1. Piping and tubing systems

Overview

Purpose

A gas technician/fitter must know how to select and use the different types of piping, tubing, valves, and connectors for constructing gas distribution systems.

Objectives

At the end of this Chapter, you will be able to:

- describe requirements of piping, tubing, and connectors; and
- describe valves and fittings.

Terminology

Term	Abbreviation (symbol)	Definition
Connector		Tubing or hose with a fitting at each end for connecting an appliance or equipment with piping or tubing
Corrugated stainless steel gas tubing	CSST	Continuous, flexible, stainless steel pipe with an exterior PVC covering
Flexible metallic hose		All-metallic flexible gas conduit
Hose		Flexible conduit
Hose connector		Flexible, assembled conduit not exceeding 6 ft (2 m) in length
Inside diameter	ID	Inside diameter of pipe
Metal connector		Corrugated or semi-rigid conduit made entirely of metal
National Pipe Thread Taper	NPT	Standard for tapered threads used on threaded pipes and fittings
Nominal Pipe Size	NPS	North American set of standard sizes for pipes used for high or low pressures and temperatures
Outside diameter	OD	Outside diameter of pipe
Standard dimension ratio	SDR	Method of rating pressure piping

the 2014 national standard for the occupation of Gasfitter – Class B, please review an expanded reference matrix at https://store.csagroup.org/.

CSA GROUP

CSA Group Gas Trade Training Materials – Red Seal Alignment

Red Seal		CSA Gas Trade Unit	1	2	3	4	4A	5	6	7	8	9
2014 Red Seal Block	2014 Red Seal Task	Title	Safety	Fasteners, Tools and Testing Instruments	Properties, Characteristics, and Safe Handling of Fuel Gases	Utilization Codes, Acts and Regulations	Utilization Codes, Acts, and Regulations – Ontario Supplement	Introduction to Electricity	Technical Manuals, Specifications, Drawings and Graphs	Customer Relations	Introduction to Piping and Tubing Systems	Introduction to Gas Appliances
A - Common Occupational Skills	Task 1	Performs safety-related functions.	✓									
	Task 2	Maintains and uses tools and equipment.	✓	✓	✓							
	Task 3	Plans and prepares for installation, service and maintenance.	✓			✓	✓	✓	✓			
B - Gas Piping Preparation and Assembly	Task 4	Fits tube and tubing for gas piping systems.									✓	
	Task 5	Fits plastic pipe for gas piping systems.									✓	
	Task 6	Fits steel pipe for gas piping systems.									✓	
C - Venting and Air Supply Systems	Task 7	Installs venting.									✓	✓
	Task 8	Installs air supply system.										
	Task 9	Installs draft control systems.										
D - Controls and Electrical Systems	Task 10	Selects and installs electronic components.						✓				
	Task 11	Selects and installs electrical components.										
	Task 12	Installs automation and instrumentation control systems.										
E - Installation of Systems and Equipment	Task 13	Installs gas-fired system piping and equipment.									✓	✓
	Task 14	Installs gas-fired system components.										
	Task 15	Installs propane storage and handling systems.										
F - Testing & Commissioning of Gas-fired Systems	Task 16	Tests gas-fired systems.										
	Task 17	Commissions gas-fired systems.	✓	✓	✓	✓	✓	✓			✓	✓
G - Servicing Gas-fired Systems	Task 18	Maintains gas-fired systems.										
	Task 19	Repairs gas-fired systems.										✓
	Task 20	Decommissions gas-fired systems.	✓	✓	✓	✓	✓	✓			✓	✓

Requirements of piping, tubing, and connectors

Clause 6 of CSA B149.1 details requirements for piping material and fittings. It also outlines the proper connecting methods and the many piping practices that gas technicians/fitters must follow. As a gas technician/fitter, you should review and become familiar with all the requirements under Clause 6. The following reinforces some of the requirements and provides some additional information:

Piping material and fittings

Table 1-1 lists the types of pipe and tubing, the fittings you use with them, and the approved methods for making connections. For a good general review of this material, look through the table and review the articles in the Code pertaining to each.

Table 1-1
Pipe or tubing, fittings, and their connections

Type of pipe or tubing	Type of fittings	Type of connections
Iron pipe	Malleable iron	Threaded
	Steel	Welded
	Compression	Flanged
	Mechanical	Connector w/forged nut
		Ring, flange, and bolts
Polyethylene	Hub to hub	Hot iron socket fusion
	Pipe to pipe	Butt fusion
	Saddle	Saddle fusion
	Slip on	Compression slip lock
Copper tube	Copper to copper	Brazing over 1000°F (525 °C)
	Flared	Single 45° flare
	Compression	Not ball sleeve
Steel tube	Flared	Single 45° flare
	Compression	Not ball sleeve
Corrugated stainless steel tubing (CSST)	Specialized manufacturer fittings	Specific to manufacturer of tubing

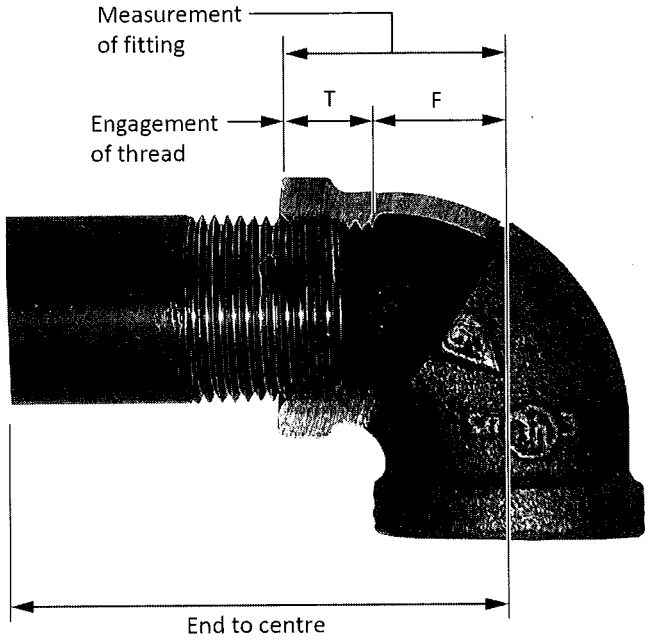
Material

Steel gas piping must conform to ASTM specification A53 or A106, as Clause 6 of CSA B149.1 describes. Gas technicians/fitters most commonly use black pipe for gas with pipe fittings of steel or malleable iron.

Pipe sizes

The gas industry sizes the black pipe it uses for gas systems using the Nominal Pipe Size (NPS). For any nominal size of pipe, the outside diameter (OD) remains the same and the inside diameter (ID) changes as the wall thickness increases. Nominal size is a designation you use for the purpose of general identification. Pipe is threaded on the outside only, therefore, the OD must remain constant.

Figure 1-1
Pipe measurement – end-to-center measurement
Image courtesy of Terry Bell



Threading

Gas piping utilizes a tapered thread (NPT) and is cut on a pipe threading machine or hand tool.

The taper on NPT threads allows them to form a seal when torqued as the flanks of the threads compress against each other. This contrasts with parallel/straight thread fittings or compression fittings, in which the threads merely hold the pieces together and do not provide the seal.

Types of ends

You may finish the ends of gas piping and tubing in the following ways, depending on the application:

- plain;
- grooved; bevelled; and

- threaded.

Wall thickness

The steel pipe that gas technicians/fitters use for gas systems is either Schedule 40 or Schedule 80, with Schedule referring to the wall thickness of the pipe:

Steel pipe	Description	OD
Schedule 40	Pipe is standard.	Have the same OD
Schedule 80	Pipe is extra heavy.	

Markings and labels

Piping used for natural gas or propane systems must have marking and labelling, as Clause 6 of CSA B149.1 describes. The gas technician/fitter needs to become familiar with this section of the Code.

Copper pipe and tubing

Canadian installation codes and regulations permit the use of copper tubing for interior gas distribution systems. Advantages of copper pipe include:

- flexibility and ease of bending;
- low weight;
- ease of making connections;
- corrosion resistance;
- availability in long lengths;
- requires fewer and smaller tools to install; and
- cleaner than steel pipe.

All these factors combine to make copper systems easier and quicker to install. In the case of multi-Chapter and multi-storey buildings, the long lengths of tubing are safer because they require fewer joints.

Types of copper tubing

The copper tubing that gas technicians/fitters use for gas systems must conform to the following specifications:

- ASTM B837 for G tube; and
- ASTM B88 for type K and L tube (seamless water tube).

Generally, you identify gas tube and fittings by their OD.

You cannot use type M copper tubing in gas systems, as its wall thickness is slightly less than that of type G tubing.

Soft and hard drawn tubing

There are two basic kinds of copper tubing:

Copper tubing	Description
Soft drawn or soft temper (annealed)	• Supplied in coils in various lengths • Most commonly used for gas systems
Hard drawn or hard temper	• Comes in straight lengths • Used in some gas system installations, but requires the use of capillary fittings and brazed joints • More practical when larger pipe sizes are required

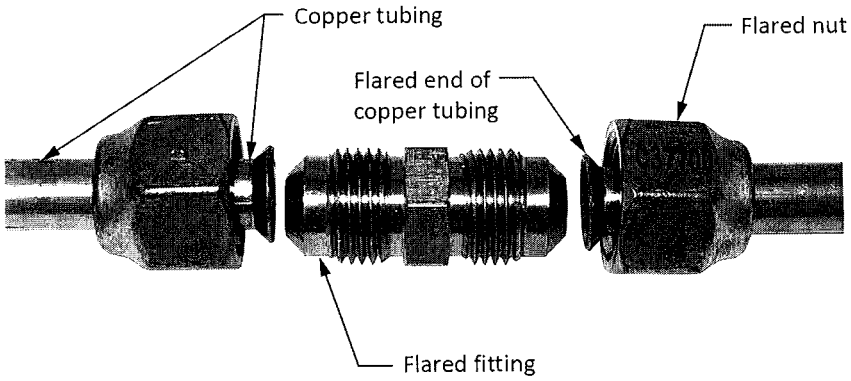
Methods of joining

There are two methods used to join copper tubing:

- brazing with a phosphorous-free material having a melting point in excess of 1000°F (525 °C); and
- joining with 45° brass flare connectors (see Figure 1-2).

Other fittings may be acceptable to the authority having jurisdiction such as the Swagelok fitting. See Figure 1-13.

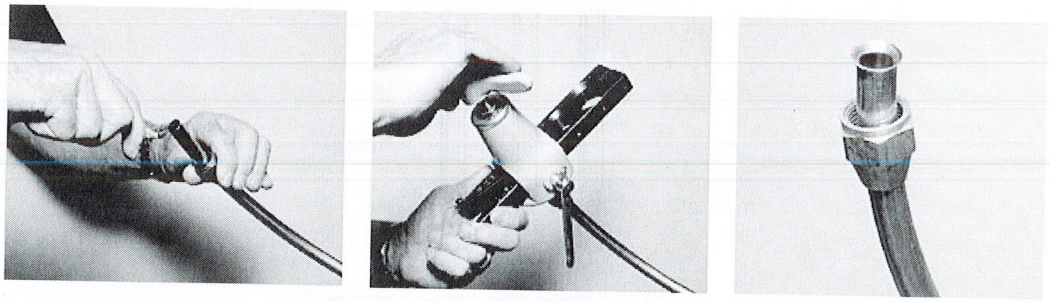
Figure 1-2
Brass flared connector
Image courtesy of Terry Bell



You should use an appropriate tool such as those that a number of tubing/piping tool manufacturers supply to make a flare joint. Make sure to use a tool that matches the OD of the tube that you are flaring and that has the appropriate 45° flare angle. The tool usually consists of flaring bars with openings for various tube sizes, a yoke that contains the flaring cone, and a clamp to grip the flaring bars. See Figure 1-3.

When flaring Types L or Type K copper tube, use annealed or soft temper tube. Cut the copper tube square using an appropriate tubing cutter. After cutting, ream the tube to the full ID leaving no inside burr. Resize tube that is out of round prior to flaring back to round.

Figure 1-3
Making a flare joint



Reaming the tubing | Flaring the tubing | 45° Flare

Corrugated stainless steel tubing (CSST)

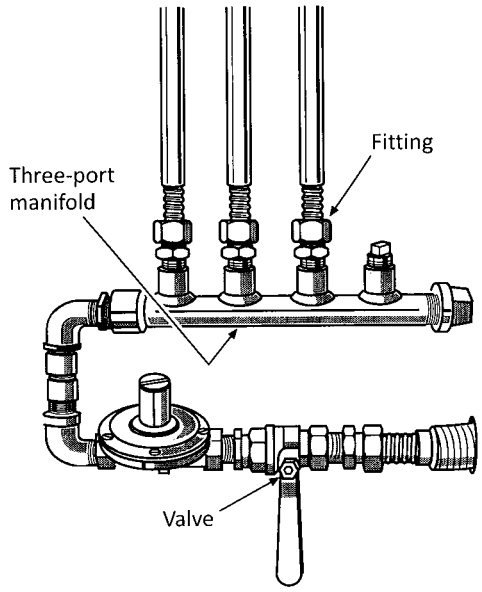
Corrugated stainless steel gas tubing (CSST) consists of a continuous, flexible, stainless steel pipe with an exterior PVC covering. The piping comes in coils that have undergone air-testing for leaks. Most often, you install it in a central manifold configuration (also called parallel configuration) with lines that extend to gas appliances. CSST is lightweight and requires fewer connections than traditional gas piping, because you can bend it easily and rout it around obstacles.

Flexible stainless-steel tubing is approved and available for installation on gas systems up to 5 psig. You can purchase it in rolls up to 250 ft. (70 m) in length and in diameters of 3/8 in to 1 in.

You must not tie CSST directly to a gas meter without you first ensuring that the meter assembly is independently supported, since CSST would not lend the same level of support as an iron piping tie. See Clause 6.14.8 of CSA B149.1.

Examples of CSST manufacturers are ProFlex/WardFlex, Track Pipe, Gas Tite, Titeflex, all of which incorporate corrugated semi-rigid stainless-steel tubing and all metal components including fittings, valves, and multiport manifolds. (See Figure 1-4.) The tubing comes with a continuous yellow polyethylene coating for easy identification. You can field measure, cut, and install it using approved fittings. The tubing and fittings are more expensive than other approved materials; however, there can be a substantial labour savings.

Figure 1-4
Components of the Titeflex system



The multiport manifold allows for easy, future expansion of the system for room additions or additional appliances. CSST has the potential for higher levels of system safety, because connections and joints behind the wall, common in black iron pipe, are essentially eliminated.

Aluminum tubing

Aluminum tubing is what you use in the following applications:

- pilot tubing;
- venting of regulators, etc.; and
- regulator vent tube within the enclosure of an appliance.

You join aluminum tubing by means of compression fittings similar to that in Figure 5-3.

Polyethylene pipe

Gas technicians/fitters often install underground gas piping using polyethylene (PE) piping. A gas technician/fitter must be able to recognize types of polyethylene piping materials, operate the specialized equipment, and be able to perform the different joining methods.

Plastic gas supply piping is an affordable alternative when deciding to run underground supply lines to larger input appliances.

Polyethylene is a thermoplastic that softens when heated and solidifies when cooled, without any chemical reaction taking place. You can fuse polyethylene piping by applying heat and pressure, normally with electricity-powered heating irons. You use these irons to heat the surfaces of the plastic pipe and fittings until you reach the necessary temperature. As the surfaces begin to melt, remove the heating irons and press the surfaces together.

Many plastic piping and fittings manufacturers provide products that incorporate friction fit couplings and connections, eliminating the need for heat fusion techniques and the equipment needed for plastic welding.

Regardless of the piping and fittings used, you should ensure that you have successfully completed the manufacturer's certified installation training program, following which you will receive a certificate allowing you to purchase that specific product. You will also be able to install the product safely and efficiently after the program.

Applications

The plastic pipe or tubing you use for gas distribution systems must conform to CSA B137.4, *Polyethylene (PE) piping systems for gas services*. Examples of exterior underground installations where you can use this are:

- distribution mains;
- house service lines; and
- after meter kits.

You can install plastic pipe or tubing underground to feed outdoor gas-fired appliances. However, when you use this in such application, plastic pipe and tubing must conform to all local and national code requirements.

Gas technicians/fitters use plastic gas piping to supply gas to appliances, such as pool heaters and BBQs, or as a customer supply line from one building on a property to another on the same property.

Due to the fragile nature of plastic pipe, you cannot use it as above-grade supply piping. Special certified sleeves protect the piping as it extends above grade to make the transition to the building supply piping or the appliance connection.

Markings

In accordance with CSA B137.4, any polyethylene piping shall have a clear marking, in a colour that contrasts with the pipe and at intervals not greater than 4.9 ft (1.5 m), that contains the following information:

- the manufacturer's name or trademark;
- the minimum wall thickness or standard dimension ratio (SDR);
- the date of manufacture or date code;
- the nominal size of the pipe (e.g., NPS 2);
- the designation B137.4; and
- the word "gas".

Specification numbers

There are many different grades of polyethylene (PE) used in plastic pipeline systems. However, many of these materials are not compatible and thus each pipe has a marking containing the grade of PE and a four-digit code:

- The first number of the code denotes the density of the pipe.
- The second number is the melt index rating.
- The last two numbers indicate the design strength for density.

Examples of code designations for different polyethylene materials include:

Code designation	Materials	Note on CSA B137.4
2306	A medium density pipe that has a melt index between 1 and 2 and a long-term design strength of 630 psig (4410 kPa)	References and material descriptions for PE 2306, PE 2406, PE 3306, PE 3406, PE 3408, PE 3608, PE 3710, and PE 4608 are no longer included in CSA B137.4. Elimination of these materials does not affect the pipelines that are in service.
3406	A high-density pipe that has a melt index between 0.4 and 1.0 and a long-term design strength of 630 psig (4410 kPa)	

Melt index numbers relate to the amount of heat required for fusion. Refer to the manufacturer's specifications for the heat needed to fuse the pipe that you are using.

Plastic pipe fittings

All fittings should have a clear marking with the following information:

- the manufacturer's name or trademark;
- the designation CSA B137.4;
- the size of the fitting (e.g., 4 in); and
- the generic plastic type (where applicable).

Following is some of the equipment you use when joining polyethylene.

Equipment	Description
Pipe cutter	Has a thin cutting wheel or blade that helps cut plastic pipe
Heating iron	Usually uses electrical heating and comes with Teflon coating or a similar non-stick coating to prevent the molten plastic from sticking to the heating plate Made for butt fusion, socket fusion, and saddle fusion, all of which are shaped to accommodate the surfaces that will be melted together
Butt fusion joining machine	Has a pipe facer attachment for simultaneously shaving off the ends of two pipes (to exactly match the surfaces to be joined) and clamps for separately gripping and aligning pipes or fittings during fusing (with adapters to accommodate various sizes) Can also be used for saddle fusion You move the handle to separate the components or to press them together.

Butt fusion, socket fusion, and saddle fusion are distinct procedures. However, certain steps are common to each of these procedures including:

Step	Description
Cutting pipe ends	Cut pipe ends square and ensure that surfaces you will join are properly aligned.
Cleaning components	Remove water, dirt, grease, oil, fingerprints, and cuttings. Wipe the inside and outside of the pipes you will join with a clean, lint-free cloth or a good quality paper towel and some soap and water.
Adjusting heating iron temperature	Plug in the power cord and set the thermoswitch to the desired temperature, 500°F ± 7°F (260 °C ± 4 °C). Allow the temperature to stabilize, then check the temperature of the heating iron face with a tempilstik. Turn the thermoswitch adjustment screw to make adjustments. Do not mark that part of the heating iron face that you will use to melt the pipe.
Applying heat	Specially shaped heating irons (also called heaters) are what you use to heat pipe ends for butt fusion, the interior of a fitting and the outer surface of the end of a pipe for socket fusion, and the exterior wall of a pipe and its mating surface on a fitting for saddle fusion. With all types of joining with heating irons, apply the heating iron to the surface of the mating components until each surface melts but does not burn. Before starting installation, it is a good idea to determine the length of time required to heat a joint and use this time interval for heating the joints systematically.

Static electricity in polyethylene piping systems

The generation of static electricity by gas flow through polyethylene piping is a well-documented phenomenon. The voltage generated on discharge is at times sufficient to cause pinholes in pipe walls as well as supplying a source of ignition if you will cut open or repair the line.

There are procedures for dealing with this occurrence in a gaseous atmosphere. Although these procedures are beyond the scope of this learning task, the gas technician/fitter must be aware there are steps that they must follow if faced with this event.

Flexible hoses and connectors

The terms flexible hose and flexible connector cover a wide range of items used in the gas industry. The following definitions cover the general types of flexible components you will encounter:

Term	Definition
Hose	Flexible conduit
Connector	Tubing or hose with a fitting at each end for connecting an appliance or equipment with piping or tubing
Metal connector	Corrugated or semi-rigid conduit made entirely of metal

Term	Definition
Hose connector	Flexible, assembled conduit not exceeding 6 ft (2 m) in length
Flexible metallic hose	All-metallic flexible gas conduit

Figure 1-5
Hose connector

Elastomeric hose

There are three types of elastometric composite hose for conducting propane and natural gas; each of the following must comply with CAN/CGA-8.1:

- Type I hose;
- Type II hose; and
- Type III hose.

Hose type	Maximum operating pressure	Minimum burst pressure	Description
Type I	350 psig (2.4 MPa)	1750 psig (12.1 MPa)	Has a tubing made of oil-resistant elastomer, with a minimum thickness of 0.047 in (0.12 mm) Has a polychloroprene or similar cover reinforced with rubber-impregnated cotton or synthetic fibres or stainless steel

Hose type	Maximum operating pressure	Minimum burst pressure	Description
Type II	350 psig (2.4 MPa)	Ranges from 1750 psig (12.1 MPa) for size 40 (60.3 mm nominal ID) to 12 000 psig (82.7 MPa) for size 4 (4.8 mm nominal ID)	Has a tubing for made of oil-resistant elastomer, with a minimum thickness of 0.047 in (0.12 mm) May have a cotton or synthetic braided cover, but must be polychloroprene-impregnated for weather protection Must be reinforced with stainless steel wire braid and or an outer braid of cotton or synthetic fibres
Type III	350 psig (2.4 MPa)	Ranges from 1750 psig (12.1 MPa) for size 40 (60.3 mm nominal ID) to 12 000 psig (82.7 MPa) for size 4 (4.8 mm nominal ID)	Has a tube or lining made of oil-resistant material with low permeability and low leaching properties Must be perforated, oil-resistant elastomeric, or thermoplastic Must be reinforced with stainless steel wire braid and or an outer braid of cotton or synthetic fibres Elastomeric hose must have certification and marking as Type I, II, or III, and have markings indicating a maximum working pressure of 350 psig (2400 kPa) and a date code.

Thermoplastic hose

Thermoplastic hose has a minimum working pressure of 350 psig (2.4 MPa) and a minimum burst strength of five times the rated working pressure. It has an inner tube made of seamless thermoplastic having a tube reinforcement consisting of one or more plies of synthetic fibre or stainless-steel wire. An outer surface of the hose is weather resistant. This hose must have certification of compliance with CAN1-8.3. Markings on the hose include the symbol of the certification agency, hose ID size, date code, and maximum working pressure.

Flexible connectors

Flexible connectors approved for use with natural gas and propane must conform to ANSI Z21.69/CSA 6.16, *Connectors for movable gas appliances*.

- They are for use with the following equipment:
  - gas-fired commercial cooking equipment that is mounted on casters or that may need to be moved for cleaning; and
  - other large, heavy gas-fired equipment that may need to be moved.
- They are for use with piping systems having fuel gas pressures not in excess of 0.5 psig (3.4 kPa).

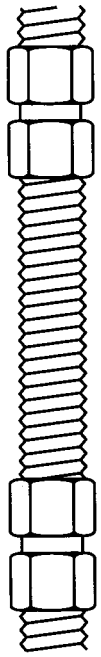
- They have nominal IDs of 1/2, 3/4, 1, 1-1/4, and 1-1/2 in.
- They are not more than 6 ft (1.83 m) in nominal length.
- They have fittings at each end provided with standard taper pipe threads for connection to gas appliances and to gas supply piping.

Corrugated metal connectors

Corrugated metal connectors are made of new, unused parts and materials, consisting of corrugated tubing. They have nominal internal diameters of 1/4, 3/8, 1/2, 5/8, 3/4, and 1 in. They have fittings at both ends provided with tapered pipe threads for connection to gas appliances and to house piping.

Corrugated metal connectors that have approval for use with natural gas and propane must conform to ANSI Z21.69/CSA 6.16.

Figure 1-6
Gas connector



Pipe joining sealants

Joint sealants are what you use on tapered threaded joints in piping systems. To be effective, a joint sealant must:

- flow to match the piping surfaces and seal tightly;
- be non-hardening;
- withstand the required temperatures and pressures;
- not be corroded by, or leach into, the piping contents;
- prevent rusting and corrosion; and
- lubricate when necessary.

Certification organizations

Sealants used with gas piping systems must receive certification for such use from one of the following agencies:

- Underwriters' Laboratories of Canada; and
- CSA Group.

The sealant container will bear a label stating the name of the agency and that the material is a *Listed Joint Compound*.

Joint sealants

Joint sealants include:

- thread compound (commonly called "pipe dope"); and
- approved Teflon pipe tape.

To seal joints

Pipe dope and pipe tape help seal joints in piping systems.

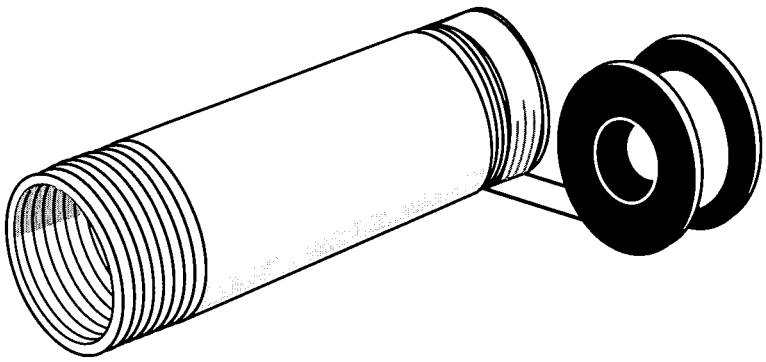
- You apply them only to the male threads of pipes and fittings. Using them on female threads may cause an obstruction to flow, as they may be forced into the pipe.
- Leave the first two threads of pipes and fittings free of dope or tape.
- Apply the pipe dope evenly to all but the first two threads, with sufficient coverage to seal the joint.
- Stretch and apply the pipe tape to the pipe in a clockwise direction, with a 50% overlap between wraps (see Figure 1-6). Only grades of Teflon pipe tape that are identified by their listing as "Approved for Gas" and often manufactured in a different colour such as orange or red are approved for use with natural gas and propane.

Pipe dope also acts as a lubricant. Friction and heat increase as you tighten the joint. The pipe dope helps keep temperatures down and reduce the amount of wrench torque needed to run up the threads.

Apply to threads

When applying pipe dope to threads, leave the first three threads free of compound in order to ensure that the pipe dope does not enter the piping and possibly damage gas valves and components downstream.

Figure 1-7
Pipe tape stretched and applied in a clockwise direction, with 50% overlap between wraps



Requirements for different installations

Expansion and contraction

In locations that experience wide fluctuations in temperature, piping installations must be able to accommodate expansion and contraction, which you can accomplish through the following:

- expansion loops;
- offsets; and
- swing joints.

These types of piping configurations allow a system to stress and flex at fitting joints rather than experience a break of pipe or fitting when piping settles or moves.

Anchor or secure piping at critical points in order to control the direction of expansion and contraction.

Hazardous locations

You cannot install gas piping and tubing in locations where you can expect diffusion of the gas throughout the building if a gas leak occurred. This includes areas such as:

- stairwells of multi-Chapter dwellings (more than two Chapters);
- heating and ventilation ducts;
- elevator shafts;
- dumb waiters; and
- chimneys.

You cannot install gas piping and tubing in locations where:

- large quantities of corrosive chemicals are used; and
- it is in contact with corrosive cinders.

Outdoor locations

Underground installations

Gas piping and tubing installed underground must meet the following requirements:

- Piping cannot be smaller than NPS 1/2.
- Its minimum depth of installation must be:
  - 24 in (600 mm) under commercial driveways or parking lots; or
  - 15 in (400 mm) in other locations.
- It must not pass beneath foundations, walls, or buildings
- Except for Type K copper, it must have an approved, corrosion-resistant coating or covering.
- All piping joints must be welded or be approved compression fittings.
- All copper tubing joints and connections must be brazed.

Runs between buildings

Gas piping and tubing run between buildings must have a shut-off valve where it exits the first building and one at the point where it enters the second.

Protection of copper tubing

Where copper tubing runs through concrete, cement block walls, or in places where contact between the pipe with another surface could cause corrosion of the pipe, the pipe must have external corrosion protection in the form of paint, anti-corrosion coating, or a double layer of certified protective tape.

Copper tubing used in underground applications must be either:

- Type G or Type L that comes with an external approved coating; and
- Type K.

Rooftop piping

When installing piping on commercial rooftops, give special considerations to support along the piping length and at threaded connections. In addition, ensure that piping exposed to the elements has protection against corrosion and linear expansion. When a rooftop piping run extends beyond 100 feet in straight length, give provisions for linear expansion in the form of piping offsets or engineered expansion joints. These piping techniques take the stress of expansion away from the rigid piping length.

Indoor installations

The minimum pipe size that you can use for indoor applications is 1/2 in diameter; however, you may use 3/8 in diameter tubing for branch lines that are 25 ft (7.5 m) or less in length and that do not supply more than 15 000 Btu/h (4.5 kW).

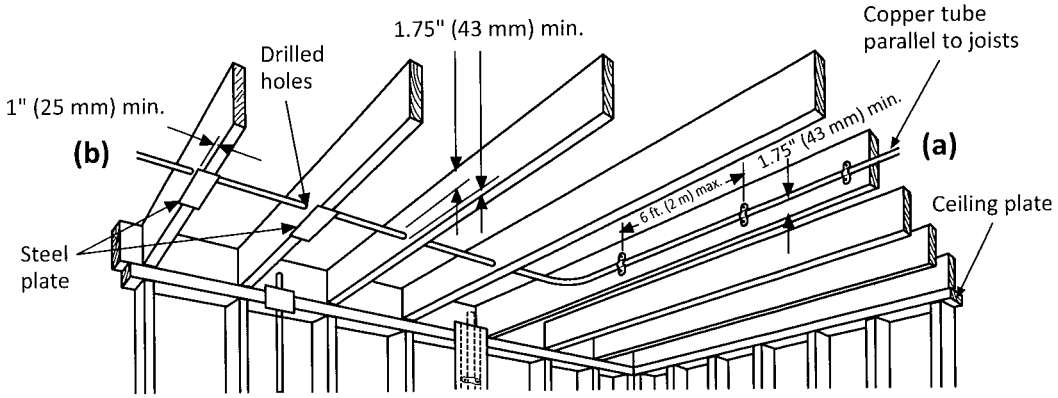
Piping and tubing runs

You can run gas system piping and tubing parallel, diagonal, or at right angles to floor joists.

- When you run the pipe or tubing parallel to joists, fasten it to the centre of the vertical face of the joist. See Figure 1-8a.

- When you run the pipe or tubing diagonally or at right angles to joists, fasten it to the bottom of the joist.
- Whenever possible, run pipe or tubing fastened to the bottom of joists close to water pipes, conduits, ductwork, or support beams.
- You may install pipe and tubing run at right angles to joists through holes drilled in the centre of the joists. See Figure 1-8b.

Figure 1-8
Piping /tubing and joists



Concealed piping and tubing

Any concealed gas piping and tubing must conform to the following requirements:

- It must not be in a location where an undetected leak could allow gas to accumulate.
- It must undergo testing and inspection in the final location before you conceal it.
- It should not have unions or swing joints made up of a combination of fittings.

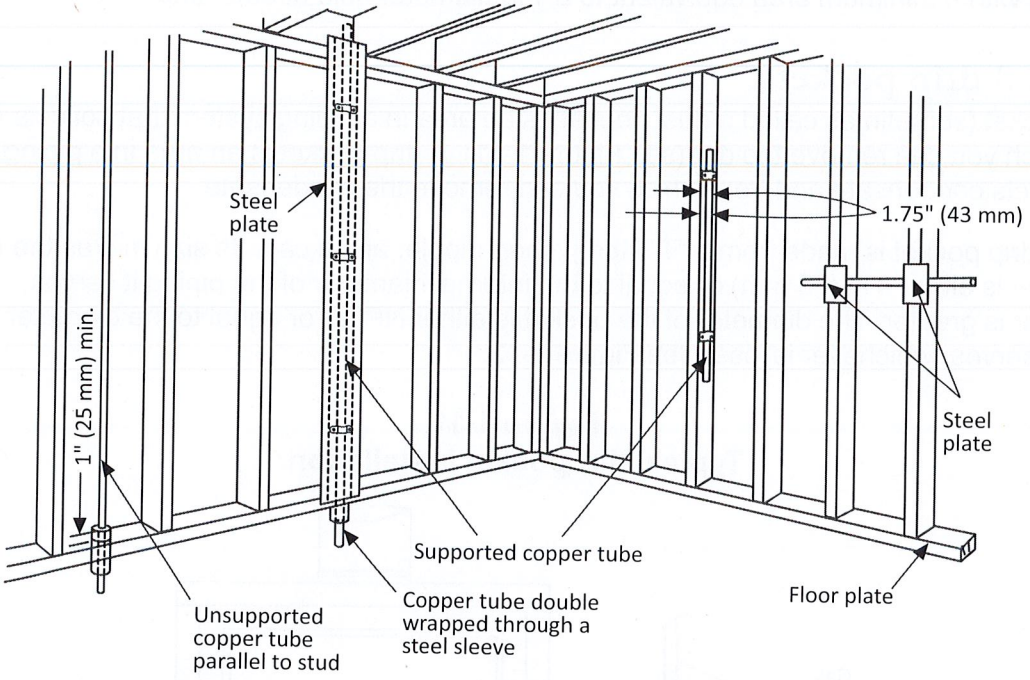
You may not conceal gas piping less than NPS 1/2.

Tubing in framed walls

Copper tubing installed in framed walls must have a metal sleeve or other similar means of protection at the point where it passes through a sill plate or other structural members (see Figure 1-9). It must also have sufficient slack to allow for expansion, contraction, and some movement. The protective sleeve must project at least 4 in (10 cm) on either side of the structural member.

When tubing runs horizontally across studs notched to accommodate the tubing, it must be protected where it crosses each stud by a 16-gauge (USG) steel plate extending at least 2 in (5 cm) on either side of the tubing as protection where it crosses each stud. Notches cut into studs must be large enough to accommodate the tubing without forcing, but not so large as to weaken the stud.

Figure 1-9
Tubing installed in framed walls

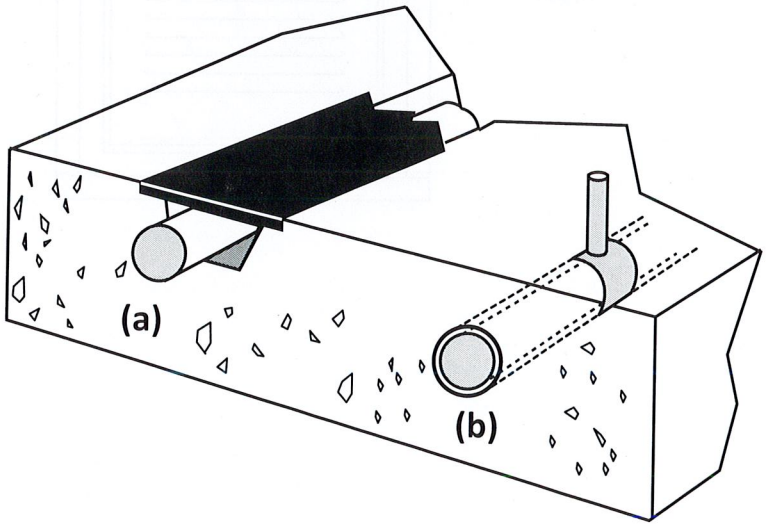


In-floor installations

When installed in concrete or other solid types of floor, locate gas piping and tubing:

- in a channel or chase with a removal, protective access cover (see Figure 1-10a); or
- in a ventilated sleeve under the floor (see Figure 1-10b).

Figure 1-10
In-floor installations



Vertical pipe chase installations

When gas piping or tubing is installed in a vertical pipe chase, the pipe chase must have openings with a minimum area equivalent to a 1 in diameter hole at each end.

Dirt and drip pockets

A dirt pocket (sometimes called a dust pocket) is an area in a piping system that collects dirt and from which you can remove the dirt (see Figure 1-11). A drip pocket is an area in a piping system that collects condensate and from which you can remove the condensate.

A dirt or drip pocket is made from a "T" fitting, short nipple, and a cap. Its size makes the depth of the pocket is either 3 in (75 mm) or equal to the internal diameter of the piping it serves, whichever is greater. The diameter of the pocket is either NPS 2 or equal to the diameter of the piping it serves, whichever is less. See Figure 1-12.

Figure 1-11
Typical dirt pocket installation

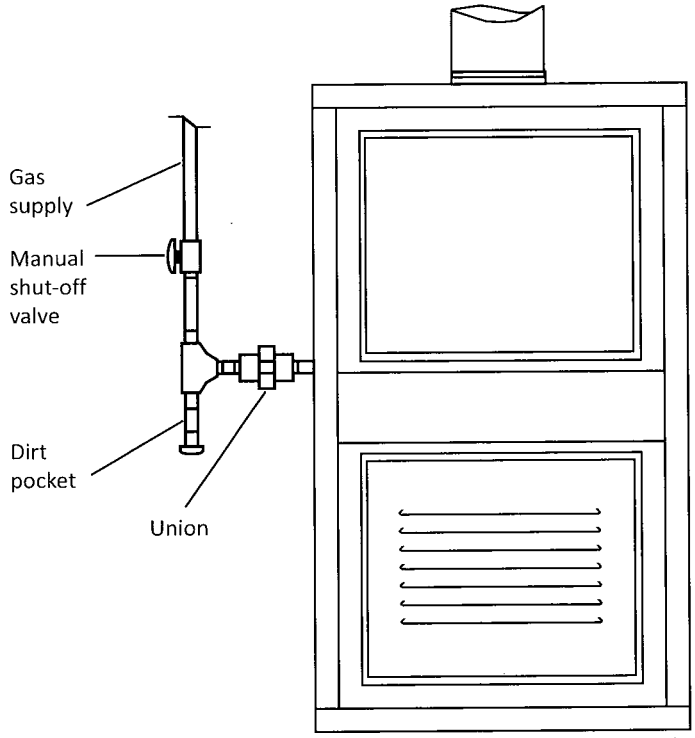
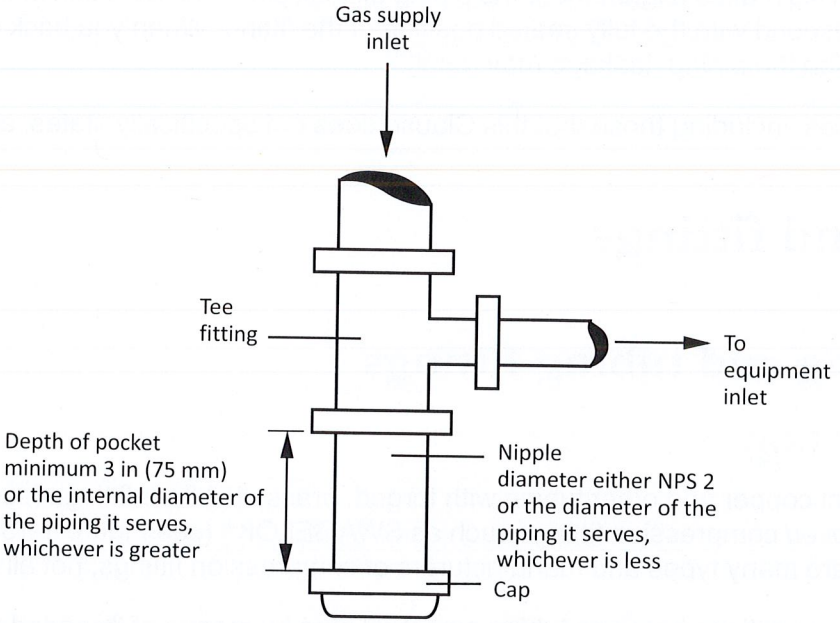


Figure 1-12
Dirt and drip pocket sizing requirements



Install a dirt pocket at the bottom of any piping or tubing on the final drop serving most appliances. Some specific appliances do not require dirt pockets. See Clause 6.13.1 of CSA B149.1.

A piping system where condensation may collect, as may be a result of the piping being exposed to wide ranges or sudden change in temperature, must have a drip pocket.

Prohibited practices

Clause 6 of CSA B149.1 partly deals with prohibited practices.

Among the prohibited practices is the nesting of bushings because the relatively thin walls of bushings can easily lead to fractures when a nest of bushings is tightened. As the likelihood of leakage when a number of bushings are nested is also significantly higher, always use a proper reduction fitting in such cases. Fittings containing both left- and right-hand threads are susceptible to the loosening of one end when the other is being tightened. Thread protectors and running threads do not allow for proper seating and thread lock-up, thereby leading to higher likelihood of leakage.

Since swing joints are susceptible to loosening at the joints over time, you cannot install it in concealed locations.

The field bending of pipe is prohibited because this may induce stresses that can lead to rupture and leakage.

You cannot use piping or tubing as a ground because it does not comply with the applicable requirements of the *Canadian Electrical Code* and may potentially result in an electrical hazard. Bonding of piping or tubing is permitted; however, when doing this, you must connect the bond to an approved electrical ground.

Close nipples do not have a shoulder, resulting in a lack of seating that can lead to leakage. Street elbows and tees are not permitted because these fittings have both male and female threaded ends. This makes alignment of the piping difficult since the direction of the piping does not always correspond with the fully seated position of the fitting. When you back off the connection to align the piping, leakage may result.

Any poor practices, including those that this Clause does not specifically states, are also prohibited.

Valves and fittings

Gas piping and tubing fittings

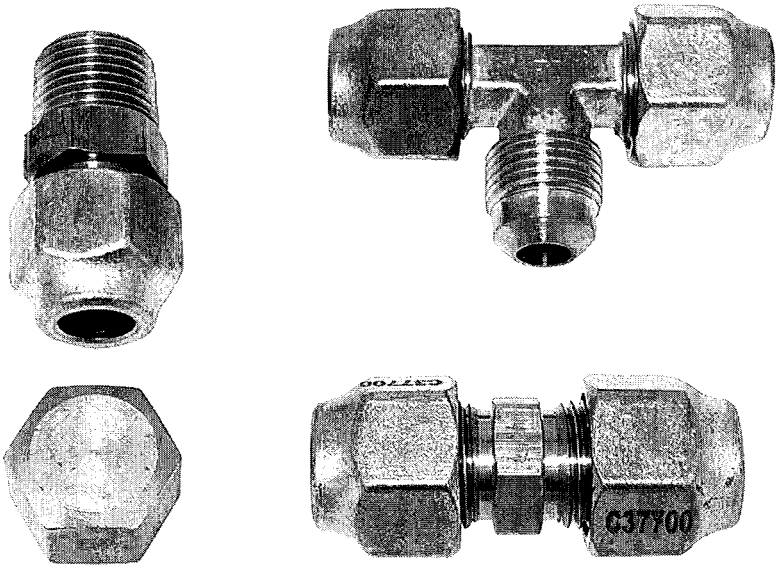
Tubing fittings

You may connect copper and other tubing with forged, brass, 45° flare fittings (see Figure 1-13a) as well as *approved* compression fittings such as SWAGELOK® (see Figure 1-13b). Note that although there are many types and manufacturers of compression fittings, not all are approved.

You can make connections between tubing and steel pipe by means of threaded-to-tubing adaptors.

Never use tubing fittings for pressures higher than those that local codes permit.

Figure 1-13
Approved tubing fittings
Image courtesy of Terry Bell



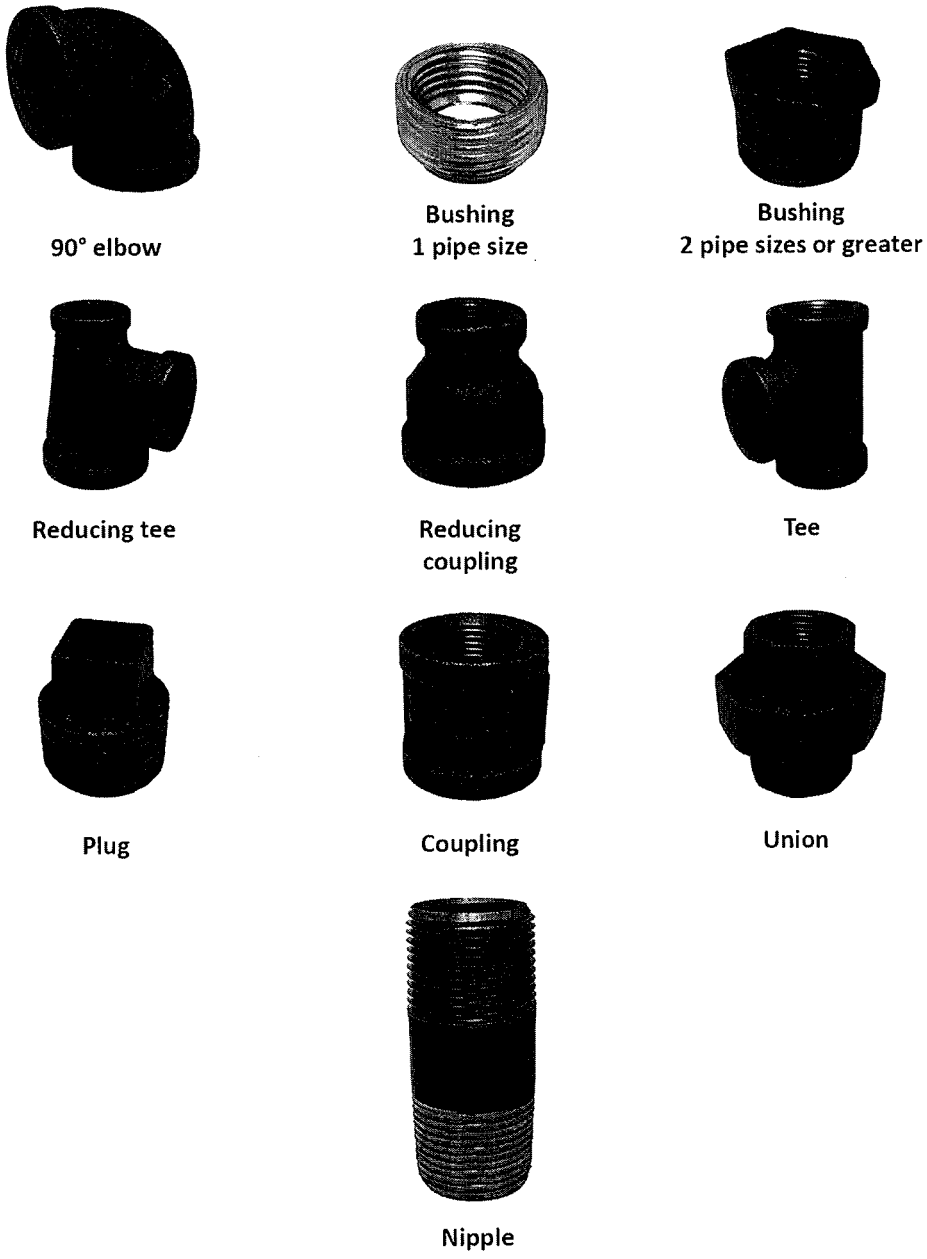
Steel piping and tubing fittings

Steel pipe fittings must be of malleable iron or steel construction and have approval for use with gas systems. Steel pipe fittings consist of:

- 45° and 90° elbows;
- straight and reducing couplings;
- nipples and unions;
- bushings;
- normal and reducing tees; and
- plugs and caps.

Figure 1-14 shows several types of steel fittings commonly used for gas systems.

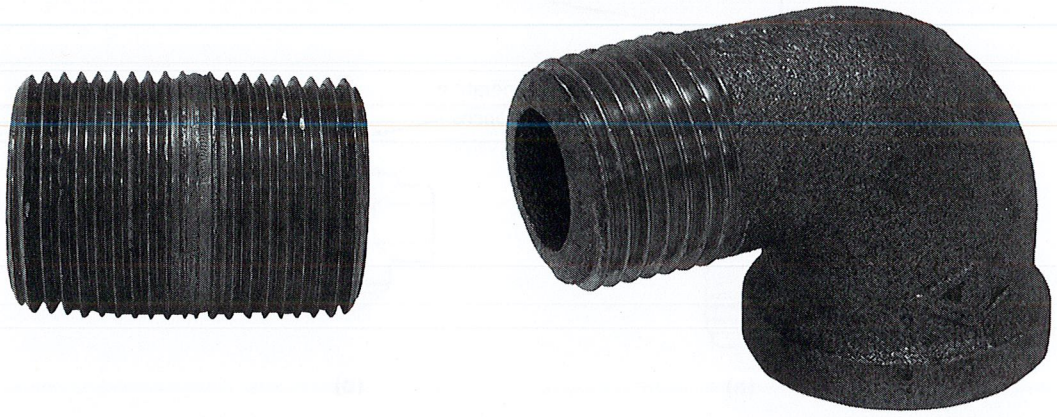
Figure 1-14
Steel gas system fittings
Image courtesy of Terry Bell



You cannot use some types of fittings (see Figure 1-15) for use with gas systems. These types include:

- fittings with running threads, such as thread protectors;
- street elbow [see Figure 1-15 b)] and tee fittings;
- close nipples [see Figure 1-15 a)]; and
- fittings with right-hand and left-hand threads.

Figure 1-15
Prohibited fittings
Image courtesy of Terry Bell



a) Close nipple

b) Street elbow

Gas valves

Gas valves control the flow of gas to different appliances and to main and pilot burners at various points along a piping system. With different valves, the gas technician/fitter can make a complete shutdown or regulate the flow at a specific location.

CSA B149.1 outlines specific locations and applications for installing manual gas valves. The gas technician/fitter must take care in selecting the correct valve for the job, since valve size, gas pressure, and location are all important factors for consideration. The gas technician/fitter must also allow for the valve's removal for repair or replacement.

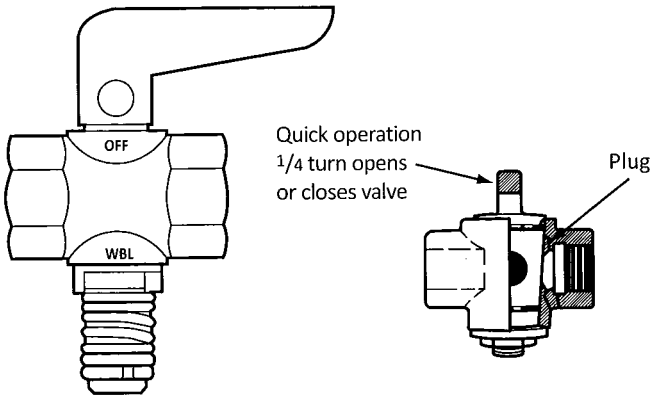
Manual gas shut-off valves

Manual gas valves are incorporated into the piping system in different ways. In most cases, the size of the valve dictates the jointing method used. The larger valves are usually flanged in place, the mid-range sizes are threaded, and the smaller sizes, when used with copper tubing, are connected using flare fittings.

Clause 6.18 of CSA B149.1 outlines the Code requirements for manual gas shut-off valves. Manual gas shut off valves fall into three categories:

- plug type;
- ball type; and
- eccentric type

Figure 1-16
Manual plug-type valve



Plug type

Plug type valves fully open or close with a quarter turn of a handle.

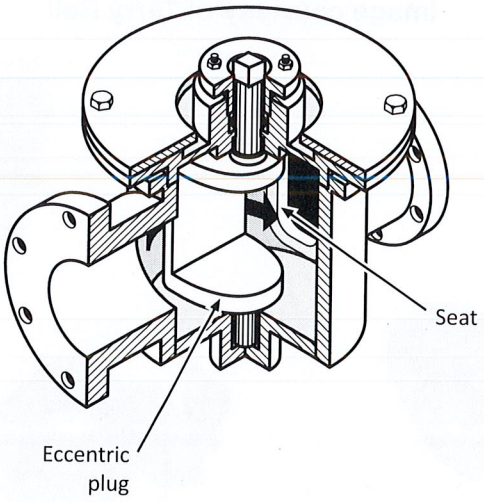
There are two basic types common to the gas industry:

Type	Description
Spring-loaded valve (See Figure 1-16a.)	Made of brass and approved only for indoor use with sizes reaching up to 1 in diameter
Lubricated plug valve (See Figure 1-16b.)	Made of malleable iron and approved for indoor or outdoor use Commonly named Lubeseal Designed to be lubricated and maintained with the valve in place and with no interruption of service (For outdoor use, you may also obtain the lubricated plug valve with a removable handle and a locking accessory for security.)

Eccentric valve

Another type of plug valve is the rotating-eccentric valve (see Figure 1-17). This design has a spherically faced plug that rotates through approximately 50° from the fully-open to fully-closed position. The eccentric motion of the plug reduces operating torque requirements. You can obtain tight shut-off with this type of valve since it produces no sliding friction between the plug and seat (reducing seat wear and seating torque).

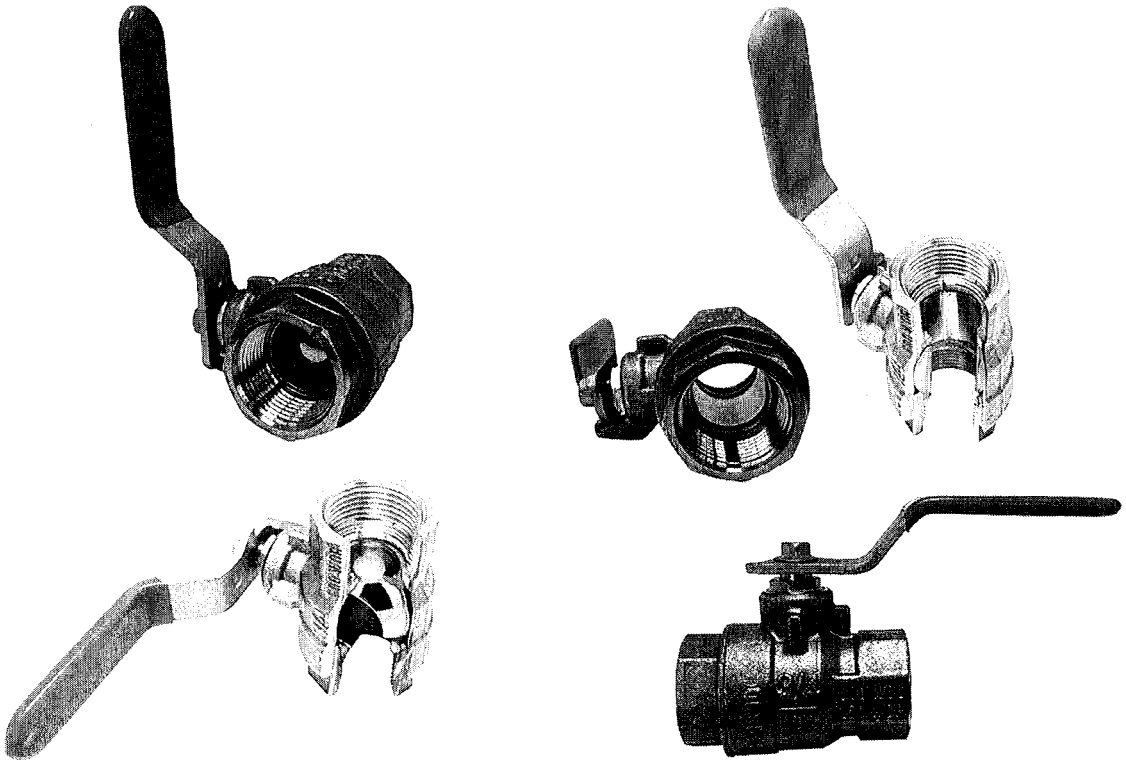
Figure 1-17
Eccentric valve



Ball type

Ball-type valves also open and close with a quarter turn of a handle and have approval for indoor or outdoor use. See Figure 1-18.

Figure 1-18
Cross-section of manual ball-type valve
Image courtesy of Terry Bell



Ball valve closed

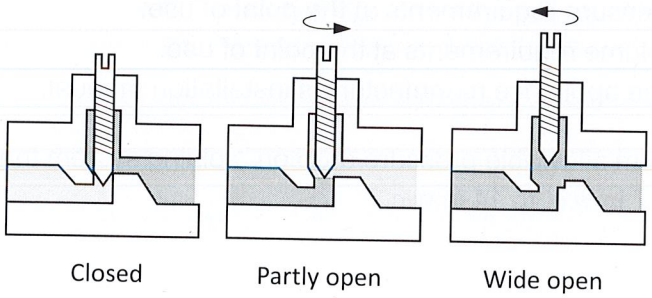
Ball valve open

Ball-type valves have a Teflon seat and a stainless-steel sealing ball. To control the flow, the ball has a hole drilled through its centre and fits tightly against the Teflon seat in the closed position. Lubrication is not a concern with this type of valve.

Needle type

Needle valves are what you use for smaller applications and internal valve control. (see Figure 1-19). They are simple restrictors of flow, which you usually open or close with a screwdriver. When slightly unscrewed, flow is limited. Full flow occurs when the needle is screwed out to its fullest extent.

Figure 1-19
Manual needle-type valve



Master shut-off valves

Clause 6.18.10 of CSA B149.1 contains the Code requirements for master shut-off valves. According to the Code, when multiple outlets are installed in a classroom, laboratory, or similar facility, a clearly identified master shut-off valve in a readily accessible location within that room must control them.

Assignment Questions – Chapter 1

1) Which of the following piping materials cannot be used in gas piping systems?
   a) Steel
   b) Copper
   c) Lead
   d) Plastic

2) Indicate True or False:
   Steel or malleable iron fittings may be used with steel pipe.
   a) True
   b) False

3) Complete the following sentence:
   You cannot use type _____ copper tubing in gas systems, as its wall thickness is slightly less than that of type G tubing.
   a) K
   b) L
   c) M

4) How shall piping be sized?
   a) To meet the volume and pressure requirements at the point of use.
   b) To meet the pressure requirements at the point of use.
   c) To meet the volume requirements at the point of use.
   d) According to the appliance manufacturers installation manual.

5) What is the maximum allowable pressure drop on a piping system that has a natural gas supply pressure of 7 in w.c. to 14 in w.c.?
   a) 0.5 Inch w.c.
   b) 1 inch w.c.
   c) 50%

6) How shall the gas pressure requirements for an appliance be determined?
   a) Pipe sizing tables
   b) Provincial regulations
   c) Appliance rating plate or from the appliance manufacturer

7) How shall an extension of an existing piping or tubing system be sized?
   a) Sized to meet the load demand of the extended piping system
   b) Sized to meet the requirements of Clause 6.3 of CSA B149.1
   c) Sized to meet the requirements of Clause 5.2 of CSA Z662

8) What is the maximum pressure drop allowed on a piping system that has a natural gas supply pressure less than 7 in w.c.?
   a) 1 inch w.c.
   b) 0.5 inch w.c.
   c) 1.5 inches w.c
   d) 2 inches w.c

9) How shall the volume of gas to an appliance be determined?
   a) From either the rating plate or the appliance manufacturer
   b) By the size of the piping system the appliance is connected to
   c) According to provincial regulations

10) Must the ends of all piping be reamed?
   a) Yes
   b) No

11) What is the maximum spacing of supports for 1 in horizontal piping?
   a) 12 ft
   b) 6 ft
   c) 8 ft
   d) 16 ft