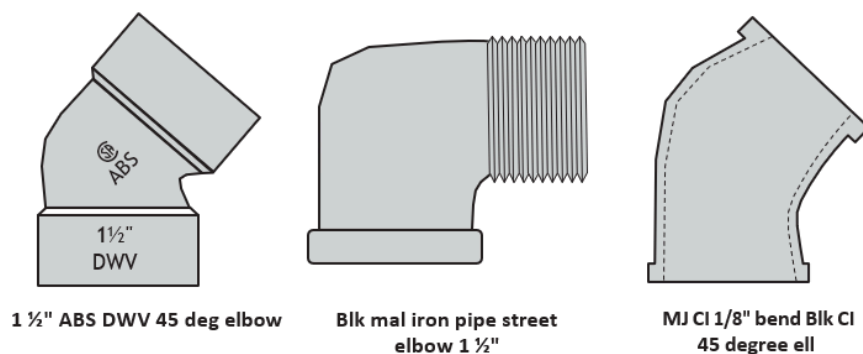


Figure 11 Various fittings for identification (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Street Elbows

A **street elbow** is an elbow with outside threads on one end (**MIP**) and inside threads on the other (**FIP**). The name *street elbow* derives from its use on water mains and services located on the street.

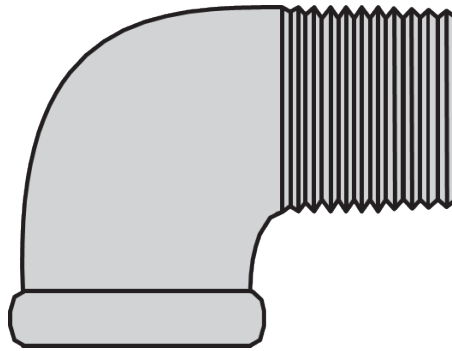


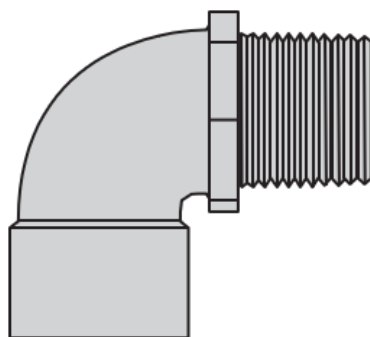
Figure 12 Blk mal IP street elbow (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Exercise

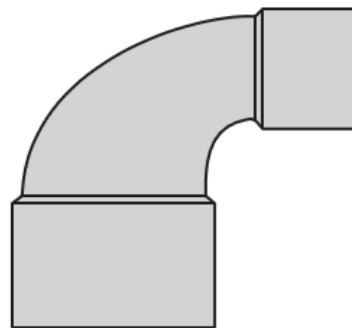
Recall the use of abbreviations while reading the descriptions of fittings shown in these illustrations.

Reducing Elbow

Elbows can be used to reduce the size of piping and at the same time change direction. These elbows are called **reducing elbows**. An elbow can also be used as an adapter, as shown here:



C x MIP adapter 90 deg elbow



C x C reducing elbow

Figure 13 Reducing elbows (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Bends

The term **bend** may also be used to describe an elbow. For example, cast iron DWV fittings are traditionally referred to as *bends* instead of elbows. A plumber would therefore refer to a 90 degree cast iron DWV elbow as a 1/4 bend. The 1/4 refers to 1/4 of a 360-degree circle. Cast iron DWV elbows are available in 1/4, 1/6, 1/8 and 1/16 bends.

Following are the equivalent degrees of cast iron DWV bends:

- A 1/16 bend is equal to a $22\frac{1}{2}$ degree elbow.
- A 1/8 bend is equal to a 45 degree elbow.
- A 1/6 bend is equal to a 60 degree elbow.
- A 1/4 bend is equal to a 90 degree elbow.

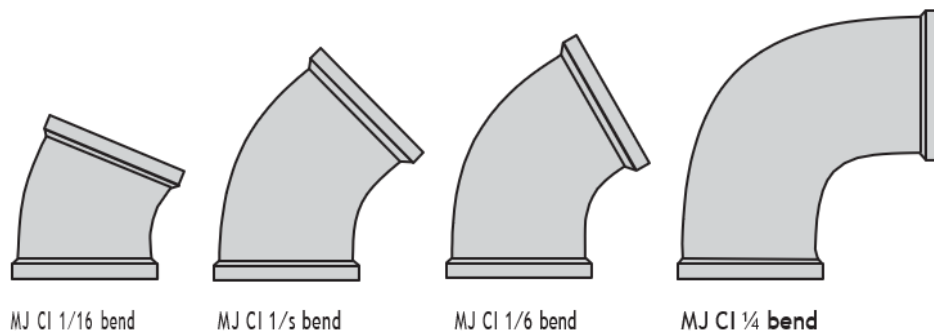


Figure 14 Bends (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0
(<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 15 MJ cast iron 3" 1/4 bend (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0
(<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Specialty Elbows

Some elbows are manufactured to serve a specific purpose in addition to allowing a change of direction. One such elbow is called a **wingback elbow**. A wingback elbow may be used to provide support for the piping in the wall behind showerheads and fixture water supply piping. The wingback elbow has two lugs that allow it to be fastened to backing. The wingback elbow is known by several other names, including:

- Lug ear elbow
- Drop-ear elbow
- Drop elbow



Figure 16 Specialty support elbows (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

A variation of the copper by copper wingback 90 degrees is the copper by female iron pipe wingback 90 deg, which is often used to secure the stub-out for a showerhead.

Tees, Wyes, and Double Sanitary Tees (Crosses)

Pipe tradespersons refer to fittings that allow three pipes to be joined together as tees and wyes. Tees are shaped similar to the letter “T,” and wyes are shaped similar to the letter “Y.”

Straight Tees, Sanitary (San) Tees and Wyes

Straight tees and **san tees** are used to connect two pipes together at an angle of 90 degrees.

A standard wye designed for DWV use connects one pipe to another at a standard angle of 45 degrees.

Plumbers will purchase DWV wyes with the standard 45-degree angle. A steamfitter, however, may be required to fabricate a wye at a different angle.

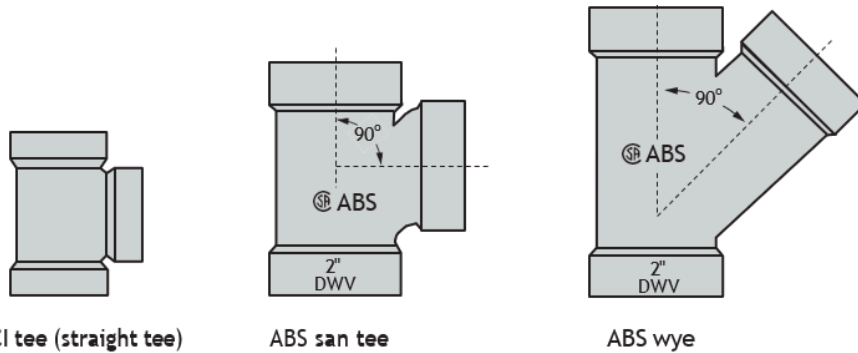


Figure 17 Tee and wye bend angles (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Double Sanitary Tee and Double Wyes

Sanitary cross (double sanitary tee) and **double wye** are the names given to fittings that allow four pipes to be joined together. The name cross comes from its shape. Plumbers use the terms *san cross* and *double san tee* interchangeably.



ABS double wye 2 x 2 (Courtesy of NIBCO INC)

ABS san cross (or double san tee) 2 x 2 x 1 1/2 (Courtesy of NIBCO INC)

Figure 18 Double sanitary fittings (Courtesy of NIBCO INC) Used with permission.

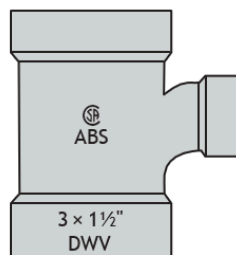
A **tee wye** is a sanitary tee with a longer radius throat. On the job today the sanitary tee has become the fitting of common use and the true tee wye is used less and less.



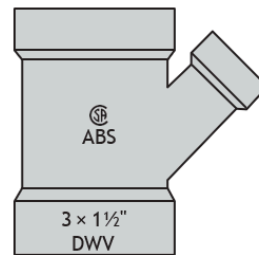
Figure 19 ABS tee wye combination, long radius (Courtesy of NIBCO INC) Used with permission.

Reducing Tees and Wyes

Tees, wyes and crosses can also be used to connect pipelines of different sizes. These fittings are called **reducing fittings** (Figure 20).



ABS DWV reducing san tee



ABS DWV reducing wye

Figure 20 ABS reducing fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Note: When naming a fitting such as these reducing fittings, the term *reducing* might not be used in the description. The fitting would instead be called a $2'' \times 1 \frac{1}{2}''$ ABS DWV san tee. Stating the fitting opening sizes with the largest opening first indicates that the tee is a reducing tee.

Specialty Tees and Wyes

Manufacturers have produced variations of tees, crosses, and wyes for use in specific plumbing installations.

Side Inlet and Tapped Fittings

A **side inlet tee** is a standard sanitary tee with an additional opening located on the right-hand or left-hand side. Side inlet fittings can have more than one opening on the side. The side inlet is usually located at 90 degrees to the branch opening but may also be 45 degrees to the branch opening.



Sanitary tee with 90 deg left inlet hub, ABS
DWV (Courtesy of NIBCO INC)



Sanitary tee with 90 deg right inlet hub, ABS
DWV (Courtesy of NIBCO INC)

Figure 21 ABS DWV left and right side inlet hubs (Courtesy of NIBCO INC) Used with permission.

Tapped (Tapt) Internal Pipe Thread Fitting Openings

Cast iron DWV fittings are often tapped to allow for adaptation to other pipe materials such as copper or ABS. The opening is referred to as a **tapt opening**, and so the fitting is described as a **tapt side outlet**.

Note: Fitting side outlets are not always tapped.

Other types of specialized wyes and tees include **Boston** (a wye and 1/8 bend combination in one fitting), **upright wye**, and **apartment tees**.



Figure 22 3 × 2" MJ tapped tee (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 23 3" MJ cast double Boston (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Specialty Fittings

Couplings

Couplings are loosely defined as short fittings that are used to join piping in a straight line without changing its direction. Couplings generally have socket-type ends and may be screwed, soldered or solvent-cemented onto piping. Malleable iron or steel couplings are usually available with internal iron pipe threads; plastic couplings may have slip-type or FIPT ends.

Standard and Reducing Threaded Couplings

Standard couplings are used to join pipes that are the same size. Reducing couplings can be used to connect different sizes of piping. Figures 24 and 25 show couplings used to connect threaded pipes. Couplings are also available to connect other piping, including ABS and PVC.

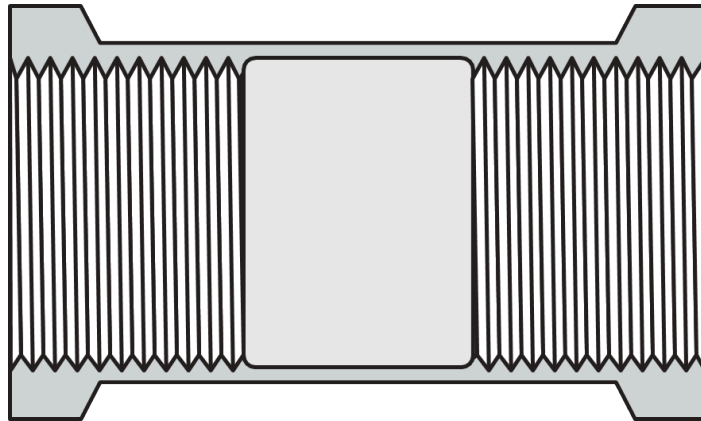
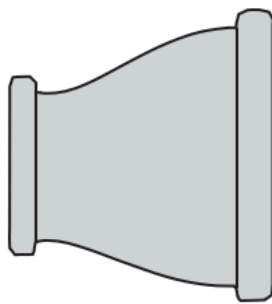
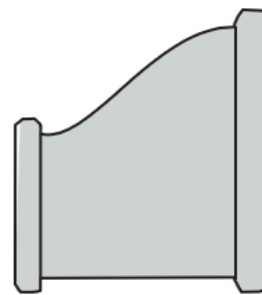


Figure 24 Black malleable coupling, cross section (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Blk mal concentric reducing coupling



Blk mal eccentric reducing coupling

Figure 25 Threaded reducing couplings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Merchant Couplings

Merchant couplings are often used to protect pipe threads during transportation. They are not generally used for pressure piping. Couplings $\frac{1}{8}$ to 2 in. are straight threads, and 2 $\frac{1}{2}$ in. and larger diameter are NPT (tapered).



Figure 26 Merchant steel coupling (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Couplings for Copper Tube

Copper tube couplings are available with or without internal stops. The internal stops are located at the centre of the fitting. The stop prevents the tubing from being pushed into the coupling past the centrepoint of the coupling. This ensures that each pipe is soldered at the correct depth in the socket.

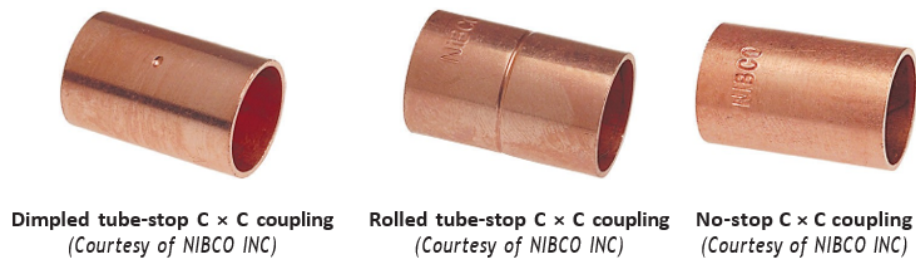


Figure 27 Copper tube couplings (Courtesy of NIBCO INC) Used with permission.



A coupling with no stop will allow the pipe to slide right through the coupling. Be cautious when using this type of coupling. Each pipe must be pushed into the coupling to an equal depth, with the ends of each pipe positioned at the centrepoint of the coupling. Failure to centre the coupling will result in a weak joint

Practical Use for No-Stop Coupling

Perhaps a less familiar fitting, let's take a look at its installation.

A **no-stop coupling** can be used to advantage when repairing or altering a pipeline. As described in the steps below, pipe ends that cannot be pulled apart far enough to allow a fitting to be installed, could be spread sideways and a no-stop coupling slid all the way over the end of one pipe.

The pipe can then be realigned and the coupling slid back from one pipe over the other until the coupling is centred on both pipes. Mark the pipe with a line to help determine where to position the coupling.

Note: Proper cleaning and **fluxing** of the joint surfaces before assembly and soldering is required.

Step 1. Pull one pipe end to one side.



Figure 28 Pull one pipe end to one side (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Step 2. Slide the no-stop coupling over one end of the pipe.



Figure 29 Slide the no-stop coupling over one end of the pipe (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Step 3. Mark the pipe.



Figure 30 Mark the pipe (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Step 4. Realign the two pipes.



Figure 31 Realign the two pipes (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Step 5. Slide the no-stop coupling back to the mark on the pipe.



Figure 32 Slide the no-stop coupling back to the mark on the pipe (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Unions

Unions allow piping to be assembled and equipment to be installed so the piping or equipment can be easily removed and reconnected if necessary.

Standard pipe threads are normally right-hand thread; therefore, connections must be turned in a clockwise direction to tighten. A union allows piping to be tightened into a stationary fixture such as a boiler.



Wrought copper union, soldered connections (Courtesy of NIBCO INC)



Malleable iron threaded union

Figure 33 Various types of unions (Courtesy of NIBCO INC) Used with permission.

A union has three parts, two of which are screwed or solvent-welded to a pipe. The third piece is a threaded hexagonal nut, collar, or ring to hold the union together.

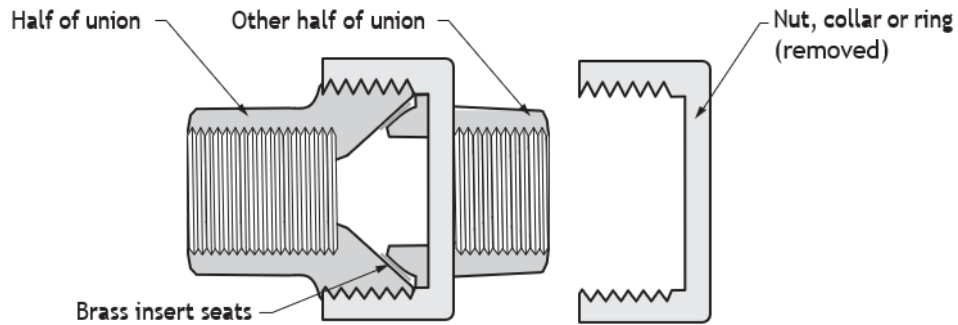


Figure 34 Parts of a union (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

There are two types of threaded unions:

Ground unions may have iron-to-iron or brass insert seats with a tapered design. The tapered seat union forms a watertight seal without a gasket.

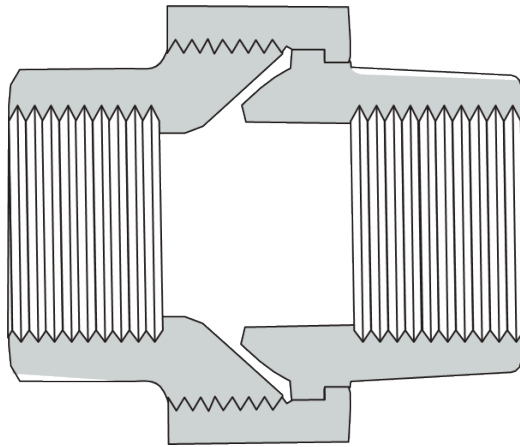


Figure 35 Ground joint union (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Gasket unions require a washer between the two fitting pieces to seal the joint. The two fitting pieces have flat seats that provide a watertight seal when used with the washer.

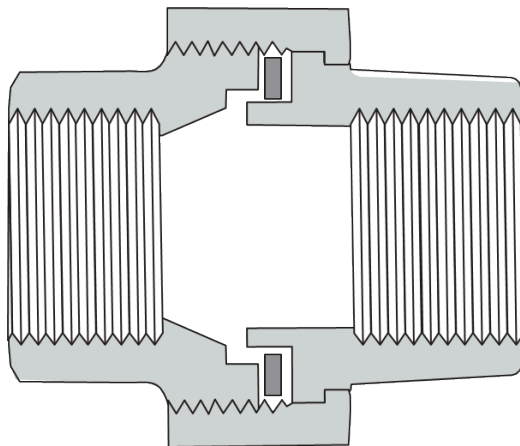


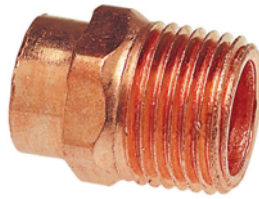
Figure 36 Gasket union (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Adapter Fittings

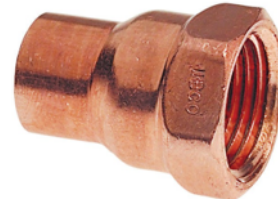
Adapters are fittings used to connect sections of piping that have different jointing designs. Adapters may be used to connect copper pipe to iron pipe threads. Adapters are sometimes called *transition fittings*. Some manufacturers identify any fitting that joins threaded pipe to soldered or welded pipe as an adapter.



C x MIP cast brass adapter
(Courtesy of NIBCO INC)



C x MIP wrought copper
(Courtesy of NIBCO INC)



C x FIP wrought copper
(Courtesy of NIBCO INC)

Figure 37 Adapter fittings (Courtesy of NIBCO INC) Used with permission.

Bushings and Reducers

Bushings and **reducers** are used to connect different sizes of piping or fittings in a straight line. Bushings generally have inside- and outside-threaded ends and are used to connect smaller piping to larger fittings or fixtures. An MJ cast iron fitting that changes a pipe size is called a **reducer or increaser**.

Figures 38 show examples of bushings and reducers.



Blk mal iron outside hex bushing



Blk mal iron inside hex bushing



Face bushing



Blk mal reducing coupling



Concentric reducer



Eccentric reducer



Flush socket reducer bushing, Spg × S, PVC Schedule 80

Figure 38 Various bushings and reducers (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Caps and Plugs

Caps and plugs are used to seal the ends of pipes. **Caps** are fittings with internal threads that screw onto the end of a pipe. Caps are also available for other piping materials such as ABS and copper. A **plug** is a fitting with external threads and a square head or square socket head. Plugs can be easily installed and removed with a wrench.

Figures 39 show various types of caps and plugs.



Threaded square head plug



Blk mal threaded pipe cap



Square head plug, cored



Copper tube permanent pressure cap
(Courtesy of NIBCO INC)



DWV temporary test cap
(Courtesy of NIBCO INC)



ABS cap (Courtesy of NIBCO INC)



BlazeMaster CPVC cap (Courtesy of NIBCO INC)

Figure 39 Various types of plugs and caps (Courtesy of NIBCO INC) Used with permission.

Cleanouts

Cleanout openings are provided to allow access to DWV pipelines to clear blockages.



ABS DWV test tee H x H x cleanout with plug
(Courtesy of NIBCO INC)



Cleanout adapter (Courtesy of NIBCO INC)



MJ CI iron body c/o (or fitting c/o)



On-grade adjustable cleanout, cast iron MIP thread
(Image courtesy of Watts)

Figure 40 Various types of cleanouts (Courtesy of NIBCO INC and Watts) Used with permission.

Factors Used in Describing Fittings

Manufacturers identify fittings by some or all of the following seven factors:

1. Size
2. Material (e.g. cast iron, copper, ABS, pipe schedule, etc.)
3. Intended use (pressure, drainage, etc.)
4. Basic shape (tee, elbow, wye, etc.)
5. Type of joint (soldered, threaded, solvent cement, compression, flared, slip joint, etc.)
6. Other components/information (e.g. hub end, spigot end, drop ear, with cleanout, without cleanout)
7. **Class designation:** manufacturers often designate their fittings as classes to indicate the maximum pressure and temperature ratings the fitting can withstand; for example, cast iron threaded fittings include classes 125 and 250. This indicates a maximum of 125 psi (862 kPa) saturated steam and 250 psi (1724 kPa) saturated steam, respectively. Other rating classes include 150- and 300-pound malleable class fittings.

Identifying Run and Branch

When identifying the size of fitting openings, you must start by first determining the **run** size. You must therefore be able to identify which openings make up the run and which opening is the **branch** (also called the *lateral*). Figure 41 illustrates how to correctly identify the run and the branch.

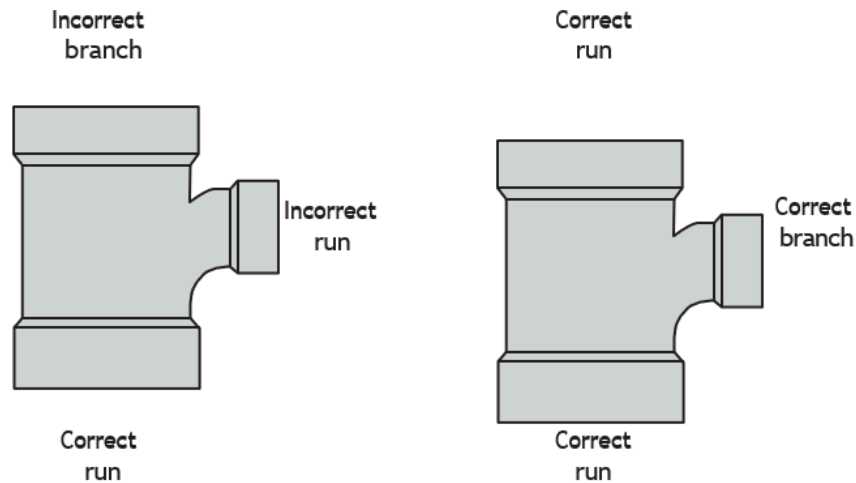


Figure 41 Run and branch identified incorrectly (left) and correctly (right) (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

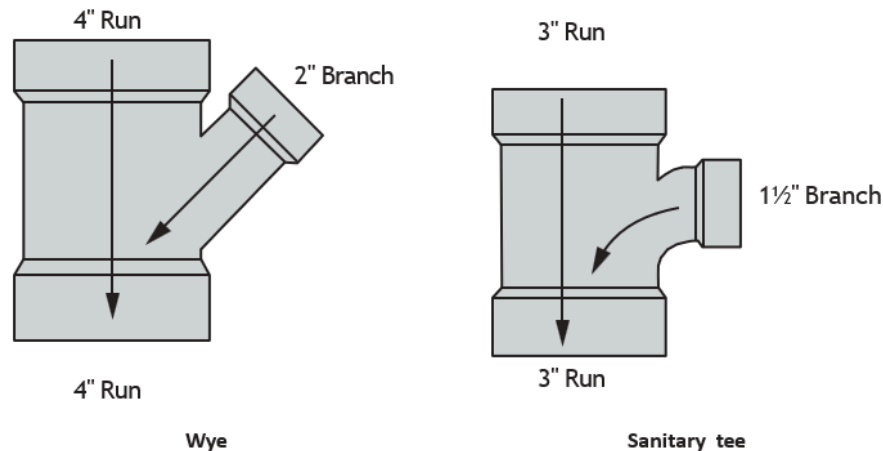


Figure 42 Branch direction of flow (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Side Inlet Connections

A tee with an additional opening on its side is identified as a **side inlet fitting**. A tee with a side inlet can be identified as

right hand or left hand by looking at the tee with the branch facing you (Figure 43), and checking which side the inlet is on. If it is on your right, it is a right-hand side inlet fitting. If the outlet is on the left, it is a left-hand side inlet fitting.

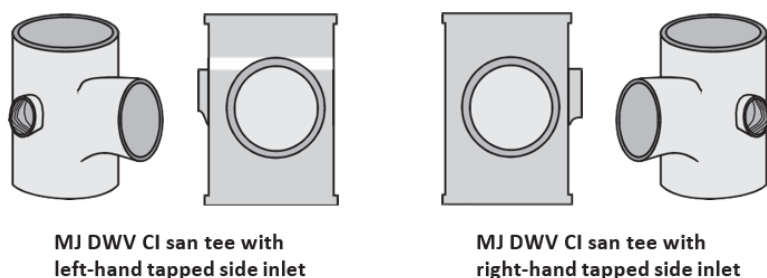


Figure 43 Side outlet connections (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Note: The side inlet is called a **tapped side inlet**. **Tapped** indicates that the side inlet is threaded internally. The tapped inlet allows the installation of an adapter to connect to another type of piping material such as copper or ABS.

Rules for Describing a Fitting

Descriptions of fittings are written in a set order and following specific rules. The order of the information is as follows (Figure 44):

1. Size
2. Material type
3. Use
4. Shape
5. Joint method
6. Additional information, if required

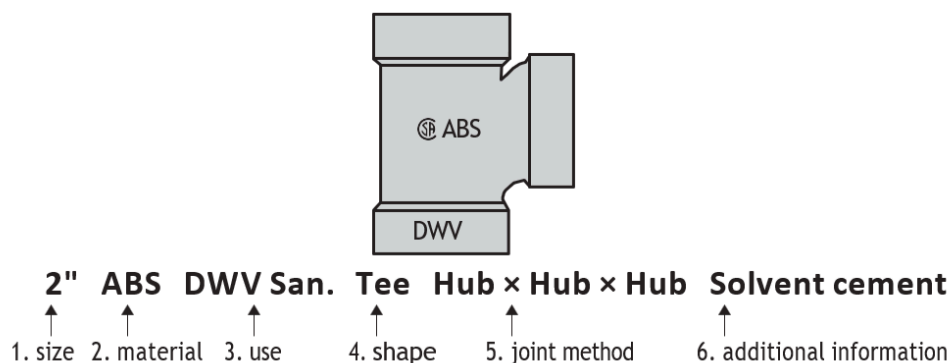


Figure 44 Order of information in a description (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

In Figure 44, since all the openings are the same size, only one opening size need be stated. (Refer to the fitting description guidelines below.) Also, fitting description numbers 5 and 6 are both optional because the material

description (ABS) indicates that solvent cement and hub-type ends are typical (for ABS fittings). If the fitting was anything other than a standard ABS fitting, you may have to include the additional descriptions. Some ABS fittings, for example, may have spigot ends or threaded ends; those ends would have to be identified. You will identify these types of fittings later in this section.

Basic Rules for Fitting Descriptions

When writing a fitting description, observe the following rules:

- Start the size description with the largest size run first, then the smallest size run, followed by the branch size last.
- Only one size description is needed when all the openings of the fitting are the same size.
- The jointing method may be obvious from the material type description. Therefore the jointing method may not have to be stated. For example, the material description ABS DWV would normally indicate a solvent cement joint, so there would be no need to mention solvent cement in your fitting description.
- Start with the opening that will be the furthest downstream.
- Specialty fittings with odd connections may require a more detailed description, or you may have to change the order of your description. Remember, be accurate and concise in your description.

Describing a Reducing Fitting

Correctly describing the sizes of the openings is of prime importance when you are identifying a fitting. Figure 45 illustrates the correct way to identify the openings of a reducing wye and a reducing tee.

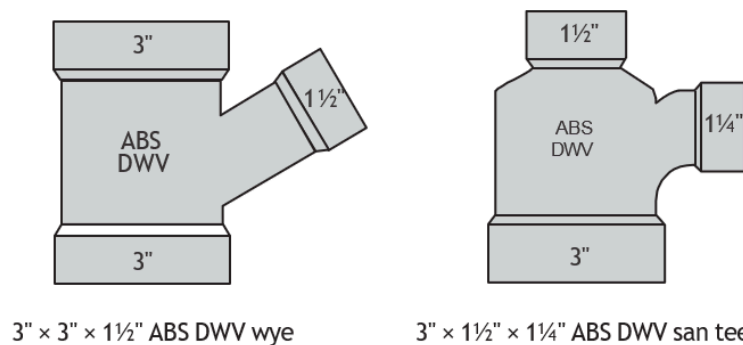


Figure 45 Correctly identifying openings in reducing tees (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Describing a Sanitary Cross or Double Sanitary Tee and Wye

Figure 46 illustrates how to describe a **DWV cross** (also called *double sanitary tee*) and an **ABS double wye**. Note that only two sizes are stated in each fitting even though there are four openings. There is no need to repeat the sizes when the

run stays the same size or the branches are the same size. Furthermore, fittings that have several openings that are all the same size can be described by one dimension.

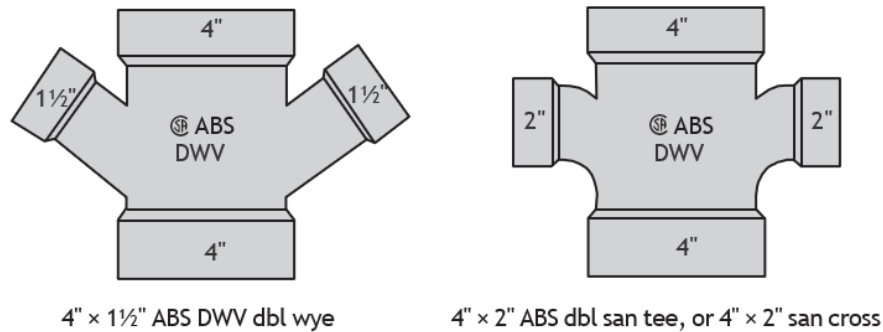


Figure 46 Describing a sanitary cross and double wye (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Describing a Bullhead Tee

Although most fitting descriptions list the largest size opening first, this is not always the case. In the case of a **bullhead tee** configuration, the openings on the run of the tee are smaller than the branch opening, so the largest opening is listed last.

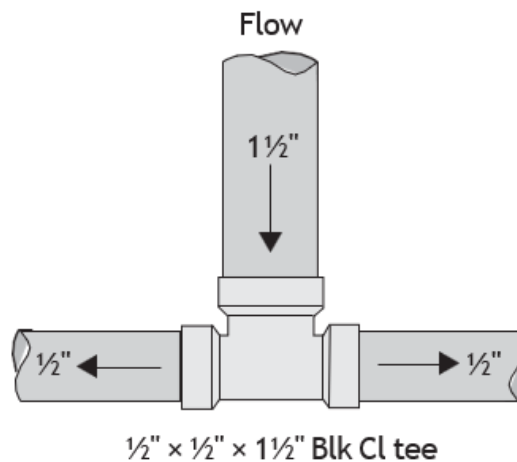


Figure 47 Describing a bullhead tee (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

In Figure 47, notice that the flow is supplied through the branch. When you describe the fitting, however, you must follow the rules and start with the run first, regardless of the flow direction. **Do not start your fitting description with the largest opening when describing a bullhead tee.**



Figure 48 Malleable cast iron bullhead tee (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Describing a Plumbing Trap

A **plumbing trap** (abbreviated as P-trap) is a type of specialty fitting used to connect plumbing fixtures to the plumbing drainage system. P-traps are available in several design types and can be made from different materials. Figure 49 illustrates how to describe traps.

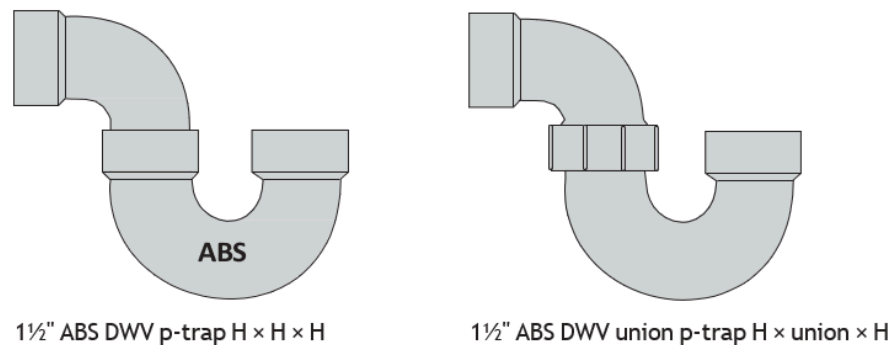


Figure 49 Describing plumbing traps (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

You can see from the plumbing trap descriptions in Figure 49 that you need to include additional information. The size, material, and use do not provide enough information to give a full description.

Examples of ABS Trap Types

Figure 50 show various types of ABS traps.



Figure 50 ABS traps (Courtesy of NIBCO INC) Used with permission.

Describing Pipe Nipples

A **pipe nipple** is a short piece of threaded piping up to 300 mm (12 in.) long. Pipe nipples are available in standard IPS diameters and may be made from any threadable piping such as black iron, galvanized steel, brass, or PVC. Nipples are used to assemble piping projects where fittings are close together or in tight spaces. Pipe tradespersons would normally purchase a variety of nipples rather than thread their own nipples on the job. In most cases, it is more economical to purchase pipe nipples. Plumbing companies with threading equipment may find it more economical to thread all their pipe nipples on the job.

Pipe tradespersons purchasing nipples commonly purchase threaded pipe nipples up to 2 in. diameter and 150 mm (6 in) long; longer pipe nipples are threaded on the job. Pipe nipples over 2" diameter are usually purchased.

There are three common types of nipples:

- Close nipple
- Shoulder nipple
- Long nipple

A **close nipple** is a short piece of pipe, threaded from each end so that it appears as though the entire outer surface is threaded.



Figure 51 1/2" Sch 40
blk IPT close nipple
(BC Industry Training
Authority, 2019). CC
BY-NC-SA 4.0
(<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

A **shoulder (short) nipple** has a short space between the threads at either end.



Figure 52 1/2" Sch 40 blk IPT short nipple (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

A **long nipple** has the same number of threads as a shoulder nipple, but is available in a range of lengths from 5–60 cm (2–12 in).



Figure 53 1/2" × 6" Sch 40 galv IPT nipple (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 54 3/4" × 3" brass IPT nipple (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Methods of Joining Pipe and Fittings

There are several methods of joining piping and fittings, and new methods are continually being developed. Pipe tradespersons must be familiar with many methods of joining pipe and fittings.

When describing a fitting, you must indicate what joint method is to be used. A $\frac{1}{2}$ inch elbow, for example, could be soldered, threaded, flared, or crimped, so you would need to include the joint type in the fitting description.

Some of the common joining methods are as follows:

- Soldered fittings (also referred to as *sweat fittings*), used for joining copper tube

- Threaded fittings, used for joining steel pipe, including stainless steels and brass pipe
- Flanged fittings, used for joining steel pipe and many other pipe material types
- Welded fittings, used for joining steel pipe, including stainless steel
- MJ clamp fittings, used for joining cast iron DWV pipe and several other pipe materials
- Flared fittings, used for joining copper tube and other pipe materials
- Compression fittings, used for joining copper tube and several other pipe materials
- Fusion welded fittings, used for joining plastics such as polyethylene gas pipe
- Solvent cement fittings, used for joining ABS and PVC pipe
- Crimped fittings, used for joining polyethylene and polybutylene pipe
- Grooved fittings, used to join steel pipe, copper and ductile iron
- Brazed fittings, used to join copper or brass
- Push-on fittings, used for water main piping

Note: Variations of these joining methods are used throughout the pipe trades.

Soldered Fittings (Sweat)

Soldered fittings (sweat) and **brazed fittings** are often used to install potable (safe for human consumption) water systems, drainage systems and other systems where soldered or brazed joints are acceptable. Soldered and brazed fittings are often made of wrought copper or brass, depending on their intended application.

Figure 55 show various types of soldered fittings.



Figure 55 Soldered fittings (Courtesy of NIBCO INC) Used with permission.

You may have noticed that **pressure fitting** has not been stated in the descriptions in Figure 55. This is because the smallest DWV fitting is $1 \frac{1}{4}$ inch, so the fitting could be assumed to be pressure. Of course, this must be clear to the person who is going to supply the material to you.

Threaded Fittings

Threaded fittings are used for joining steel pipe, including stainless steels and brass pipe. Typically, threaded joints are

used in gas piping, hot water and steam heating systems, for compressed air, fire protection or in any system where threaded piping is acceptable.

Figure 56 illustrates typical threaded fittings with their descriptions.



Figure 56 Threaded fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Threaded Fitting Classifications

Cast iron threaded fittings are available in classes 125 and 250. Malleable threaded fittings are available in classes 150 and 300, with black or galvanized finishes.



Figure 57 Class 150 threaded fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Cast Iron Drainage Fittings

Cast iron threaded drainage fittings (also known as *Durham fittings*) have an interior shoulder to create a smooth, continuous interior surface. Figure 58 illustrates cast iron drainage fittings. Cast iron drainage fittings are no longer used on new installations.



Figure 58 Cast iron threaded drainage fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Flanged Fittings

Flanged fittings are another pipe joint method used where ease of assembly and disassembly of piping or system components is required. Flanged joints are assembled using flange gaskets and bolts. Flanges are made from various materials, including steel, cast iron, and brass.

Flange Fitting Classifications

Flanges are designated in several classes according to the material from which they are made. It is best to consult the job specification and/or manufacturer's information to obtain the correct classification of the flange you require.

Flange Styles

Flanges are available in different styles, some of which are:

- Weld-neck flange
- Slip-on flange
- Lap joint flange
- Threaded flange
- Socket flange
- Blind flange

Figures 59 to 63 illustrate these flange styles.



Figure 59 300 psi weld-neck flange (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

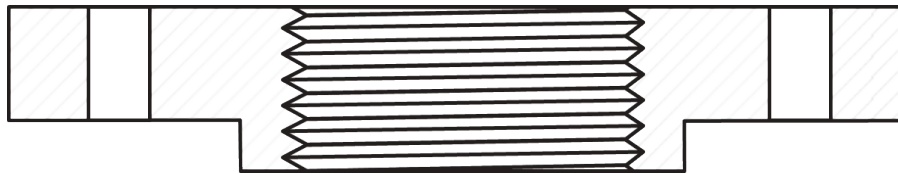


Figure 60 Threaded flange (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

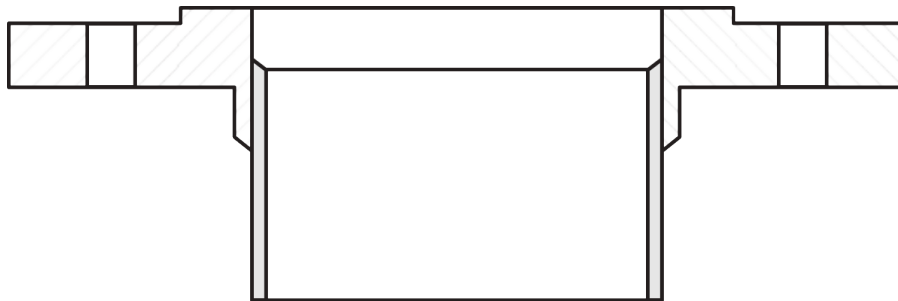


Figure 61 150 psi slip-on flange (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 62 300 psi lap joint flange (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 63 Blind flange (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0
(<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Flange Faces

Flanges are manufactured with a variety of face types, some of which are:

- Flat face
- Raised face
- Ring joint face
- Lap joint face

Figures 64 to 67 illustrate these flange face types.

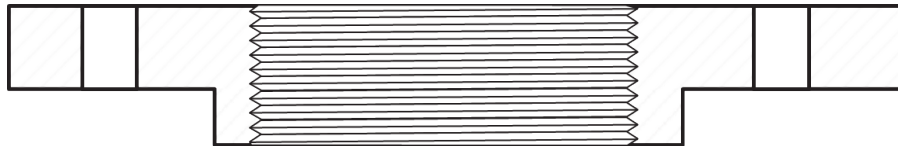


Figure 64 Flat face flange (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0
(<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 65 Raised face flange (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0
(<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

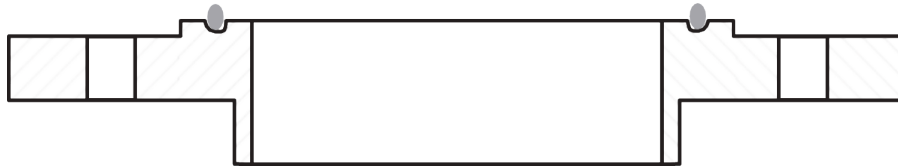


Figure 66 Ring joint face flange with O-ring (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 67 Lap joint face flange (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Flange faces may have smooth or serrated finishes (Figures 68 and 70).



Figure 68 150 class smooth face steel slip-on flange (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 69 125 class CI serrated face flange (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 70 Example of assembled flanges (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Identify Flange Types

A **companion flange** is a pipe flange designed to receive a pipe length, and drilled so it may be bolted to another similar flange—or any flange that fits together in companion to another flange. The term is often referred to as a flange that is not part of a valve or piece of equipment.

The following are several examples of different types of manufacturers' companion flanges.



150 class soldered/brazed companion flange
(Courtesy of NIBCO INC)



150 class threaded companion flange
(Courtesy of NIBCO INC)



125 class cast iron black threaded companion flange



Socket flange S, PVC Schedule 80, two-piece van stone (Courtesy of NIBCO INC)



Assembled set of flanges

Figure 71 Flange types (Courtesy of NIBCO INC) Used with permission.

Slip-on Pipe Flanges

Slip-on pipe flanges actually slip over the pipe. These pipe flanges are typically machined with an inside diameter slightly larger than the outside diameter of the pipe. Slip-on pipe flanges are secured to the pipe with fillet welds at the top and bottom of the slip-on pipe flange.

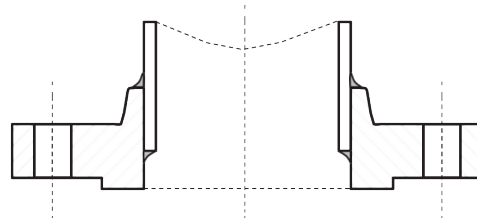


Figure 72 Slip-on pipe flange (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0
(<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Weld-neck Pipe Flanges

Weld-neck pipe flanges attach by welding the neck of the flange to the pipe. This reduces the high concentration of stress at the base of the flange hub and transfers the stress from the flange to the pipe. This makes weld-neck pipe flanges suitable for high-pressure applications.

Weld-neck pipe flanges are machined so that their inside diameter matches the inside diameter of the pipe. Weld-neck pipe flanges have raised, flat or RTJ facing. Weld-neck pipe flanges under 400 pounds have a standard raised face height of $\frac{1}{16}$ in. For flanges of 400 pounds or more the standard is $\frac{1}{4}$ in.

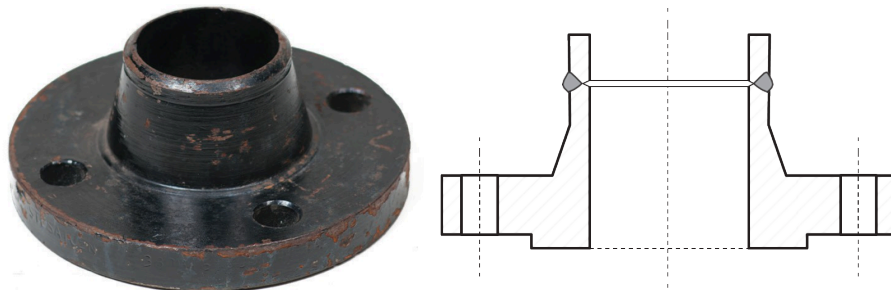


Figure 73 Weld-neck (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Blind Pipe Flanges

Blind pipe flanges are pipe flanges used to seal the end of a piping system or pressure vessel openings to prevent flow. Blind pipe flanges are commonly used for pressure testing the flow of liquid or gas through a pipe or vessel. Blind pipe flanges also allow easy access to the pipe in the event that work must be done inside the line.



Figure 74 Blind flange (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Lap Joint Pipe Flanges

Lap joint pipe flanges are usually used together with a matching stub end that fits inside the flange. The stub end is welded to the pipe, and the flange is left free to rotate around the stub end. The same arrangement is made on the pipe section that is to be joined together. The ability of the flanges to rotate means that the bolt holes on each flange can be easily aligned when bolting the pipe sections together. Lap joint pipe flanges are often used in systems where frequent dismantling is required.



Figure 75 Lap joint (Van Stone) flange with stub end (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Threaded Pipe Flanges

Threaded pipe flanges resemble slip-on pipe flanges except that the bore of the threaded pipe flange has tapered threads that enable the flange to be attached to a pipe that has external threads. This eliminates the need for welding. Threaded pipe flanges are generally used with small-diameter piping that operates under high pressure.



Figure 76 Threaded flange (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Socket Weld Flanges

Socket weld pipe flanges have a recess on their inside surface that creates a smooth bore when the correct size of piping is inserted. This enables a smooth flow of fluid through the joint. The flange is attached to the pipe by a fillet weld around the top edge of the flange. Typical applications are in high-pressure, small-diameter piping systems.

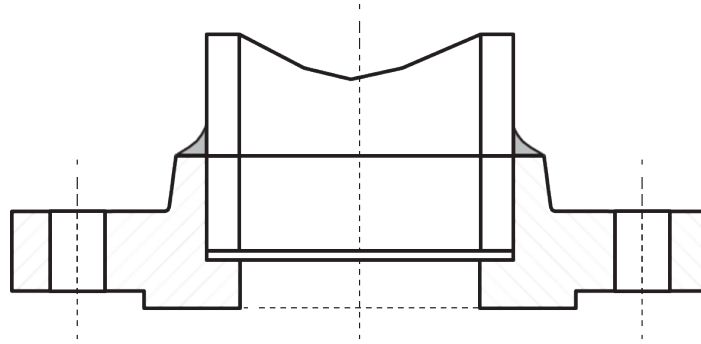


Figure 77 Socket weld flange (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Welded Fittings

Welded fittings are used for joining steel pipe, and are available in elbows, tees, flanges, increasing and reducing types.

Figure 78 show various welded fittings. Refer to Level 1 B-5 Use Soldering and Brazing and Oxy-Fuel Cutting Equipment (<https://b-handmeasuringtools-bcplumbingapprl1.pressbooks.tru.ca/part/b-5-use-soldering-and-brazing-equipment-and-oxy-fuel-cutting-equipment/>) and D-1 Describe Piping and Tubing Materials (#chapter-d-1-1-describe-piping-and-tubing-materials) for more information on pipe welding, fitting, and fabrication.



Figure 78 Welded fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Socket Welded Fittings

Socket welded fittings are typically used to connect smaller pipe diameters such as 2 inch and under. The socket weld connection is made by slipping the pipe into the socket of the fitting, then fillet welded.



Socket Weld outlet



1 1/2" 316 stainless 150 pound cast
socket 90 deg elbow

Figure 79 Socket welded fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0
(<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Compression Fittings

Compression-type fittings similar to the one shown in Figure 80 can be used to join copper tubing, steel piping, PVC, polyethylene, and polybutylene.

Compression fittings consist of the following parts:

- Compression fitting body
- Compression ferrule
- Compression nut

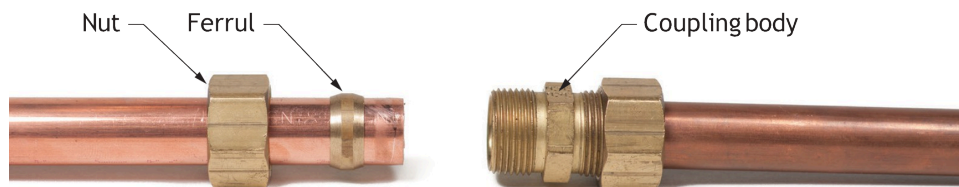


Figure 80 Parts of a compression fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0
(<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

The design of compression fittings can vary, but they all rely on the same principle: As a coupling nut is tightened onto the fitting, the **ferrule** is compressed against the tubing into a tapered seat.

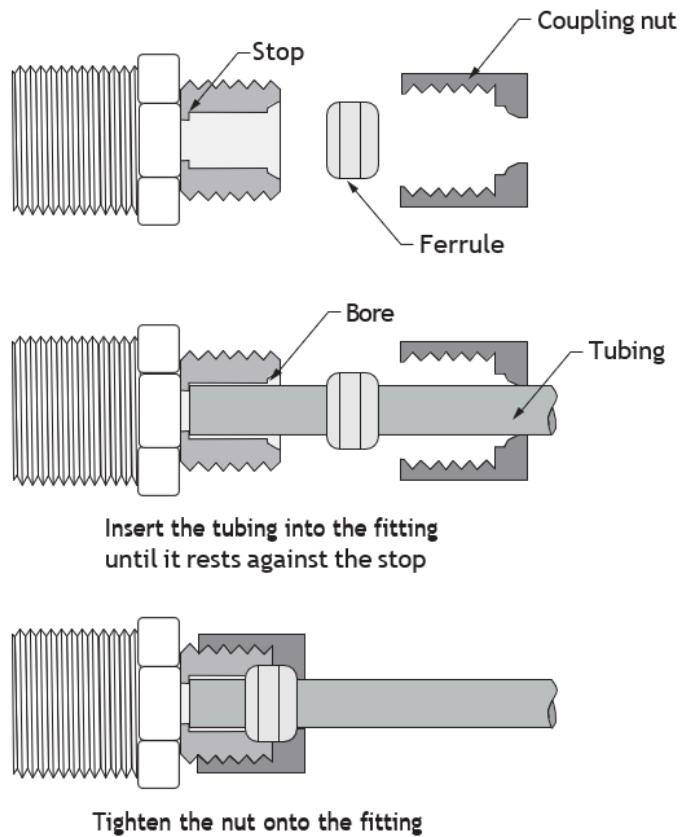


Figure 81 3/8" MIP × 1/4" OD comp adapter for copper tube (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Figure 82 shows examples of compression fittings.

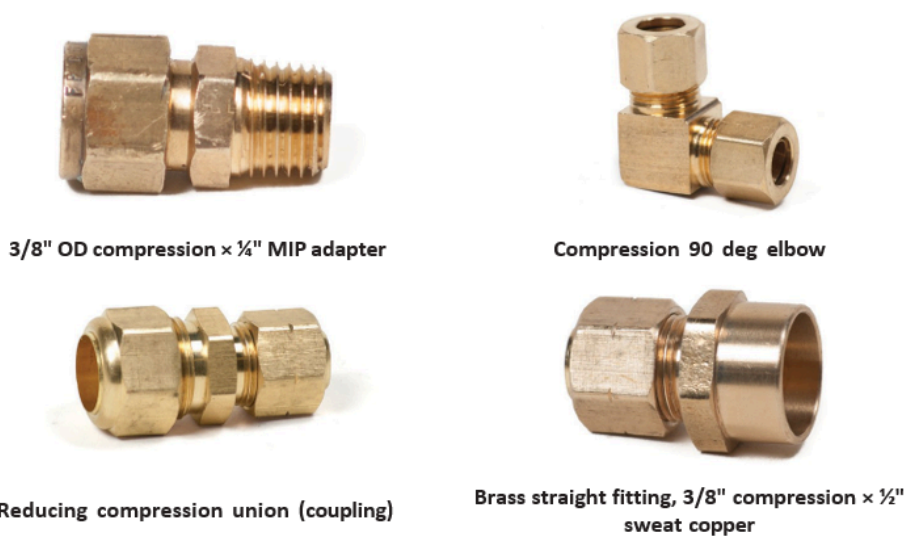


Figure 82 Compression fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Insert Sleeves

A plastic or metal insert sleeve is used with some types of plastic tubing compression fittings. The **insert sleeve** provides additional support to the walls of the tubing. Many manufacturers have designed compression fittings for use with specific types of tubing or pipe. When identifying compression fittings, it is important to include in your description the specific tubing type to which the fitting will be joined (e.g. PE, PB, PEX, etc.).



Figure 83 Insert sleeve or stiffener.

Always check the manufacturer's information for specific requirements as to where and how the fitting is to be used. You must order the correct fitting to match the tubing or pipe, otherwise the warranty will not be valid. It is not a good idea to mix and match fittings and use them for applications for which they were not specifically designed.

The fitting shown in Figure 84 is a generic example of a plastic tubing compression coupling using an insert sleeve.

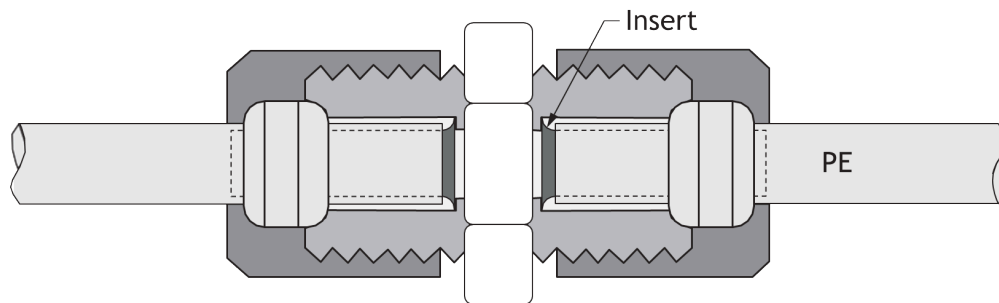


Figure 84 3/4" compression coupling for PE plastic tubing (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Flare Fittings

Flare fittings are a type of compression fitting generally used to join copper tubing, although they can also be used with other types of tube and piping systems. Flare nuts can be machined from brass stock or forged (cast brass).

Three types of flare fittings are available:

- SAE flare
- Inverted flare (discussed below)
- JIC flare

The **SAE flare** is the flare that is most commonly used by the plumbing trade for gas copper tubing systems. The angle of the SAE flare is 45 degrees.



Figure 85 Flare-to-flare union without flare nuts (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

The **JIC flare** is suitable for hydraulic fittings and steel tubing. The angle of the JIC flare is 37 degrees.

Figures 86 and 87 show examples of SAE flare fittings.

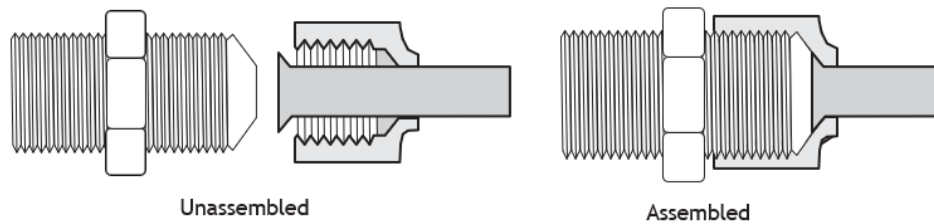


Figure 86 Saddle fusion components (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

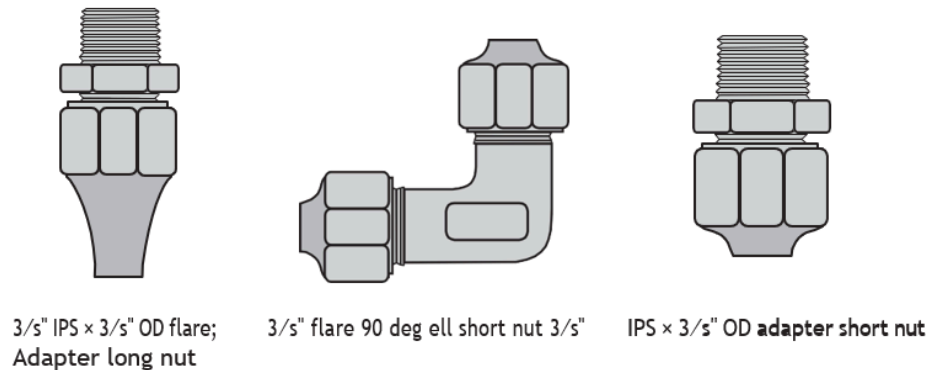


Figure 87 Flare fitting assembly (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Flare Nuts

Machined brass long and short **flare nuts** are not to be used on gas systems, they must be forged as seen in Figure 88.

The following images show a series of flare nuts.



Figure 88 Flare nuts (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Inverted Flare

A flare nut fits over the flared end of a brake or fuel pipe at a union, used to clamp the tubing flare against another fitting. The **inverted flare** is usually used in the automotive industry for fuel lines and brake lines.

Figures 89 to 91 show various inverted flare fittings.

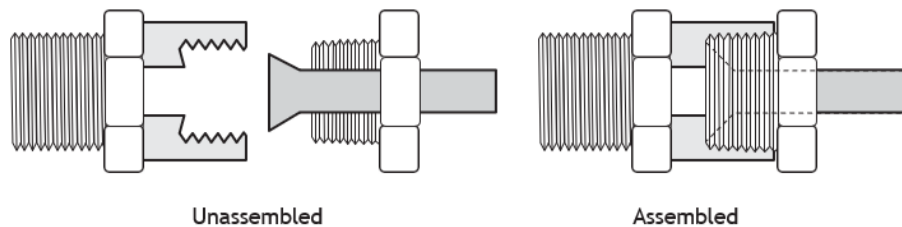


Figure 89 Inverted flare assembly (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 90 Male inverted flare used in hydraulic systems such as automobile brake lines (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 91 Female inverted flare connection (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

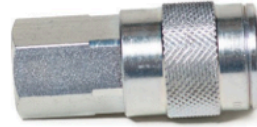
Quick-Connect Fittings

Quick-connect fittings, as the name suggests, are used to make quick connections, usually for pneumatic, hydraulic, and water hoses, and piping and equipment. They are made out of steel, stainless steel, brass, or plastic.

Figure 92 shows examples of quick connect fittings.



Steel 1/4" MIP x 1/4" coupler, straight through



Steel 1/4" FIP x 3/8" coupler, straight through



Brass 3/8" nipple x 1/4" FIP, straight through



3/8" nipple x 1/4" MIP, straight through



Brass water hose quick connect coupling x female water hose thread



Brass water hose coupling nipple x male water hose thread



CSA LPG/nat gas coupler; 1/4" coupler x 1/4" FIP

Figure 92 Various types of quick connect fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Insert Fittings for Polyethylene

Insert fittings are another type of fitting used to join polyethylene tubing. Insert fittings may be made of brass, copper, galvanized iron, or plastic. Insert fittings have barbed ends that help to hold the fitting in place and seal the joint inside the tubing. A stainless steel **gear clamp** is used to squeeze the pipe onto the fitting.

An extra gear clamp is sometimes applied on the elbow when a little more insurance against leakage or pulling apart is desired. The gear clamps are installed in alternating directions to each other for a better seal (Figure 93).



Figure 93 3/4" plastic insert, 90 deg for series 100 PE (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

There are different pressure designations of polyethylene tubing. It is important to identify exactly what type of tubing you are working with when ordering these fittings. Insert fittings used with gear clamps are designed to work with polyethylene of series 75, 100, 125, etc. They are not designed for series 160 golden-flow PE or PEX tube. **Note:** Insert fittings using gear clamps are not approved by the plumbing code for use in potable water systems.



Figure 94 Polyethylene fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

PEX Fittings

PEX fittings are available in a variety of types to suit various types of installations. They can be made from metal or poly, and can use the push connection method.

Polybutylene (PB) plastic pipe is a grey-coloured, flexible pipe that was introduced in the 1980s and was installed in many residential buildings. The pipe has since been discontinued and PEX piping has taken its place. Polybutylene pipe is included here because you may have to repair existing systems.



The BC Plumbing Code (Part 7 of the BC Building Code) (<https://nrc-publications.canada.ca/eng/view/object/?id=6e7cabf5-d83e-4efd-9a1c-6515fc7cdc71>) (Canadian Commission on Building and Fire Codes, 2022) only permits the use of series 160 PE (Polyethylene) for a water service pipe underground outside the building and underground inside the building. Series 160 PE is not to be used above ground inside the building. Series 160 PE uses compression fittings for joining.

PEX can be used for both hot- and cold-water piping. PEX can be installed outside below ground and inside the building above and below ground. However, crimp joints and expanding ring joint methods are not permitted underground. One word of caution: some manufacturers require that no PEX piping be used to connect to a hot water storage heater within 458 mm (18 in.) of storage heater piping connections.

PEX/aluminum/PEX is a composite pipe used in the hydronic heating industry. It is also approved for potable water. This pipe has been discontinued.

PEX Crimp Fittings

Crimp fittings are designed to join cross-linked polyethylene used in domestic water systems. The fittings were originally made of plastic (no longer approved), but they are now made from wrought copper or brass. Crimp fittings insert into the tubing. **Note:** Crimp fittings used for PEX are not to be used with gear clamps or polybutylene fittings. Look closely at the barbs on the insert fittings and compare them to the barbs on the crimp fittings—note the difference.

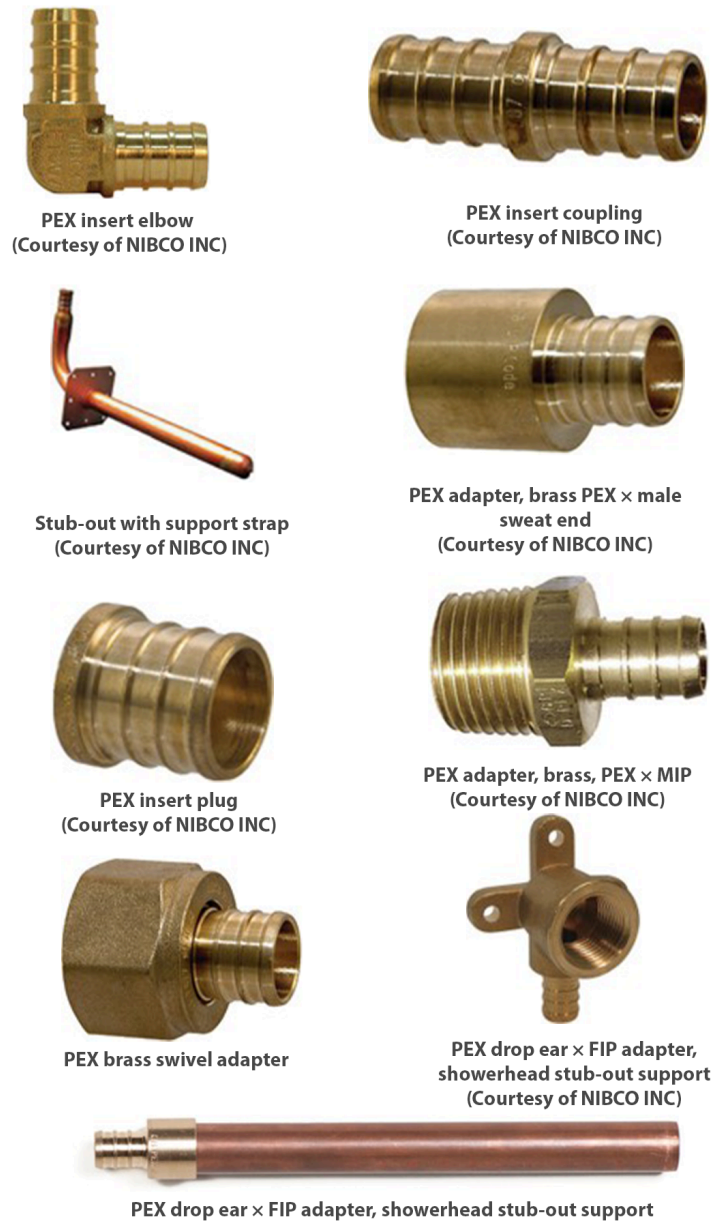


Figure 95 PEX crimp fittings (Courtesy of NIBCO INC) Used with permission.

Crimp Rings

Crimp rings (Figure 96) slide over the tubing and positioned over the fitting. A special crimping tool (Figure 97) is used to squeeze the crimp ring onto the tube and fitting, creating a leak-tight joint. Figure 98 shows the correct placement of crimp rings before crimping.



PEX crimp ring, black
(Courtesy of NIBCO INC)



Polybutylene crimp ring, copper colour
(Courtesy of NIBCO INC)

Figure 96 Crimp rings (Courtesy of NIBCO INC) Used with permission.



Figure 97 Crimping tool (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

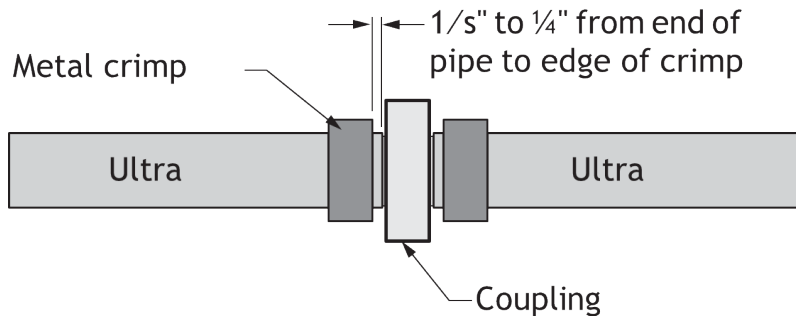


Figure 98 Placement of crimp ring before crimping (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Crimp Gauges

After installing a crimp fitting and crimp rings, use a **Go/No-go gauge** (Figure 99) to check the crimp for correct compression.

First, slide the Go side of the gauge over the crimped ring. If the crimp was made correctly, the gauge will pass over the ring with no problems.

Then turn the gauge over and try to pass the No-Go side of the gauge over the crimp ring. The crimp ring should be unable to enter the gauge at any point on the No-Go side of the gauge.

If the crimp ring fails either test, cut the PEX fitting out and replace it with a new crimp ring and fitting.



Figure 99 Go/no-go gauge (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

SDR Fittings

SDR stands for *standard dimension ratio*. It is an identification system that is used on plastic tubing. For example, you may read the number SDR 9 stamped on a PEX plastic tube. The number 9 is found by dividing the average outside diameter by the minimum wall thickness. Comparing two similar tubes from the same manufacturer, one with an SDR 11 rating and one with an SDR 9, typically the SDR 9 rating would have a higher pressure rating than the SDR 11 rating. The thicker the pipe wall, the lower the SDR number will be.

Transition from PEX to Polybutylene Piping

When transitioning from PEX tubing to polybutylene piping, you must use the correct transition coupling and crimp rings for each type of pipe.

Figure 100 shows a coupling used to connect PEX piping to PB piping. The left side is used for PB and the right side is for PEX. Notice that the PEX side has three rings and the PB side has four rings.



Figure 100 PB to PEX transition coupling (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Oxygen Barrier

An **oxygen barrier** is a plastic layer on the outside of PEX tubing in hot water heating systems. The oxygen barrier prevents oxygen from permeating through the tube into the water. Water containing oxygen can damage the heating system by corroding or oxidizing the metal components of the system.

ProPEX (Wirsbo) PEX Fittings

ProPEX (formally called *quick and easy*) rings are manufactured from **PEX-A** material, and are required to make a proper ProPEX connection.

- **Wirsbo** = brand (older name people still use) – now part of Uponor (<https://www.uponor.com/en-ca>)
- **ProPEX** = connection method (expansion system)

ProPEX rings and pipe come in red, blue and white. This colour-coding helps identify the piping system as conveying hot or cold, and reduces the chance of unintentionally cross-connecting the hot and cold water supplies.

Figure 101 shows examples of expansion ring fittings.



Figure 101 ProPEX rings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

ProPEX® fittings are made from brass or engineered plastic (EP).



ProPEX brass tee ½"

ProPEX × copper adapter

ProPEX EP tee ¾" PEX × PEX × PEX

Figure 102 PEX expansion fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

These rings are not crimped using a crimping tool. After the ring has been positioned on the pipe, an expanding tool (Figure 103) is used to expand the pipe end and the ring at the same time.



Figure 103 PEX expansion tool with expansion heads (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

The expanded pipe and ring are then quickly slid over the fitting up to the stop lugs on the fitting (Figure 104). After a very short time the pipe and ring contract and compress onto the fitting. When the procedure is completed according to the manufacturer's directions, the joint is tight and leak- proof.

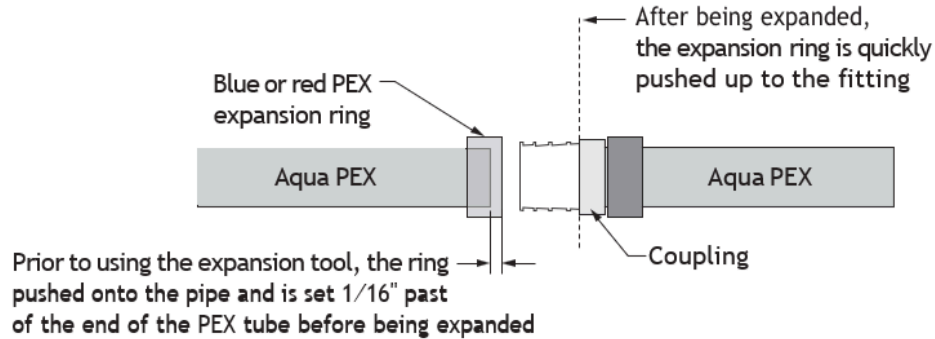


Figure 104 Applying an expansion ring (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Compression Fittings and PE or PEX Connections

A stainless steel, plastic or brass stiffener/sleeve must be used inside the end of the PE or PEX tubing to prevent the plastic pipe from collapsing inward when the compression nut is tightened. If the stiffener is not used, the connection may fail. Check the manufacturer's directions for accurate assembly of these compression fittings and tubing.



Figure 105 Stiffener slid inside PE tubing (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

PEX/AL/PEX Fittings

PEX/AL/PEX [Cross-link Polyethylene (PEX)/Aluminum (AL)/Cross-link Polyethylene (PEX)] has been discontinued, but you may find this tube and fittings on the job.

Fittings used to join PEX/AL/PEX tubing are manufactured specifically for this tubing. The fittings are a type of compression fitting that has a built-in insert complete with two O-rings that slip inside the tube. A nut is first slipped onto the tubing and a split brass ferrule is then slipped over the end of the tube. The fitting and tube are then pushed together until the tube bottoms out in the socket of the fitting. When the nut is tightened with a wrench, the ferrule is compressed against the tube, completing a tight joint.

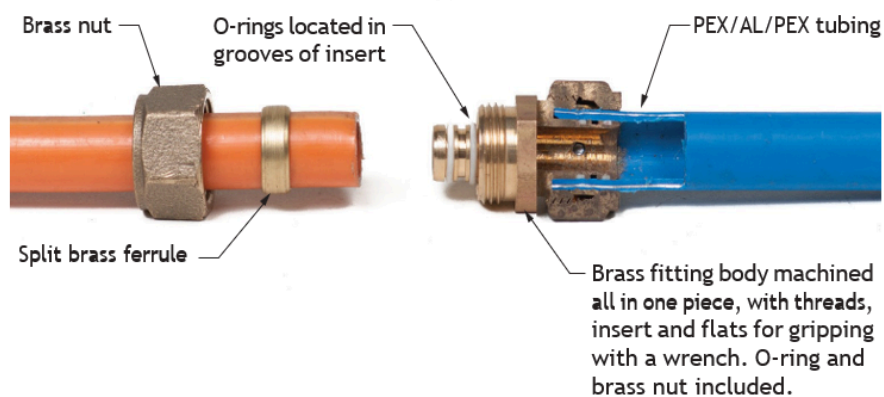


Figure 106 Parts of a fitting for PEX/AL/PEX tubing (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 107 PEX compression coupling, nuts and brass ferrule (Courtesy of NIBCO INC). Used with permission.

Push Fittings

The **push-fitting system** is completed without any soldering, crimping or joining materials. These fittings can be used to join PEX, copper, CPVC, or CTS pipe. Refer to the manufacturer's instructions.

Push fittings are available in a variety of types, including adapters, caps, couplings, elbows, and tees.

Figure 108 shows examples of push fittings.



Push-fitting coupling, push x push
(Courtesy of NIBCO INC)



Push x MIP adapter (Courtesy of NIBCO INC)



Tee, push x push x push
(Courtesy of NIBCO INC)



Push fitting removal and deburring tools

Figure 108 Push fittings (Courtesy of NIBCO INC) Used with permission.

The **press-fit joint** fitting is a quick seal that is reliable, permanent and watertight. The press system joins seamless copper water tube or PEX in residential and commercial potable, hot, chilled and process water applications for plumbing and HVAC systems.

The term “press-fit” refers to a generic connection method. A number of companies manufacture tools and fittings for

these types of systems. All press-fit fittings can be used with standard pipe or tubing that they were made for, but check with manufacturers' literature to be sure that the pressing tools can be used with intended fittings before making any connections.



Figure 109 Copper x PEX press-fit adapter (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Press fittings are available in a broad range, including adapters, caps, couplings, elbows, flanges, manifolds, tees, and unions. Figure 110 shows examples of press fittings.



45 deg grooved elbow



Grooved tee



Grooved elbow



Outlet coupling, Style 72



**Plain end Roust-A-Bout coupling,
Style 99**



**Snap-joint coupling, a
type of quick-connect
grooved fitting**

Figure 110 Examples of press fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Vic-Press

Vic-Press is a patented system manufactured by the Victaulic Co. (<https://www.victaulic.com/>) that uses stainless press fittings and pipe for sprinkler systems. Figure 111 shows various types of Vic-Press fittings.



Figure 111 Vic-Press fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Vic-Press couplings have internal rubber O-rings to create a seal as seen in Figure 112.



Figure 112 Cutaway of a Vic-Press coupling showing O-rings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

The Vic-Press® tool compresses the fitting to create a rigid mechanical connection as seen in Figure 113.



Figure 113 Vic-Press tool (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

CPVC Fire Protection

Injection-moulded CPVC thermoplastic fittings are designed for use in residential and commercial fire protection and fire sprinkler systems. Fittings include adapters, bushings, caps, couplings, crosses, elbows, flanges, tees, and unions.

Figure 114 shows examples of CPVC thermoplastic fittings.



Figure 114 CPVC Fire protection fittings (Courtesy of NIBCO INC). Used with permission. (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

PVC Schedule 80 Fittings

Polyvinyl chloride (PVC) Schedule 80 fittings are designed for use with chemical processing, industrial plating, chilled water distribution, deionized water lines, chemical drainage and waste water treatment systems.

Figure 115 shows various types of PVC Schedule 80 fittings.



Figure 115 PVC Schedule 80 fittings (Courtesy of NIBCO INC) Used with permission.

PVC Schedule 40 Fittings

PVC Schedule 40 fittings are similar to Schedule 80 fittings; however, they are not designed to withstand higher pressures.

Mechanical Joint Fittings

The term **mechanical joint fittings** refers to a variety of fittings that use specially designed clamps and elastomeric gaskets to connect the pipe and fittings. Many of these fittings are described by the manufacturer's name, such as Victaulic or Gruvlok. A mechanical joint clamp used for joining cast iron no-hub DWV pipe and fittings is simply referred to as an **MJ clamp**.

Elastomeric refers to a flexible synthetic rubber-like compound (neoprene) designed for specific uses. Some elastomeric compounds, for example, must be able to resist different chemicals, temperatures and pressures. Manufacturers supply elastomeric gaskets for many different applications.

Grooved Fittings

Victaulic and Gruvlok fittings are used to join steel pipe and tubing, copper tubing, or piping materials that are suitable for grooving. The term **grooving** refers to a process of rolling or cutting a groove into the end of the pipe. The groove provides a channel into which the clamp body fits, as shown in the joint cross-section in Figure 116. The clamp is held together with bolts and the elastomeric gasket.

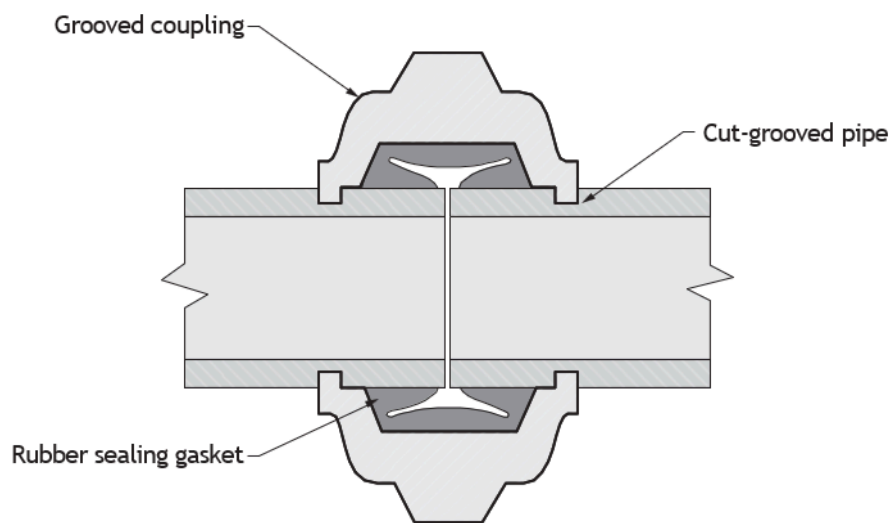


Figure 116 Grooved mechanical joint cross-section (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

When describing these types of fittings, you are often required to include the name of the manufacturer and specify the gasket required to suit the pressures, temperatures and fluid that will be transported.

Victaulic's Zero-Flex coupling (<https://www.victaulic.com/products/style-07-zero-flex-rigid-coupling/>) (Figure 117) adjusts so that it can be clamped to a pipe with standard pipe tolerances, providing resistance to flexing and twisting.



Figure 117 Zero-Flex coupling with gasket for grooved pipe (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Figure 118 shows various types of grooved fittings. The plain end Roust-A-Bout coupling, also from Victaulic, features gripping teeth that help form a strong joint between plain and bevelled ends (including Schedule 80 carbon steel pipe). However, it cannot be used on plastic pipe, pipe with brittle linings, cast or ductile iron pipe, or any pipe with a surface hardness greater than 150 Brinell.



45 deg grooved elbow



Grooved tee



Grooved elbow



Outlet coupling, Style 72



Plain end Roust-A-Bout coupling,
Style 99



Snap-joint coupling, a
type of quick-connect
grooved fitting

Figure 118 Various types of grooved fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Mechanical Joint Couplings for Cast Iron Drainage

A **mechanical joint (MJ) coupling** is used to join no-hub cast iron DWV piping and fittings. The coupling is a neoprene sleeve inside a stainless steel sleeve with attached gear clamps. Mechanical joints have replaced the **bell and spigot (lead and oakum) joint**.



Figure 119 An assembled MJ coupling (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

MJ clamps can be made entirely of elastomeric compounds with individual gear clamps and no stainless steel sleeve. These clamps are used as transition couplings (adapters) from one type of piping material to another, and can be purchased as straight or reducing couplings. They are popular for renovations.

Bushings can be purchased that will allow a standard size clamp to be used to join pipes of the same size but with different OD. The bushing fits inside the clamp to adapt to the OD of the smaller pipe (Figure 120).



Figure 120 4" MJ clay coupling with 4" clay x ABS bushing (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

MJ couplings are quite flexible—they make leak-proof seals on virtually any pipe material: plastic, cast iron, asbestos cement, clay, concrete, steel, copper, and ductile iron. All couplings are clearly marked with part number, size, and pipe materials that the coupling will connect.

Some examples of trade names for these clamps are Zip, Fernco, Mission Clay, and Rollee. When you describe these clamps, you should include the trade name in the description.



Figure 121 Examples of flexible coupling fittings (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Push-on Fittings

A **push-on joint** is a type of fitting that resembles a bell and spigot joint. These joints are used extensively for water mains, sanitary and storm sewers, and municipal services.

Push-on fittings are available in a variety of materials for different piping materials, including PVC and ductile cast iron. This method of joining pipe uses a type of ring gasket, which is placed in a groove in the hub of the fitting. The gaskets may be designed for use with only the fittings of a specific manufacturer. You must specify the manufacturer of the fittings to ensure you receive the right gaskets.

Push-on fittings must be restrained when they are pressurized in use. Fitting restraint is accomplished by a system of rodding, thrust blocks, and clamping devices.

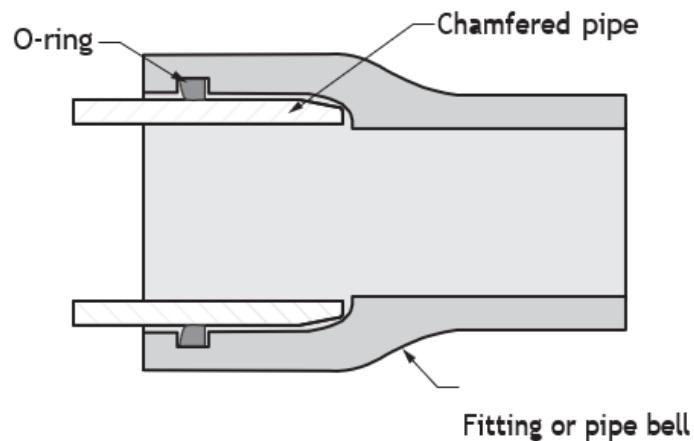
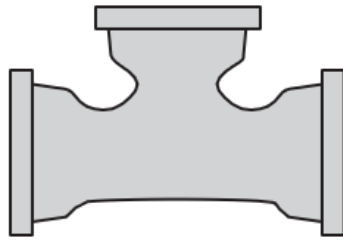
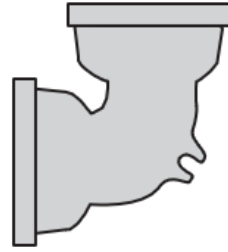


Figure 122 Cutaway of push-on fitting connection (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Ductile CI tee



Ductile CI 90 deg

Figure 123 Common ductile iron push-on fittings for water mains (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Figure 124 Ductile iron push-on joint pipe fitting (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)



Self-Test D-3.1 Describe Fittings Used in the Pipe Trades

Complete Self-Test 3.1 and check your answers.

If you are using a printed copy, please find Self-Test D-3.1 (#chapter-self-test-d-3-1-describe-fittings-used-in-the-pipe-trades) and Answer Key (#chapter-answer-key-self-test-d-3-1) 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=2055#h5p-9> (<https://d-pipingcomponents-bcplumbingapprl1.pressbooks.tru.ca/?p=2055#h5p-9>)

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- The following images are courtesy of NIBCO INC (<https://www.nibco.com/nibco-products/fittings/>), and are used with permission:
 - **Figure 18** Double sanitary fittings
 - **Figure 19** ABS tee wye combination, long radius
 - **Figure 21** ABS DWV left and right side inlet hubs
 - **Figure 27** Copper tube couplings
 - **Figure 33** Various types of union
 - **Figure 37** Adapter fittings
 - **Figure 39** Various types of plugs and caps
 - **Figure 40** Various types of cleanouts
 - **Figure 50** ABS traps
 - **Figure 55** Soldered fittings
 - **Figure 71** Flange types
 - **Figure 95** PEX crimp fittings
 - **Figure 96** Crimp rings
 - **Figure 107** PEX compression coupling, nuts and brass ferrule
 - **Figure 108** Push fittings
 - **Figure 114** CPVC Fire protection fittings
 - **Figure 115** PVC Schedule 80 fittings
- **Figure 40** [Various types of cleanouts] Ongrade adjustable cleanout is courtesy of Watts and is used with permission.

D-3.2 Describe Connection Methods of Fittings

Sealants

Most piping joints are designed to be leak-proof. **Sealants**, such as thread compounds, gaskets made of elastomeric or fibrous substances or some type of packing can be used to prevent leaks. Sealants may be used in combination with gaskets to ensure that liquids or gases do not leak out and that dirt and contaminants are prevented from entering the piping system.

An effective sealant should have some or all of these characteristics:

- Spread evenly over piping surface or threads
- Seal tightly
- Be non-hardening (should act as lubricant)
- Withstand system temperatures and pressures
- Withstand corrosive effects of pipe contents resist rust and corrosion
- Not leach into piping contents

Piping installation codes may prohibit the use of certain types of compounds, especially on potable water systems.

These common types of sealants are:

- Thread compounds
- Gaskets
- Packing
- Plumber's putty
- Silicone caulking

Thread Compounds

Thread compounds (often referred to as *pipe dope*) are used to ensure a tight seal between threaded piping and fittings. Thread compounds also act as lubricants as joints are tightened. When a wrench is used to run up the threads, the amount of torque required to tighten the joint and the heat caused by friction will be minimized.

Thread compounds are available to suit each application. They may be in paste, stick, liquid, powder, or spray form. Pastes are usually squeezed from a tube. Sticks are paper-wrapped solids that are scraped off and deposited as the stick is rubbed across threads. Liquid compounds are generally applied with a brush applicator which is often attached to the lid of the compound container. Some types of compounds, such as graphite, are available in powder, liquid, or paste forms.



Many thread compounds should only be used in well ventilated conditions. Some are flammable or mildly toxic if swallowed or left on skin. Make sure you check the labels on any products you use and obtain Safety Data Sheets from supplier.

Thread compounds have been formulated to be used in a wide range of operating temperatures and pressures. A common line of pipe sealants known as Permatex® (<https://www.permatex.com/>) has a pipe joint compound that can be applied over grease or oil and is suited to temperature ranges from -54 °C to 204 °C (-65 °F to 400°F). Other popular compounds are available under the line known by the “Unyte” trade name by J. C. Whitlam (<https://www.jcwhitlam.com/>), a long-running family-owned plumbing chemical manufacturer based in Wadsworth, Ohio. “Tyte-Unyte®” is a type of thread compound safe for potable water systems that has a temperature range from -26 °C to 204 °C (-15 °F to 400 °F) and a pressure range up to 13 790 kPa (2000 psi).

Teflon Thread Compounds

Teflon thread compound is available in tape or liquid form. It can be used when joining iron, stainless steel, aluminum, **Monel steel**, and plastics. The tape form is widely used because it is simple to use, clean, strong, durable and extremely effective (Figure 1). Teflon® tape can be used in potable water systems.

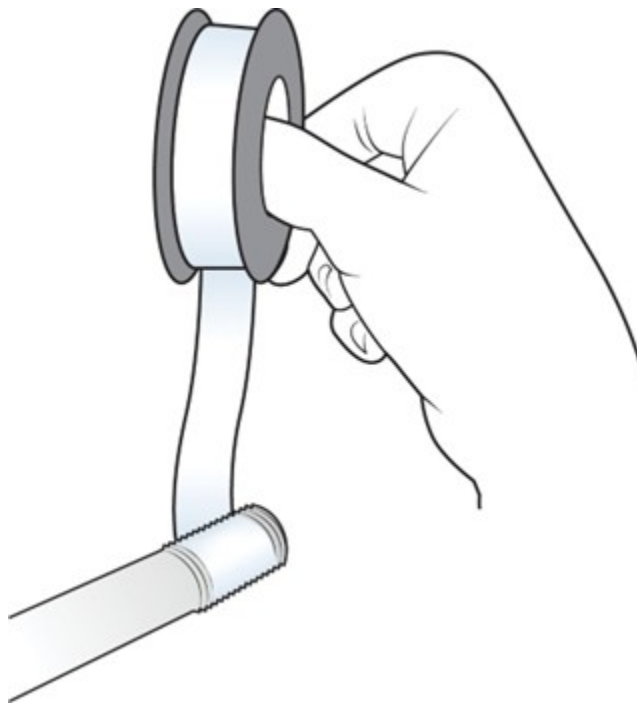
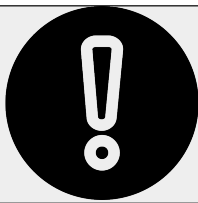


Figure 1 Teflon pipe tape (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Teflon is widely used because of its superior chemical, thermal, electrical, and mechanical properties. It is non-flammable and does not react with most chemicals. It can be used for a wide range of operating temperatures and pressures. Teflon can withstand pressures up to 13 790 kPa (2000 psi). It is used in systems that carry water, steam, chemicals, hydraulic fluids, natural gas, compressed natural gas (CNG), and liquefied petroleum (LP) gas, freon, and food products.

Graphite Thread Compounds

Graphite is finely-flaked carbon that can be used in powder form or mixed with oils and greases for easier application. It can be used to seal and lubricate all threaded, flanged, and gasketed joints on pipe systems carrying alkalis, brine, acids, steam, air, fuel gas, hot or cold water, and aqueous solvents. It will not harden over time so joints should not seize, and disassembly for maintenance is relatively easy.



Graphite mixed with oil or grease must never be used on medical gas piping.

Liquid Thread Compound

Liquid thread compounds can be easily brushed on pipe threads (Figure 2).

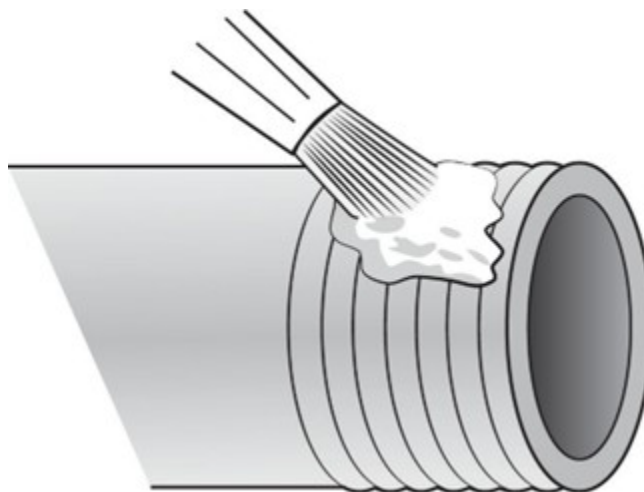


Figure 2 Liquid thread compounds are easy to apply (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Lead-based compounds are not suitable for portable water service piping. Lead is toxic if ingested. Dispose of in accordance with provincial regulations. Refer to the compound product Safety Data Sheet (SDS) for detailed information.

Applying Thread Compounds

Before applying any thread compound, check that pipe joint surfaces are clean, free of oil, dirt, scratches, burrs or imperfections. The following basic steps should be followed before applying any type of thread compound:

1. Clean external and internal threads.
2. Inspect threads for damage. The mating threads should be perfect (sharp at the top and bottom of the thread). Run a tap (for internal threads) or a die (for external threads) to repair any damage.
3. Apply thread compound only to external threads. Start from the second thread and apply it to the remaining perfect threads (Figure 3). This will prevent the compound from squeezing into the pipe.

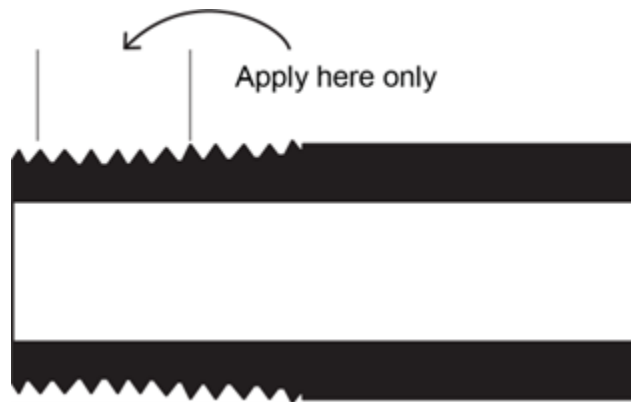


Figure 3 Applying thread compounds (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

4. Engage the threads by hand first and run up the threads as far as possible. Complete the job with a wrench. Be careful not to over-torque the pipe.

Applying Teflon Tape

1. Clean and repair the threads as necessary.
2. Lay the tape on the externally threaded pipe. Start from the second thread and wrap in the direction of the thread (clockwise for right-hand threads). This will prevent the tape from unravelling when the joint is tightened. Wrap the tape in a spiral fashion, overlapping half the width of the tape as you go up the pipe. This will provide two layers of tape where the threads are engaged.
3. Engage the threads by hand first and run up the threads as far as possible. Be careful not to over-torque the pipe when using a wrench for final tightening. Teflon is a very effective lubricant and it is easy to overtighten joints. If joints are overtightened, fittings will stretch and may leak over time.

Gaskets

Gaskets are placed between pipe connections and squeezed together to seal a joint. Sometimes referred to as

compression type fittings or connections, gaskets will only form an effective seal if they are smooth and properly aligned. Gaskets will seal joints, prevent leaks and reduce vibration and noise in piping systems.

The shape of a gasket and the type of material it is made from will depend on the piping size, the type of connection (such as flanged, compression or grooved), and the requirements of particular applications. Before selecting a gasket, you must consider the following characteristics:

- Pipe and fitting sizes
- Type of join connection
- Pipe material
- Temperature range
- Pressure range
- Corrosive nature of pipe content

You must also consider whether ready-made gaskets can be purchased or whether they should be fabricated on the job.

Full-face gaskets (Figure 4) are ready-made gaskets that fit flat flanges and have matching bolt holes for easy installation.

Raised face flanges use ring gaskets without bolt holes.

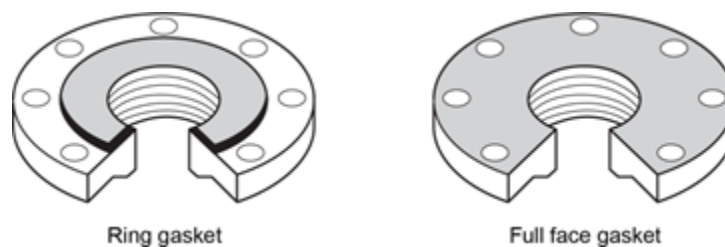


Figure 4 Gaskets for flanges (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Gaskets made from elastomeric compounds (Figure 5) are found in many types of pipe fittings or joints. **Ring gaskets** are made of neoprene or other elastomeric compounds that fit inside the hub of piping such as iron soil pipe and form a tight, sealed joint. **Sleeve type gaskets** are used to seal hub-and-spigot type piping or plain end piping (such as an MJ coupling). Special types of ring gaskets are used inside the housing of Victaulic couplings.

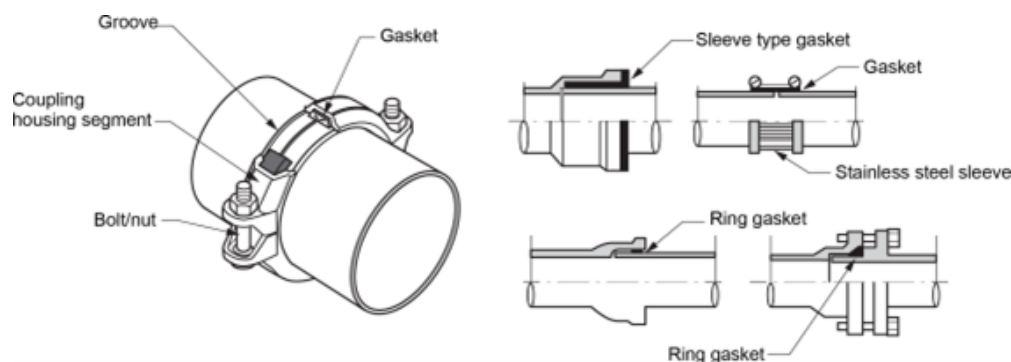


Figure 5 Various types of gasketed joints (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Gasket Materials

Different materials are used to construct different styles of gasket. These include:

- Metal gaskets
- Vegetable fibre gaskets
- Wax gaskets
- Elastomeric gaskets
- Teflon gaskets

Metal Gaskets

Gaskets may be made from tin, aluminum, Monel steel, stainless steel, copper, silver, nickel, brass, iron, low carbon steel and chrome steel. **Metal gaskets** can be used for high temperatures up to 835 °C (1,600 °F) or for high pressures up to 70,000 kPa (10,000 psi). These gaskets are available in a wide variety of shapes and can be used where rubber or fabric type gaskets are unsuitable.

Vegetable Fibre Gaskets

Natural fibres such as cotton, flax, or cork may be saturated with a glue-glycerin solution and used as gaskets in hydraulic applications, such as pumps. The **glue-glycerin solution** ensures that they are permanently oil-proof and natural **vegetable fibre gaskets** can be used for hot oil or steam and hot water applications. They are recommended for temperatures up to 121 °C (250 °F).

Wax Gaskets

Thick, soft **wax gaskets** are used to seal toilets to floor flanges.

Elastomeric Gaskets

Elastomeric substances such as natural rubber, synthetic rubber and PCV are used to make gaskets for a wide range of applications. They may be found in hot and cold water piping, steam piping and drainage piping. Synthetic rubbers, such as neoprene, silicone, nitrile and Viton A, are recommended for oil and corrosive chemical applications. Newer types of gaskets for sealing floor-mounted or wall-hung toilets may be plastic or special types of foam or neoprene.

Rubber gaskets can be reinforced with high tensile cloth or bronze wire mesh for added strength. Natural rubber gaskets are used for pressures up to 1,050 kPa (150 psi) and over a wide range of temperatures from -54 °C to 150 °C (-65 °F to 330 °F). Synthetic rubbers can be used from -90 °C to 288 °C (-130 °F to 550 °F) and with a wider range of pressures.

Teflon Gaskets

A type of plastic, known as Teflon, is very versatile and durable and can be used with almost any substance. **Teflon gaskets** can be used in systems that carry acids, alkalis, oil, water or corrosive solvents. These gaskets are suitable for a wide range of temperatures from -268 °C to 288 °C (-450 °F to 550 °F) and high pressures.

Selecting and Applying Gaskets

Before applying gaskets, you must consider a number of factors to ensure that the proper material and shape of gasket is used and that a tight, durable seal will result.

1. Determine the fluid contents, operating pressures and temperatures. The gasket may have to withstand very high temperatures and pressures. Materials such as Teflon or metal may be more suitable. Temperatures and pressures may not be the important factor. Some systems carry very corrosive liquids at lower pressures and temperatures. Rubber gaskets may be more suitable than others.
2. Consider the type of joint. Is it a flange-type connection or will the gasket be used for pressure type connections between hub-and-spigot piping or fittings? Flange types must be compatible with system pressures. Raised face flanges have smaller surface areas so greater pressure is exerted by the connecting bolts. Full-face gaskets are made to fit flat flanges. If flanges are slightly misaligned, you may choose thicker gaskets to ensure a proper seal.
3. Make sure that gaskets are sized so that they will not protrude past the opening of the pipe when the flange or fitting is tightened. An improperly sized gasket will interfere with the flow of liquid or gases through the pipe. When ordering gaskets, specify:
 - Normal pipe size (i.e., 6" pipe)
 - Service pressures
 - Services temperatures
 - Type of fitting
 - Pipe contents (intended used)
4. With the gasket type selected, check for imperfections in joining surfaces. Clean the end of pipe or flange surfaces. Check for imperfections in mating surfaces such as scratches, warps, or gouges. Make sure all surfaces are clean and dry.
5. Check the gasket manufacturer's specifications for the appropriate lubricant or sealant. Some lubricants may damage the gasket material. Plastic piping may require silicone or petroleum jelly. Teflon is widely used. For ring gaskets or **Tyton® joints** (used to join ductile iron pipe), apply lubricant to the inside of the gasket and to about 75 mm (length of mating surface) of the spigot end of the pipe.
6. For hub and spigot type connections, insert the spigot end until it is seated against the gasket and apply pressure until the pipe is firmly seated and sealed. Flange-type connections should be tightened carefully. Align flanges as accurately as possible, insert bolts and tighten.

Packing

Packing is made of various kinds of pliable materials that will provide a dynamic seal between a moving part and a stationary part. For example, gate valves require packing to prevent leaks from around the centre stem.

A common type of packing is graphite, held in place by a gland and adjustable nut mechanism (Figure 6). In the gate valve stem shown, the graphite will seal the valve and provide lubrication to the stem as it travels up and down. The rubber O-ring packing shown in Figure 7 is usually lubricated by grease.

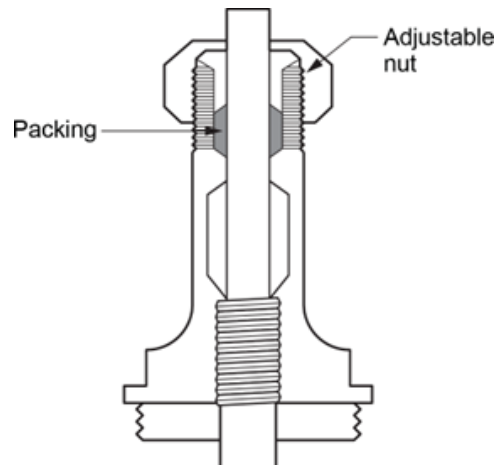


Figure 6 Gland nut mechanism (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

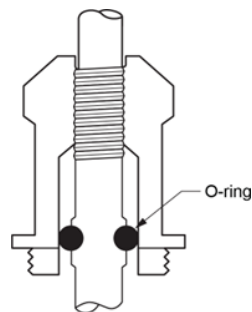


Figure 7 Rubber O-ring packing (BC Industry Training Authority, 2019). CC BY-NC-SA 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>)

Packing is also available in a circular braided ring made of Teflon with a temperature range of -240°C to 315°C (-400°F to 600°F). It can withstand pressures up to 68,950 kPa (10,000 psi).

Other Common Sealants

Plumbers will often use silicone caulking or **plumber's putty** to seal fixtures and some fittings. Plumber's putty is a malleable paste that is rolled into narrow tubes or strips and placed under lavatory or shower drain fixtures, under the rim of counter-top basins and wherever watertight seals are required in fixture trim. This type of compound becomes

softer as it is kneaded or handled. Plumber's putty will harden and set but it can always be worked to become pliable again.

Silicone caulking for plumbing applications is an adhesive compound that has mildew-resistant chemicals added. It is available in tubes of various sizes and will remain in a paste-like form as long as it is not exposed to air.

Silicone is applied along joints between bathtubs and acrylic enclosures or tiles, along sink ledges or rims and along all seams of shower enclosures. Silicone sets fairly quickly but must be allowed to cure, usually for 24 to 36 hours, before being exposed to water.



Silicone caulking is toxic and should not be swallowed or left on skin. Use only in well-ventilated conditions. Consult SDS or manufacturers' directions for safe storage and use.

Solvent Cements

Solvent cements are special types of glue that chemically weld plastic piping together, forming a tight, permanent seal. Some types of cements come in different weights:

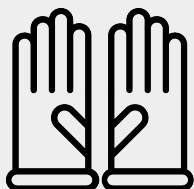
- Light
- Medium
- Heavy
- Extra-heavy

Light cements are free flowing while heavier weights become progressively thicker and can be used on larger diameter, thicker walled plastic piping.

Some solvent cements are formulated to seal effectively in wet installation conditions such as irrigation systems, pools and spas. Acrylonitrile-butadiene-styrene (ABS), polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polyethylene (PE) and polypropylene (PP) may require different types of solvent cements.



Solvent cements are flammable and should not be used near heat, sparks or flames. They must be stored in tightly sealed containers at moderate temperatures. Refer to manufacturer's directions for safe storage and handling.



Solvent cements are toxic. Avoid contact with skin or eyes. Use in well ventilated condition or wear a respirator. Check the Safety Data Sheet (SDS) available for each product.

Solvent cements are spread on the surface of plastic piping with brushes, rollers or daubers. **Daubers** are similar to a cotton ball on a stick but are made from nylon or cotton fibres. Cements are sold in different sizes of cans or glue-pots and the brush, roller or dauber is usually attached to the inside of the container's lid.

Solvent cements will generally set within 2 to 5 minutes and cure in 15 to 20 minutes for common plumbing installations. However, setting and curing times will vary with the temperature and the pipe size. Consult manufacturer's detailed information before applying solvent cement (Tables 1 and 2).

Table 1: Initial Set Times for Weld-on PVC Solvent Cements* (Courtesy of IPS Corporation)

Temperature Range	Pipe Sizes ½" to 1¼"	Pipe Sizes 1½" to 2"	Pipe Sizes 2½" to 6"	Pipe Sizes 10" to 15"	Pipe Sizes 15"+
60°–100°F 16°–38°C	2 minutes	3 minutes	30 minutes	2 hours	4 hours
40°–60°F 4°–16°C	5 minutes	8 minutes	2 hours	8 hours	16 hours
0°–40°F –18°–4°C	10 minutes	15 minutes	12 hours	24 hours	48 hours

Note. Initial set schedule is the necessary time to allow before the joint can be carefully handled.

Table 2: Joint Cure Schedule for Weld-on PVC Solvent Cements* (Courtesy of IPS Corporation)

Relative Humidity 60% or Less**	Cure Time Pipe Sizes ½" to 1¼"		Cure Time Pipe Sizes 1½" to 2"		Cure Time Pipe Sizes 2½" to 8"		Cure Time Pipe Sizes 10" to 15"	Cure Time Pipe Sizes 15"+
Temperature Range During Assembly and Cure Periods	Up to 160 psi	Above 160 to 370 psi	Up to 160 psi	Above 160 to 315 psi	Up to 160 psi	Above 160 to 315 psi	Up to 100 psi	Up to 100 psi
60°–100°F 16°–38°C	15 minutes	6 hours	25 minutes	12 hours	1½ hours	24 hours	48 hours	72 hours
40°–60°F 4°–16°C	20 minutes	12 hours	30 minutes	24 hours	4 hours	48 hours	96 hours	6 days
0°–40°F –18°–4°C	30 minutes	48 hours	45 minutes	96 hours	72 hours	8 days	8 days	14 days

Note. Joint cure schedule is the necessary time to allow before pressurizing system.

*These figures are estimates based on our laboratory tests. Due to many variables in the field, these figures should be used as a general guide,

only.

**In damp or humid weather, allow 50% more cure time.



Self-Test D-3.2: Describe Connection Methods of Fittings

Complete Self-Test 3.2 and check your answers.

If you are using a printed copy, please find Self-Test D-3.2 (#chapter-self-test-d-3-2-section-2) and Answer Key (#chapter-answer-key-self-test-d-3-2) 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.



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- Steamfitter: Competency D-2 Install Fittings

- Sprinkler Fitter: Competency D-5 Install Fittings

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D-3.3 Select Fittings

In the pipe trades, the ability to create a clear and accurate materials list is essential for planning and completing any plumbing installation. In this section, you will learn how to compile a basic materials list that effectively communicates the required fittings and materials for a job. You will explore common practices used in the field, including organizing materials logically, using clear descriptions, and ensuring readability. By the end of this section, you should be able to compile a basic, readable, and logically ordered materials list using standard procedures. Developing these skills will help you work more efficiently, reduce errors, and communicate effectively with suppliers and other tradespeople.

Basic Materials List

A **materials list** is a list of materials that a pipe tradesperson will need to complete the installation of a plumbing system. The pipe tradesperson compiles a materials list to communicate with the plumbing wholesale supplier or other pipe tradespersons.

A **materials takeoff** is similar to a basic *materials list*, but is more detailed. The materials takeoff is sometimes referred to as a *quantity survey* or *quantity cost sheet*. These terms are generally associated with estimating job costs. Estimating job costs is beyond the scope of this section.

Many pipe tradespeople have their own procedures for making a materials list. The procedure outlined in this section is simplified to provide you with a system to compile a basic materials list when on the job.

Compiling a Basic Materials List

The four basic rules to follow when compiling a materials list are:

1. **Use a suitable material list form.**

Materials list forms are not standardized. They can be simple or very detailed, depending on the intended use. A materials list form, or just a simple sheet of paper, may be used on the job. Many pipe tradespeople use lined pads provided by the wholesaler. A pipe tradesperson on the job would use a simple materials list to order fittings or to prepare work for the day. The materials list form example provided here (Table 1) is for illustration only, and may not be exactly what you use on the job.

Table 1: Sample materials list form

Job #	Address		
Description	Quantity	Unit Price	Cost
Drainage ABS			
3" ABS 90O ell	5	\$ 3.00	\$ 15.00
2" ABS 90Oell	3		
1.5" ABS 90O ell	6		
Potable water			
0.5" C × C 90O ell	20		
0.5" C × C × C tee	8		
		Net cost	

2. Write clearly.

Your list must be legible. Unclear handwriting could be interpreted incorrectly.

3. Describe each fitting fully.

Describe each fitting in as much detailed as required to ensure that the materials list is complete.

4. List fittings in a logical order.

Listing in a logical order means to list fittings of the same type one after the other. Listing the fittings in this way allows the use of ditto marks ("").

5. Use headings to group fittings into common uses.

For example, list all the drainage fittings under one heading and all the potable water systems fittings under a different heading. Heading choice is up to you.

Examples of Materials Lists

Table 2 is an example of a materials list that is written in a logical order. Compare it to Table 3, which is not written in a logical order.

Table 2: Materials List in Logical Order

Job #	Address		
Description	Quantity	Unit Price	Cost
Drainage ABS			
3" ABS 90O ell	5	\$3.00	\$15.00
2" " "	3		
1.5" " "	6		
3" ABS 45O ell	3		
2" " "	12		
1.5" " "	6		
Potable water			
0.5" C × C 90O ell	20		
0.5" C × C × C tee	8		
		Net cost	

Table 3: Materials List That is Not in Logical Order

Job #	Address		
Description	Quantity	Unit Price	Cost
3" ABS 90O ell	5	\$ 3.00	\$15.00
0.5" C × C × C tee			
1.5" ABS 90O ell			
3" ABS 45O ell			
3" ABS wye			
1.5" ABS 45O ell			
2" ABS 90O ell		Net cost	

The materials list in Table 3 has no headings and the fittings are in a random order. A materials list such as the one in Table 3 is not in a logical order, and it would therefore take longer to write, longer to fill out, and longer to price.



Self-Test D-3.3: Select Fittings

Complete Self-Test 3.3 and check your answers.

If you are using a printed copy, please find Self-Test D-3.3 (#chapter-self-test-d-3-3-select-fittings) and Answer Key (#chapter-answer-key-self-test-d-3-3) 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=2104#h5p-13> (<https://d-pipingcomponents-bcplumbingapprl1.pressbooks.tru.ca/?p=2104#h5p-13>)

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

- Plumber: Competency D-5 Install Fittings
- Steamfitter: Competency D-2 Install Fittings
- Sprinkler Fitter: Competency D-5 Install Fittings

CSA Group. (2025). *CSA B149.1:25—Natural gas and propane installation code*. https://www.csagroup.org/store/product/CSA_B149.1%3A25_OT/

Smith, L. (2013). *IPT's pipe trades handbook* (10th ed.). IPT Publishing and Training Ltd.

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Self-Test D-3.1 Describe Fittings Used in the Pipe Trades

Complete Self-Test D-3.1 and check your answers.

1. The abbreviation “SO,” when used for plumbing fitting descriptions, stands for
 - a. Soldered outlet
 - b. Side outlet
 - c. Steam outlet
 - d. Slip-on
2. The abbreviation “Galv,” when used for plumbing fitting descriptions, stands for
 - a. Grey aluminum valve
 - b. Galvanic
 - c. Gallon volume
 - d. Galvanized
3. The abbreviation “San,” when used for plumbing fitting descriptions, stands for
 - a. Sanitary
 - b. Steam and nitrogen
 - c. Sand cast
 - d. Sand finish
4. The abbreviation “CSA,” when used for plumbing fitting descriptions, stands for
 - a. Canadian Standards Association
 - b. Copper Systems Alliance
 - c. Copper Standard Adapter
 - d. Canadian Safety Association
5. The abbreviation “w/o,” when used for plumbing fitting descriptions, stands for
 - a. Wide/offset
 - b. White/orange
 - c. With/out
 - d. Water/oil
6. The abbreviation “IPS,” when used for plumbing fitting descriptions, stands for
 - a. Internal pipe size
 - b. International plumbing system
 - c. Inside pipe size
 - d. Iron pipe size
7. The abbreviation “DWV,” when used for plumbing fitting descriptions, stands for
 - a. Drain water valve
 - b. Double waste vent
 - c. Drainage waste and vent
 - d. Downstream water valve
8. The abbreviation “MIPT,” when used for plumbing fitting descriptions, stands for
 - a. Male iron pipe thread
 - b. Malleable iron pipe thread

- c. Maximum inside plastic tapping
 - d. Medium iron pipe tap
9. When comparing a DWV fitting to a pressure fitting, which one of the following statements is true?
- a. The pressure socket is shallower.
 - b. The pressure fitting has a gradual bend throat.
 - c. The DWV fitting has a gradual bend throat.
 - d. The DWV socket is deeper.
10. The end of a fitting that fits into the socket end of another fitting is called the
- a. Bell
 - b. Hub
 - c. Spigot
 - d. Face
11. A malleable iron fitting differs from a cast iron threaded fitting in which of the following ways?
- a. Cast iron fittings will not crack; malleable fittings will crack.
 - b. Cast iron fittings have a thicker bead; malleable fittings have a thinner bead.
 - c. Cast iron fittings will stretch; malleable fittings will not stretch.
 - d. Cast iron fittings have a short radius; malleable fittings have a long radius.
12. Which category of fitting is primarily used to change direction of piping?
- a. Elbow
 - b. Tee
 - c. Coupling
 - d. Adapter
13. Which category of fittings is used to join three pipes together?
- a. Elbow and bushings
 - b. Tees and wyes
 - c. Union and couplings
 - d. Branch and runs
14. Which type of fitting will change the direction and reduce the size of a pipe at the same time?
- a. Sanitary double tee
 - b. Copper by MIP adapter
 - c. Reducing elbow
 - d. Reducing coupling
15. Another name for an elbow is a
- a. Wye
 - b. Union
 - c. Bend
 - d. Round turn
16. Which fitting is used change direction and to secure piping to backing for support?
- a. Street elbow
 - b. Wingback elbow
 - c. Pipe clamp
 - d. Pipe cap
17. Which elbow has MIP threads on one end and FIP threads on the other end?
- a. Wingback elbow
 - b. Reducing elbow

- c. Spigot elbow
 - d. Street elbow
18. Which fitting allows four pipes to be joined together?
- a. Sanitary tee
 - b. Double wye
 - c. Reducing tee
 - d. Cleanout
19. Which fitting allows two straight lengths of pipe to be joined together without changing direction of the pipe?
- a. Tee
 - b. Wye
 - c. Elbow
 - d. Coupling
20. This fitting allows connection of piping to equipment and provides for easy removal, if necessary.
- a. Street elbow
 - b. Union
 - c. Coupling
 - d. Bushing
21. Which fitting is used to provide easy access to a pipeline for maintenance?
- a. ABS permanent cap
 - b. ABS test cap
 - c. Cleanout
 - d. Reducer
22. Which of the following choices is not a factor used to identify a fitting?
- a. Size
 - b. Use
 - c. Shape
 - d. Weight
23. When describing the opening sizes of a wye, which one of the following rules applies?
- a. State the largest size of the run first.
 - b. State the smallest size of the branch first.
 - c. State the smallest size of the run first.
 - d. State the largest size of the branch first.
24. The first item written when describing a single fitting is the fitting
- a. Shape
 - b. Size
 - c. Use
 - d. Joint method
25. Which one of the following rules applies when describing the sizes of a sanitary double tee?
- a. State each size starting with the branch when all sizes are the same.
 - b. State the largest size on the branch first and then each size on the run.
 - c. Only one size needs to be described when all sizes are the same.
 - d. No sizes need to be stated when all sizes are the same.
26. In which type of tee is the branch connection larger than the run?
- a. Sanitary
 - b. Straight

- c. Double sanitary
 - d. Bullhead
27. A short piece of threaded pipe that appears to be threaded over its entire length is a
- a. Short nipple
 - b. Close nipple
 - c. Long nipple
 - d. Shoulder nipple
28. Which of the following is a pipe flange style?
- a. Goose neck
 - b. Slip-on
 - c. Strap-on
 - d. Gear
29. Which of the following is a flange face type?
- a. Flat
 - b. Round
 - c. Square
 - d. Rough
30. Which fitting joint includes a coupling nut and ferrule?
- a. Flange
 - b. Soldered
 - c. Compression
 - d. Slip-on
31. An insert sleeve is used with which one of the following joint types?
- a. Compression
 - b. Flanged
 - c. Soldered
 - d. Socket-weld
32. The SAE flare fitting angle is
- a. 37 deg
 - b. 45 deg
 - c. 60 deg
 - d. 30 deg
33. Which fitting requires a gear clamp to join polyethylene tube?
- a. Insert
 - b. Crimp
 - c. PEX
 - d. Compression
34. Which joint method is used to join no-hub cast iron?
- a. Victaulic clamp
 - b. MJ clamp
 - c. Flange

- d. ABS coupling
35. Which joint method uses a ring gasket and joint restraint to hold the pipe together?
- Welded
 - Solvent cement
 - Push-on
 - MJ clamp
36. The fitting shown in Figure 1 is a C × C
- Adapter
 - Streamline elbow
 - 45 deg DWV elbow
 - Coupling
37. The fitting shown in Figure 2 is a
- 45 deg elbow
 - three-way elbow
 - 45 deg wye
 - DWV tee
38. The fitting shown in Figure 3 is a
- Wye
 - Sanitary tee
 - Offset tee
 - Short turn tee
39. Figure 4 shows a copper
- Bushing
 - Rolled tube-stop coupling
 - Adapter
 - MJ coupling
40. Figure 5 shows a
- Compression fitting
 - 3-piece coupling
 - Gasket union
 - Flare fitting



Figure 1 Image for question 36 (Courtesy of NIBCO INC)



Figure 2 Image for question 37 (Courtesy of NIBCO INC)



Figure 3 Image for question 38 (Courtesy of NIBCO INC)



Figure 4 Image for question 39 (Courtesy of NIBCO INC)

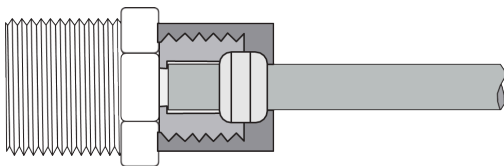


Figure 5 Image for question 40

Fill in the blanks in the Table below with the correct abbreviation or description.

Table 1: Abbreviation Exercise Table

Abbreviation	Meaning
ell	
	Adapter
	Black cast iron (threaded pipe fittings)
	Black malleable (threaded pipe and fittings, not galvanized)
C×C	
C×FIPT	
c/o	
	Cast iron (pipe and fittings)
CSA	
Dbl	Double (e.g. double wye)
DWV	
FIPT	
Galv	
IPS	
IPT	
FPT or FIPT	
	Malleable (pipe and fittings)
	Mechanical joint clamp (pipe and fittings)
OPT and MPT	
RH or LH	
MIPT	
SAE	
	Sanitary (drainage fittings)
	Schedule (used to describe a steel pipe wall thickness)

	Side outlet (used to describe a tee with a side outlet connection)
	Spigot end
Tapt	
	without (e.g. an ABS P-trap w/o cleanout)
WC	
WB	
WOG	
	Wrought
	Y fitting

Answer Key: Self-Test D-3.1 (#chapter-answer-key-self-test-d-3-1) is on the next page.

Answer Key: Self-Test D-3.1

1. b. Side outlet
2. d. Galvanized
3. a. Sanitary
4. a. Canadian Standards Association
5. c. Without
6. d. Iron pipe size
7. c. Drainage waste and vent
8. a. Male iron pipe thread
9. c. The DWV fitting has a gradual bend throat.
10. c. Spigot
11. b. Cast iron fittings have a thicker bead; malleable fittings have a thinner bead.
12. a. Elbow
13. b. Tees and wyes
14. c. Reducing elbow
15. c. Bend
16. b. Wingback elbow
17. d. Street elbow
18. b. Double wye
19. d. Coupling
20. b. Union
21. c. Cleanout
22. d. Weight
23. a. State the largest size of the run first.
24. b. Size
25. c. Only one size need be described when all sizes are the same.
26. d. Bullhead
27. b. Close nipple
28. b. Slip-on
29. a. Flat
30. c. Compression
31. a. Compression
32. b. 45 deg
33. a. Insert
34. b. MJ clamp
35. c. Push-on
36. b. Streamline elbow
37. c. 45 deg wye
38. b. Sanitary tee
39. b. Roll-stop coupling
40. d. Compression fitting

Fill in the blanks in the Table below with the correct abbreviation or description.

Table 1: Abbreviation Exercise

Abbreviation	Meaning
ell	elbow
Adpt	Adapter
Blk CI	Black cast iron (threaded pipe fittings)
Blk mal	Black malleable (threaded pipe and fittings, not galvanized)
C×C	Copper by copper (pipe and fittings)
C×FIPT	Copper by female iron pipe thread
c/o	Clean out
CI	Cast iron (pipe and fittings)
CSA	Canadian Standards Association. Note: All fittings and pipe used in the plumbing system must be CSA approved for the application for which they are used.
Dbl	Double (e.g. double wye)
DWV	Drainage waste and vent fittings and pipe
Fit.C×FIPT	Fitting copper by female iron pipe thread
Galv	Galvanized (pipe and fittings with a zinc coating for corrosion resistance)
IPS	Iron pipe size
IPT	Internal pipe thread, or iron pipe thread
FPT or FIPT	Female pipe thread or Female iron pipe thread
Mal	Malleable (pipe and fittings)
MJ	Mechanical joint clamp (pipe and fittings)
OPT and MPT	Outside pipe thread and male pipe thread
RH or LH	RH = right hand; LH = left hand (used when identifying the location of the side outlet on a DWV fitting)
MIPT	Male iron pipe
SAE	Society of Automotive Engineers
San	Sanitary (drainage fittings)
Sch	Schedule (used to describe a steel pipe wall thickness)

SO	Side outlet (used to describe a tee with a side outlet connection)
SP	Spigot end
Tapt	tapped (refers to fitting openings that are threaded to accept MIP threads)
w/o	without (e.g. an ABS P-trap w/o cleanout)
WC	Wingback
WB	Water closet
WOG	Water, oil, gas
Wrot	Wrought
Wye	Y fitting

Self-Test D-3.2 Describe Connection Methods of Fittings

Complete Self-Test D-3.2 and check your answers.

1. To lubricate and seal threaded piping, you should use
 - a. Teflon thread
 - b. Pipe dope
 - c. Silicone
 - d. Plumber's putty
2. Two common forms of Teflon thread sealants are liquid and
 - a. Gelatin
 - b. Spray
 - c. Stick
 - d. Tape
3. O-ring and shaped gaskets are used to form seals between
 - a. Bell-and-spigot piping
 - b. Flanged piping
 - c. Groove piping
 - d. Threaded piping
4. The most common types of sealing gaskets used in domestic plumbing installations are made from
 - a. Wax
 - b. Lead
 - c. Silicone
 - d. Elastomeric substances
5. The sealants that may be toxic and should only be used in well-ventilated conditions include
 - a. Plumber's putty, silicone caulking, wax
 - b. Silicone caulking, pipe dope, solvent cement
 - c. Solvent cement, vegetable fibre gaskets, wax
 - d. Pipe dope, graphite packing, plumber's putty
6. Ready-made gaskets that fit flat flanges and have matching bolt holes for easy installation are
 - a. Donuts
 - b. Ring gaskets
 - c. O-rings
 - d. Self-sealing gaskets
7. A self-sealing gasket is found in a
 - a. Victaulic fitting
 - b. Bell-and-spigot joint
 - c. Full face flange
 - d. Mechanical joint coupling
8. Thread compounds act to lubricate, seal and protect threaded pipe joints from
 - a. Overtightening
 - b. Damage from rapid temperature changes

- c. Rust and corrosion
 - d. Staining
9. Metal gaskets are usually found in
- a. Fixture drains
 - b. Industrial applications
 - c. Medical fixtures and fittings
 - d. Hot water piping
10. The sealant used to form watertight seals under faucets, drains and strainers
- a. Plumber's putty
 - b. Silicone caulking
 - c. Solvent cement
 - d. Teflon

For questions 11 to 15, use the set times and cure schedule for PVC solvent cements shown in Table 1.

Initial Set Times for Weld-on PVC Solvent Cements*								
Temperature Range	Pipe Sizes ½" to 1¼"		Pipe Sizes 1½" to 2"		Pipe Sizes 2½" to 6"		Pipe Sizes 10" to 15"	Pipe Sizes 15" +
60°–100° F	2 minutes		3 minutes		30 minutes		2 hours	4 hours
40°–60° F	5 minutes		8 minutes		2 hours		8 hours	16 hours
0°–40° F	10 minutes		15 minutes		12 hours		24 hours	48 hours
Note: Initial set schedule is the necessary time to allow before the joint can be carefully handled.								
Joint Cure Schedule for Weld-on PVC Solvent Cements*								
Relative Humidity 60% or Less**	Cure Time Pipe Sizes ½" to ¾"		Cure Time Pipe Sizes 1½" to 2"		Cure Time Pipe Sizes 2½" to 8"		Cure Time Pipe Sizes 10" to 15"	Cure Time Pipe Sizes 15" +
Temperature Range During Assembly and Cure Periods	Up to 160 psi	Above 160 to 370 psi	Up to 160 psi	Above 160 to 315 psi	Up to 160 psi	Above 160 to 315 psi	Up to 100 psi	Up to 100 psi
60°–100° F	15 min.	6 hrs	25 min.	12 hrs	1½ hrs	24 hrs	48 hrs	72 hrs
40°–60° F	20 min.	12 hrs	30 min.	24 hrs	4 hrs	48 hrs	96 hrs	6 days
0°–40° F	30 min.	48 hrs	45 min.	96 hrs.	72 hrs.	8 days	8 days	14 days
* These figures are estimates based on our laboratory tests. Due to many variables in the field, these figures should be used as a general guide only.								
** In damp or humid weather all 50% more cure time.								
Note: Joint cure schedule is the necessary time to allow before pressurizing system.								

Table 1 Set times and cure schedule for PVC solvent cement (courtesy of IPS Corporation)

11. If you were sealing 1/2 PVC piping inside a house, in the summer, how much time should you allow for the cement to set?
- 1. 2 minutes
 - 2. 2 minutes
 - 3. 2 minutes
 - 4. 2 minutes
12. How long would you allow the 1/2 PVC piping to cure completely?
- 1. 15 minutes
 - 2. 20 minutes

3. 30 minutes
 4. 6 hours
13. If you were sealing 6 PVC piping in an irrigation system on a mild, dry day in the middle of winter, how long would you allow for the cement to set?
1. 10 minutes
 2. 15 minutes
 3. 30 minutes
 4. 2 hours
14. Assuming that the irrigation system was at pressures above 160 psi, how long would you allow the joints to cure?
1. 12 hours
 2. 24 hours
 3. 48 hours
 4. 8 days
15. If you had to solvent weld 2 PVC piping at freezing temperatures, how long would you allow the joint to set?
1. 3 minutes
 2. 5 minutes
 3. 8 minutes
 4. 13 minutes

Answer Key: Self-Test D-3.2 (#chapter-answer-key-self-test-d-3-2) is on the next page.

Answer Key: Self-Test D-3.2

1. b. Pipe dope
2. d. Tape
3. a. Bell-and-spigot
4. d. Elastomeric substances
5. b. Silicone caulking, pipe dope, solvent cement
6. b. Ring gaskets
7. a. Victaulic fitting
8. c. Rust and corrosion
9. b. Industrial applications
10. a. Plumber's putty
11. a. 2 minutes
12. b. 15 minutes
13. d. 2 hours
14. c. 48 hours
15. d. 15 minutes

Self-Test D-3.3 Select Fittings

Complete Self-Test D-3.3 and check your answers.

1. Complete the materials list sheet provided for the fittings shown in Figure 1 and then check your answers. Recall that your goal is to be able to identify and name fittings correctly, and to be able to compile a basic material list.

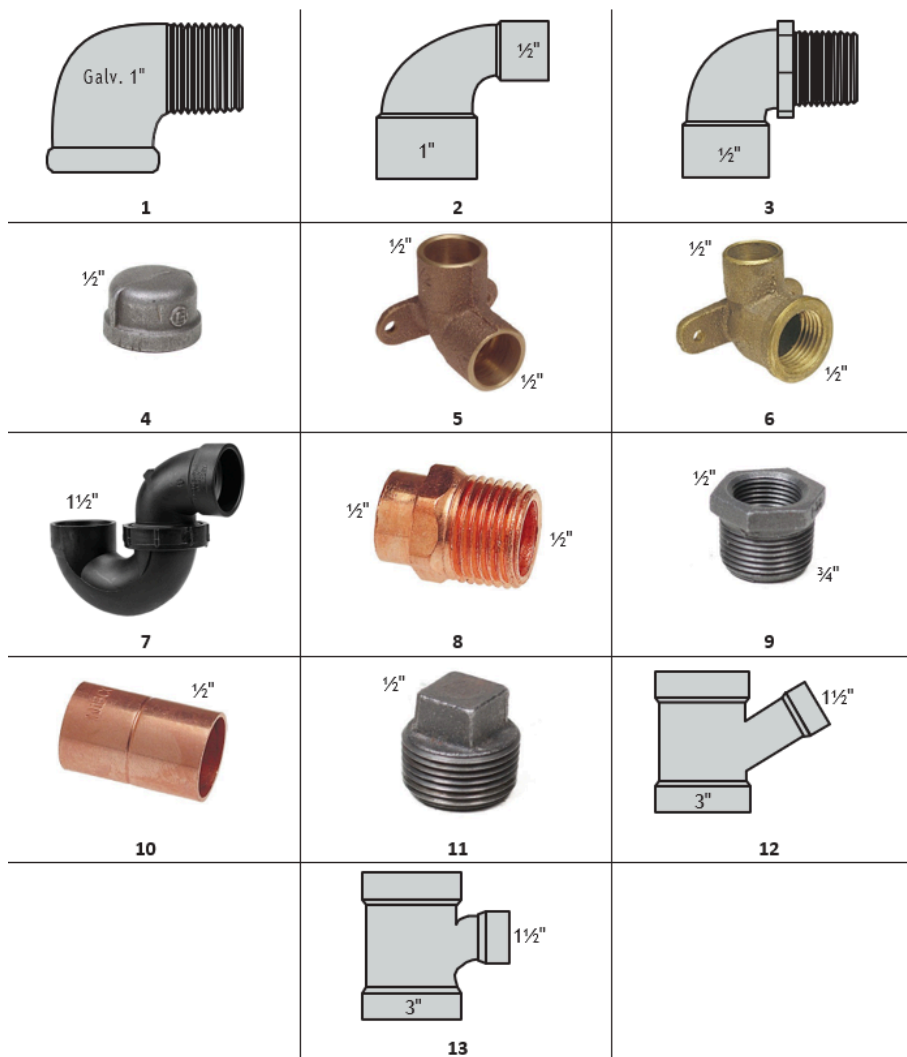


Figure 1 Images for Question 1

The fittings in Figure 1 are identified as numbers 1 to 13. Write these numbers in the appropriate space in the "No." column, then fill in the rest of the table.

Table 1: Material List for Figure 1

Job #	No.	Quantity	Fitting Description
ABS DWV			
Sweat Copper			
Iron Pipe			

2. Identify the fittings in Figure 2 and complete the materials list.

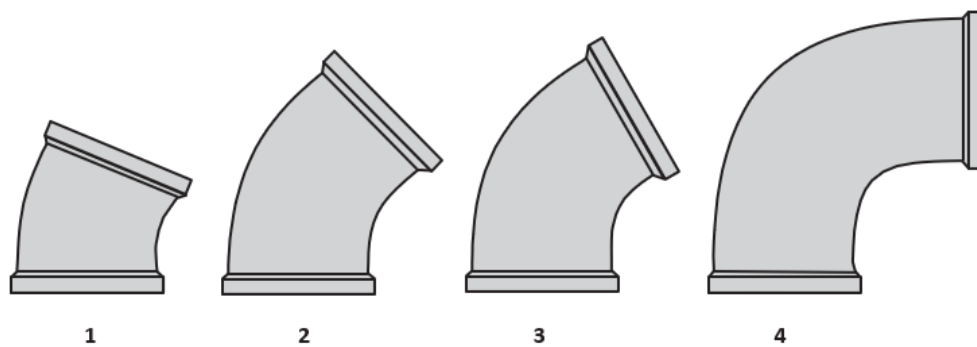


Figure 2 Images for Question 2

The fittings in Figure 2 are 3 in. cast iron drainage.

Table 2: Material List for Figure 2

Job #	No.	Quantity	Fitting Description
Drainage	1		
	2		
	3		
	4		

3. Identify the fittings in Figure 3 and complete the materials list.

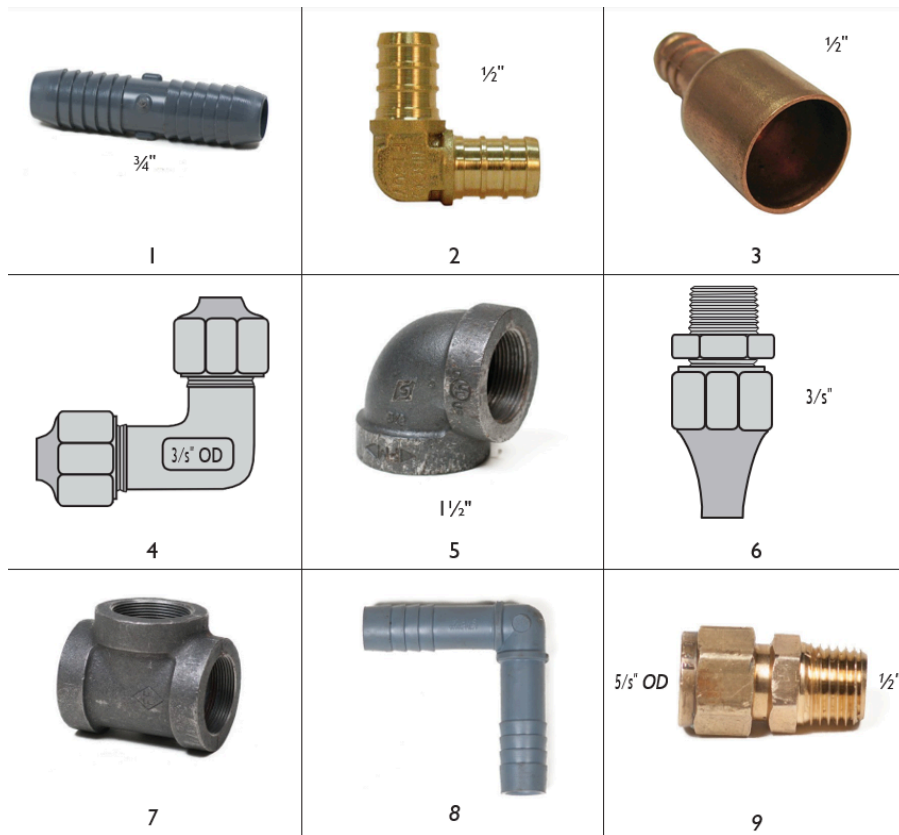


Figure 3 images for Question 3

The fittings in Figure 3 are identified as numbers 1 to 9. Write these numbers in the spaces in the No. column, then fill in the rest of the table.

Table 3: Material List for Figure 3

Job #	No.	Quantity	Fitting Description

4. Identify the fittings in Figure 4 and complete the materials list.

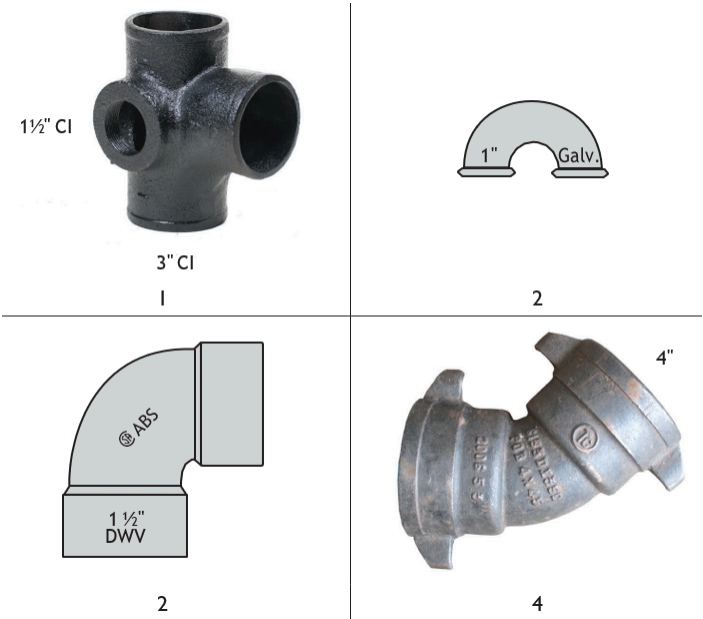


Figure 4 Images for Question 4

The fittings in Figure 4 are identified as numbers 1 to 4. Write these numbers in the spaces in the No. column, then fill in the rest of the table.

Table 4: Material List for Figure 4

Job #	No.	Quantity	Fitting Description

5. Identify the fittings in Figure 5 and complete the materials list.

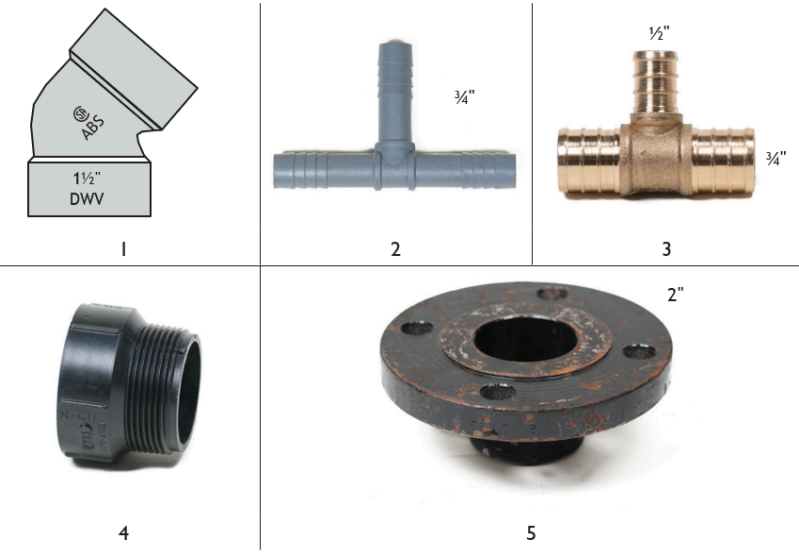


Figure 5 Images for Question 5

The fittings in Figure 5 are identified as numbers 1 to 5. Write these numbers in the spaces in the No. column, then fill in the rest of the table.

Table 5: Material List for Figure 5

Job #	No.	Quantity	Fitting Description

Answer Key: Self-Test D-3.3 (#chapter-answer-key-self-test-d-3-3) is on the next page.

Answer Key: Self-Test D-3.3

The fitting descriptions used on these answer sheets are generic. They may not exactly match your answers or a given manufacturer's descriptions. On the job, you may wish to consult the manufacturers' catalogues for exact fitting descriptions.

1.

Table 1: First Answer Material List

Job #	No.	Quantity	Fitting Description
ABS DWV	7	1	1.5" ABS DWV hub × union P trap
	12	1	3" × 1.5" ABS DWV wye
	13	1	3" × 1.5" ABS DWV san tee
Sweat Copper	2	1	1" × 0.5" C × C red. 90° ell
	3	1	0.5" C × 0.5" MIP 90° ell
	5	1	0.5" C WB 90° ell
	6	1	0.5" C × FIP WB 90° ell
	8	1	0.5" C × 0.5" MIP adapt
	10	1	0.5" C roll tube coupling
Iron Pipe	1	1	1" galv IP street 90° ell
	4	1	0.5" blk mal IP cap
	9	1	$\frac{3}{4}$ " × 0.5" IP blk mal bushing
	11	2	0.5" blk IP plugs

2.

Table 2: Second Answer Material List

Job #	No.	Quantity	Fitting Description
Drainage	1	1	3" MJ CI 1 16 bend
	2	1	3" MJ CI 1/8 bend
	3	1	3" MJ CI 1/6 bend
	4	1	3" MJ CI 1/4 bend

3.

Table 3: Third Answer Material List

Job #	No.	Quantity	Fitting Description
PE Insert	1	1	$\frac{3}{4}$ " plastic insert coupling for series 100 PE
	8	1	0.5" plastic insert 90° ell for series 100 PE
PB Crimp	2	1	0.5" crimp 90° ell
	3	1	0.5" crimp × 0.5" sweat female adapt
Flare	4	1	$\frac{3}{8}$ " OD SAE flare 90° ell short nut
	6	1	$\frac{3}{8}$ " OD flare × $\frac{3}{8}$ " IP adapt
Threaded	5	1	1.5" blk CI IP 90° ell (designate class 125 or 250)
	7	1	1.5" blk CI IP tee (designate class 125 or 250)
Compression	9	1	$\frac{5}{8}$ " OD compression × 0.5" IP adapt

4.

Table 4: Fourth Answer Material List

Job #	No.	Quantity	Fitting Description
Misc. Fits.	1	1	3" MJ san tee w/1.5" LH tapt SO
	2	1	1" galv IP 180° return bend
	3	1	1.5" ABS DWV 90° ell
	4	1	4" ductile Ring-Tite 45° ell

5.

Table 5: Fifth Answer Material List

Job #	No.	Quantity	Fitting Description
ABS DWV	1	1	1.5" ABS DWV 45° ell
ABS DWV	2	1	1.5" ABS DWV hub × MIP adapt
Misc. Fits	3	1	$\frac{3}{4}$ " plastic insert tee for PE series 100
	4	1	$\frac{3}{4}$ " × $\frac{1}{2}$ " crimp tee
	5	1	2" 150 psi weld neck raised face flange

Version History

This page provides a record of changes made to this learning resource, Plumbing Apprenticeship Level 1, Block D (<https://d-pipingcomponents-bcplumbingappr1.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.