iFLEX
iFLEXCSST

DESIGN & INSTALLATION GUIDE

STAINLESS STEEL CORRUGATED TUBING AND FITTINGS FOR GAS

COMMERCIAL I INDUSTRIAL I RESIDENTIAL

SEPTEMBER 2024

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1. Instructions

This DooBon Flexible System Design and Installation Manual provides general instructions for the design and installation of flexible gas piping systems using Doobon Flexible branded Stainless steel corrugated pipe for gas(CSST) and it is intended to assist the professional gas pipe installer in the design, installation, and testing of the Doobon Flexible gas piping system. So it is not to be used as a guide for the design, installation, and testing of other manufacturers' CSST products.

1.1 User's Warnings

► DooBon Flexible CSST installations must be installed by qualified installers who train DooBon Flexible CSST Installations, in accordance with the System Design and Installation Manual provided by DooBon Flexible.

The instructions and procedures outlined in the DooBon Flexible System Design and Installation Manual must be strictly adhered to for a safe and effective installation. Prior to beginning installation, competent engineering practices and principles must be employed in designing the system, taking into account local codes, requirements of the natural gas utility or propane supplier, and the requirements of the gas system being installed. All installations must be inspected by the local authority that oversees gas plumbing prior to the supplying of gas to the system.

Additional resources beyond this guide can be accessed on the DooBon Flexible web site : https://www.doobonflex.com

► DooBon Flexible CSST Installers must meet applicable qualifications set forth by the state and/or local administrative authorities which enforce the plumbing, mechanical and/or electrical codes where the gas piping is being installed.

If you are not qualified for installation suitable for the state and/or local administrative authorities which enforce the plumbing, mechanical and/or electrical codes, then you should not purchase or install DooBon Flexible products.

► DooBon Flexible System Design and Installation Manual is to be used in conjunction with state and local code. In the event of a conflict between this guide and local codes, the local code takes precedence. In the absence of local codes, installation shall comply with the current edition of the National Fuel Gas Code (ANSI Z223.1/NFPA 54), the National Standard of Canada, the Natural Gas and Propane Installation Code (CSA B149.1), the Uniform Plumbing Code, 24 Code of Federal Regulations(CFR), the Federal Manufactured Home Construction and Safety Standards (ICC/ANSI 2.0), and the Standard on Manufactured Housing (NFPA 501), as applicable.

1.2 Limitations of Manual

This System Design and Installation Manual is intended to assist the professional gas pipe installer in the design, installation, and testing of the DooBon flexible gas piping system for residential, commercial, and industrial buildings.

So it is not possible for this guide to anticipate every variation in construction style, building configuration, appliance requirement, or local restriction. This document will not cover every application.

The user should either exercise his own engineering judgement on system design and installation, or seek technical input from qualified sources. Additional information on gas piping systems is available from your local gas utility or propane supplier. General usage guidelines of DooBon Flexible gas piping are outlined as follows:

1.2.1

The piping system is for use with fuel gases only and is intended for operating pressures not exceeding 25 PSI (172.5 kPa). The maximum actual operating pressure, including transients, shall not in any case exceed 30 PSI (207 kPa) for 25 PSI (172.5 kPa) rating.

1.2.2

DooBon Flexible CSST and fittings are engineered and tested to work in combination, so using DooBon Flexible CSST or fittings with the tubing or fittings of other CSST flexible gas piping manufacturers is strictly prohibited and could lead to serious bodily injury or property damage. Connection between DooBon Flexible CSST and other brand CSST can be accomplished with standards malleable iron fitting.

1.2.3

The size and depth of installation clearance holes or notches for routing the tubing through wall studs and joists shall comply with the requirements of the local building code.

1.2.4

Concealed tubing shall be protected from puncture threats, using the shielding devices specified by DooBon Flexible Co., Ltd., at all points of penetration through studs, joists, plates or similar structures. The extent of protection shall be defined as follows:

A) At points of penetration less than 2" (50.8 mm) from any edge of a stud, joist, plate,
etc., a listed striker plate is required to provide protection at the area of support
and within 5 in (127 mm) of each side (if appropriate) of the support.

B) At points of penetration 2" - 3" (50.8 to 76.2 mm) from any edge of a stud, joist, plate, etc., a listed striker plate is required to provide protection throughout the area of support.

C) At points of penetration greater than 3" (76.2 mm) from any edge of a stud, joist, plate, etc., no protection is required.

D) Tubing routed horizontally through studs shall be protected from puncture threats between the studs using the shielding devices specified.

E) The width of the installed striker plate, at the points of penetration through wall studs, floor joists, plates, sills, etc., shall be at least 1.5 times the outside diameter of the tubing.

1.2.5

The inspection, testing and purging of the installation shall be performed using the procedures specified in Part 4, General, of the National Fuel Gas Code (ANSI Z223.1/NFPA 54), and/or the Natural Gas and Propane Installation Code (CSA B149.1), the International Fuel Gas Code, the Uniform Plumbing Code, or in accordance with the requirements of the applicable local codes. The installed gas piping system shall not exhibit any loss of pressure during the field pressure test.

1.2.6

Avoid sharp bending, stretching, bending or twisting of the tube, as it can damage the CSST when routing the CSST of DooBon Flexible. The minimum permissible radius of curvature of the CSST of DooBon Flexible is 1 / 2″ (R = 30mm) tubing, 3 / 4″ (R = 40mm) tubing and in any case it should not bend below this minimum radius of curvature.

1.3 Applicable Standards Lists and Codes

This System Design and Installation Manual is based on ANSI LC-2018, CSA6.26-2018, you can refer to the standard lists and code as follows:

1) CSA 6.26 Standard : CSA 6.26 -2018
2) CANADA-CSA B149.1 Natural Gas and Propane Installation Code
3) American National Standards Institute : ANSI LC 1-2018
4) NFPA 54/ANSI Z 223.1 National Fuel Gas Code
5) Manufactured Home Construction and Safety Standards : ICC/ANSI 2.0
6) International Fuel Gas Code : IFGC-2015
7) Control Valve Capacity Test Procedures of International Society for measurement and control : ANSI/ISA S75.02.01-2008
8) American Electronical Code : NFPA 70-2014
9) Standard for Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities : NFPA201A-2013/ANSI A225.1-2013
10) Federal Standards for Manufactured Housing Construction and Safety : 24 CFR Port 3280

Products with CSA logos are CSA-certified by Canada.

Note: CSST certification in the above code does not mean that CSST has been certified for use in all regions. The installer is responsible for verifying that the local authority with jurisdiction over the installation site approves the CSST. Dooboon Flexible Inc. is not responsible for materials or labor costs incurred by not verifying local certification by the installation program.

2. Description of System Components

2.1 Tubing (Stainless Steel Corrugated Pipe for Gas : CSST)

The DooBon Flexible fuel gas piping system employs corrugated, flexible, semi-rigid stainless steel tubing with brass attachment fittings terminating in NPT pipe fittings for integration into traditional rigid black pipe systems or direct connection to gas systems. Tubing is available in sizes of 1/2", 3/4", 1″,1¼".

The Doobon Flexible CSST is marked with the certification body, product size, maximum working pressure and EHD (Equivalent Hydraulic Diameter) and is coated with flame resistant yellow polyethylene containing UV blocker.

A) Tubing (CSST)

Tubing Materials	Part No	Size	EHD * (AGA Size)	OD (max)	ID (nini)	Specifıcation Operating Pressure	Coating Thickness
STS 304	002-15	1/2"	18	0.701″	0.547″	25 PSI	0.5~0.6mm
	002-20	3/4"	25	1.010″	0.815“		
	002-25	1"	32	1.260″	1.063″		0.6~0.7mm
	002-32	1¼"	39	1.536″	1.300″		

B) CSST Drawing

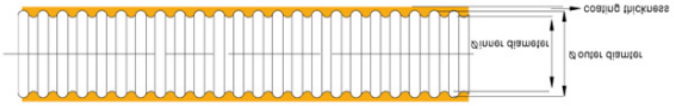


figure 1.1 CSST Drawing

C) The drawing of attaching the fitting to the CSST

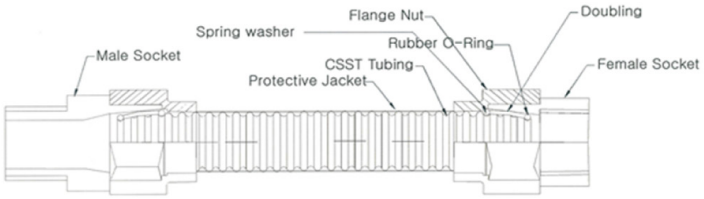


figure 1.2 attaching the fitting to the CSST

2.2 Fitting

DooBon Flexible fittings are available for 1/2", 3/4", 1" and 1″,1-1/4″. DooBon Flexible tubing and allow for easy connection to gas systems and accessories using standard NPT threads. (See Figure 2.1)In addition to standard NPT adapter fittings, the following are also available: Wall fixation flange fitting to integrate with different tubing runs, and special termination flanges for convenient gas appliance connections.

Name	Fitting picture	Part No	Size	Materials	Specifcation Operating Pressure
PM		DBF-PM-15	1/2"	Brass	25 PSI
		DBF-PM-20	3/4"		
		DBF-PM-25	1"		
		DBF-PM-32	1¼"		
PF		DBF-PF-15	1/2"		
		DBF-PF-20	3/4"		
		DBF-PF-25	1"		
		DBF-PF-32	1¼"		
AF		DBF-AF-15	1/2"	Plated on brass	
		DBF-AF-20	3/4"		
		DBF-AF-25	1"		
		DBF-AF-32	1¼"		
WTF		DBF-WTF-15	1/2"		
		DBF-WTF-20	3/4"		
		DBF-WTF-25	1"		
		DBF-WTF-32	1¼"		

2.3 Fix Ring

Fix ring is the part tightend in PM and PF, part name of fitting; PM and PF provided by DooBon Flexible must be fitted with the following fix rings.

Name	Fitting picture	Part No	Size	Materials	Specifcation Operating Pressure
Washer		DBF-05-15	1/2"	STS304	25 PSI
		DBF-05-20	3/4"		
		DBF-05-25	1"		
		DBF-05-32	1¼"		
Copper packing		DBF-06-15	1/2"	cu	
		DBF-06-20	3/4"		
		DBF-06-25	1"		
		DBF-06-32	1¼"		
Rubber O-Ring		DBF-07-15	1/2"	Viton	
		DBF-07-20	3/4"		
		DBF-07-25	1"		
		DBF-07-32	1¼"		

2.4 Striker Plates

Striker plates are used to protect CSST from puncture hazards when passed through studs, joists, and other building materials.

Striker Plate	Part No.	Materials	Description
	DBF-08	S45C	4″x9″×0.59″ Striker Plate

2.5 Pressure Regulators

Pressure Regulators	Part No.	Description
	Use CSA certified products in your country	1/2" NPT 7-11" w.c. Gas Line Pressure Regulator (250,000 Btu/hr max)
		3/4" NPT 7-11" w.c. Gas Line Pressure Regulator (425,000 Btu/hr max)

Pressure regulators are used in elevated pressure system installations (over 14 inches water column, or ½ PSI) to reduce pressure to standard low pressure required for appliances.

2.6 Manifolds

Manifolds allow for parallel installations of DooBon Flexible tubing with runs to each appliance. Manifolds are available with 1/2" or 3/4" inlets and have four 1/2" or 3/4" NPT outlets.

Pressure Regulators	Part No.	Description
	DBF-09-01	3/4″ * 1/2″x1/2x″x1/2″ * 3/4″ NPT
	DBF-09-02	1″ * 3/4″x3/4″x3/4″ * 1″ NPT
	DBF-09-03	32″ * 3/4″x3/4″x3/4″ * 32″ NPT

2.7 Shut-off valves and Quick-Connect Devices

A) Shut-off valves

Shut-off valves (ball valves) are to comply with ANSI/ASME B16.44-2012, Manually Operated. Metallic Gas Valves for Use in Above Ground Piping Systems up to 5 PSI. Valves must be used in the following conditions:

a) Gas appliances must have an accessible 1/2 PSIG manual shut-off valve upstream of connectors with a union to allow removal of appliance.

b) An accessible manual gas shut-off valve is required upstream of each pressure regulator on elevated pressure systems.

c) T100 valves may be used on the elevated pressure side of CSST installations. Standard approved gas shut-off valves may be used on low pressure (appliance) side of installations.

DooBon Flexible valves use CSA Certification parts.

Fitting picture	Name	Part No.	Description
	Ball valve	DBF-BV-15	1/2″Male NPT x CSST
		DBF-BV-20	3/4″Male NPT x CSST
	Butterfly valve	DBF-BTV-15	1/2″Female NPT x CSST
		DBF-BTV-20	3/4″Female NPT x CSST

B) Quick-connect devices

Quick-connect devices provide a safe and easy way to make connections to moveable outdoor gas appliances like barbecues and space heaters.

Quick-connect devices used with DooBon Flexibe gas piping systems must conform to ANSI Z21.41 ·CSA 6.9 or ANSI Z21.90·CSA6.24.

A shut-off valve should be installed upstream of the quick-connect device and remain in the off position when the quick-connect device is not in use.

All installations and devices must conform with local codes. Quick-connect devices that can be used with DooBon Flexible gas piping systems include, but are not limited to, models in the M. B. Sturgis 3/375 family of products.

2.8 Other valves : Bonding Clamps

Bonding clamps are used to connect the CSST gas piping system to the structure's existing grounding system. Connection is to be made to an DooBon Flexible fitting or manifold and not to be made directly to the DooBon Flexible tubing.

Bonding Clamps	Part No.	Description
	Use CSA Certification	Bronze UL listed 467 bonding clamp for use with 1/2" and 1/4" systems
		Bronze UL listed 467 bonding clamp for use with 3/4" fittings

2.9 Protection Devices

Like striker plates, Flexible Protective Conduit of DooBon Flexible is used to protect DooBon Flexible tubing from puncture hazards.

Double protective pipe	Part No.	CSST Size	Protective pipe Size(OD)	Thickness
	DBF-003-15	1/2″	32mm	0.8mm
	DBF-003-20	3/4"	36mm	
	DBF-003-25	1"	42mm	

3. System configuration and dimensions

3.1 System Configuration

Before routing DooBon Flexible tubing, it is advisable to draw a sketch showing the location of the gas line service, the load demand, the supply point (gas meter or Line pressure regulator), the system pressure, and possible piping path and length. Device load requirements can be found on the nameplate of the manufacturer on the device or provided by the manufacturer or contractor. Confirming this sketch will help to select the appropriate DooBon Flexible tubing and accessories and prevent any potential modifications in the installation process.

For any given system and its load requirements, there are several piping system designs for installers using DooBon Flexible company piping. The following sections outline some of the request scenarios and various system options that are open to the installer. It would be impossible to outline all possible installation methods.

Using these examples as a guide, it is the installer's responsibility to determine the best routing solution using the information provided here.

a) Determine local piping restrctions prior to purchasing and installing Doobon Flexible gas tubing. In particular, ensure that the local authority managing the installation location has accepted the use of corrugated stainless steel (CSST) flexible gas piping. While CSST is adopted by major national and international code agencies, the adoption of local laws may lag behind or require special requirements in addition to national codes.

b) Determine the meter (supply) pressure of the gas source at the installation location.

i) Natural Gas

- The North American standard low pressure source is typically a 6-7 inch water column (w.c.), and instead designated as 4 mg / PSI..
- Medium pressure supply, such as 14 inches w.c. (½ PSI) provides significant CSST size reduction. Check with the local gas utility for the availability of elevated pressure. Most appliances distributed in the US and Canada are designed to operate up to 14 inches w.c.
- Elevated pressure supply of 2 PSI is typically the highest pressure supplied within residential buildings in the US and Canada. Installations for systems of this pressure always require installation of a pounds-to-inches pressure regulator between the utility meter and the appliances.

ii) Propane (Liquefied Petroleum or LP) Gas

- The pressure of the LP system is typically set to 11 inches w.c in a second stage regulator of the system..
- As with natural gas, a rising pressure setting of 2 inches and a PSI of 14 inches w.c reduces the CSST size. Contact your gas supplier for availability. For 2PSI and above, use a gas line pressure regulator with an 11 inch w.c. outlet pressure on the side of the equipment in the LP system.

c) To determine the total capacity required for installation, you must determine the load demand of each device to be used at the installation location and the total load of all devices. CFH / BTBT equivalents for natural gas or propane gas flows can be purchased from local gas utilities or propane suppliers.

- For natural gas with a specific gravity of 0.60, 1 cubic foot per hour (1 CFH) is about 1,000 BTUH.
- For LP gas with a specific gravity of 1.52, 1 cubic foot per hour (1 CFH) is about 2,500 BTUH.

3.1.1 Serial and parallel low pressure systems

There are two installation options for the low pressure system: a series layout that connects the main source of the gas source to each instrument and a parallel arrangement leading to a central power distribution manifold that serves the instrument as the main source of the gas source.

A) Low Pressure Series Systems

The series system is the layout most commonly used for black steel pipe installations with low pressure feeders. In the serial layout, the T value for each device is branched at the main run of the gas supply source. The working pressure downstream of the meter is generally less than 1/2 PSI.

It is important to consider the minimum pressure supplied to any given appliance in a series layout. Most natural gas appliances require a minimum of 4" w.c. pressure, while LP appliances require a minimum of 10" w.c. pressure. Local code restrictions may dictate allowable pressure drop along any particular runs.

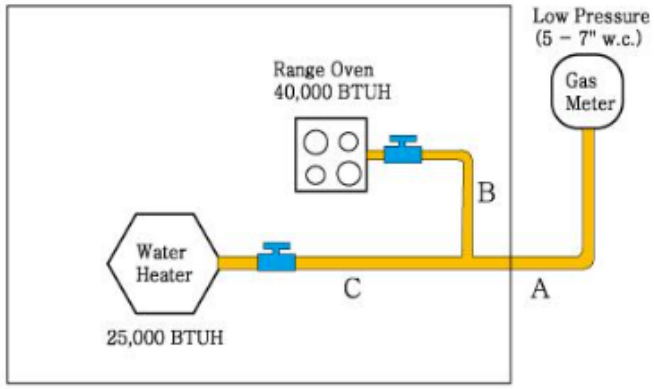
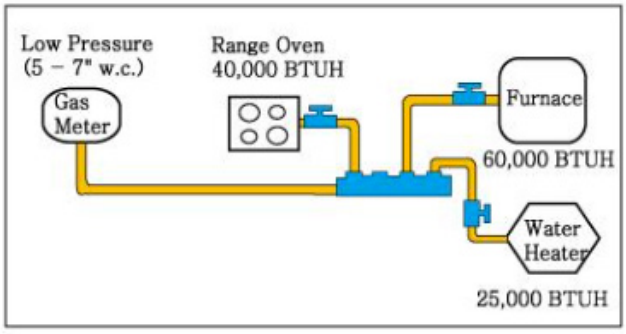


figure 3.1 A low pressure series layout

B) Low pressure parallel system

Parallel systems have a central distribution manifold, which has branch piping for electrical products. Typically, the main feed line is connected to the manifold from the gas feeder and the "home runs" are routed to each appliance location.



picture 3.2 A low pressure parallel layout

3.1.2 Dual pressure system

Elevated pressure systems generally have a main line from the gas supply to one or more gas pressure regulators and then a manifold with "home runs" to appliances. These runs may branch off through use of a tee, if gas loads permit.

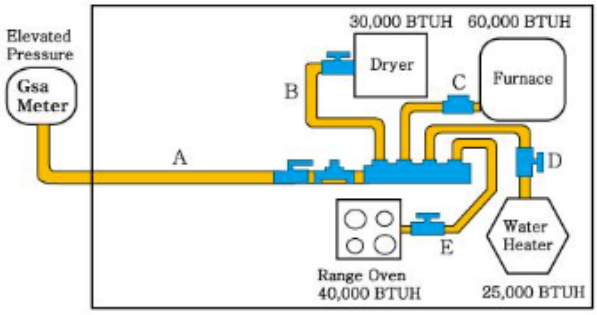


figure 3.3 A dual pressure system layout

A) Elevated pressure system

It is also possible to have a complete elevated pressure system where the pressure regulators are positioned at each appliance. This method is typically employed in systems with high loads or long runs.

B) Multiple manifold system

Another variant used with elevated pressure is to have multiple manifolds, each with a regulator before the manifold. This approach allows for large BTU load demands while using smaller diameter tubing.

3.1.3 Hybrid System (Steel Pipe and CSST)

Using both CSST and rigid black pipes can generally help to minimize the pressure drop in systems with high loads or long runs. For example, a parallel system may require a larger diameter major branch to provide a total appliance load. It is about 2,500 BTUH.

3. 2 Sizing Methods and Examples

► This section outlines the sizing procedure for various situations to demonstrate how to choose the appropriate CSST size and configuration for DooBon Flexible. These examples show the process of using the sizing tables to determine the required pipe size and configuration. Each installation is different, which means that the installer must go through the process described below for the proper size and configuration of the gas piping system, depending on the circumstances and requirements of the installation location.

► All piping systems generate pressure loss (cubic feet per hour) depending on piping size and gas flow rate. When "sizing" the system, the installer determines the minimum size of piping to supply the required flow rate according to the amount of allowable pressure drop. The scaling table provides the maximum load on the runway, taking into account the gas pressure, permissible pressure drop, pipe size and run length. Different scaling tables are used for each combination of system pressure and pressure drop.

► Allowable pressure drop is the maximum pressure loss that can occur and maintain the supply pressure for proper equipment or equipment operation.

Natural gas appliances are typically designed to operate at pressures of at least 4 inches w.c. LP instruments are typically designed for a minimum pressure of 10 inches w.c. The sizing tables in this guide should be used to provide 5 "w.c. or greater for natural gas appliances and 10.5" w.c. for LP appliances. The permissible pressure drop can be calculated by subtracting the desired equipment inlet pressure (5 inches w.c. for natural gas and 10.5 inches w.c. for natural gas) from the gas source pressure (natural gas for LP or gas meter for auxiliary regulator).

► The low pressure serial system scales in the same way as the low pressure steel pipe system using the "longest length method" (also known as the "branch length method"). The sizing can be calculated using the table in the National Fuel Gas Code (NFPA 54). The pressure drop of the low pressure system is generally limited to 0.5 inch w.c. For high pressure systems there are two operating pressures downstream of the gas supply. : The pressure set by the service regulator in meters (typically 2 PSI), which leads to a pounds-to-inches regulator. Since the proper drop between the meter and the regulator is typically 1 PSI, the ¾ PSI regulator can be downstream while providing ¼ PSI (6-7 inches w.c.) as required by the unit. The size between the regulator and the device is calculated the same as for the low pressure system. However, the allowable pressure drop is typically 3 inches w.c. for a single device installed in "home runs" on the manifold.

3.2.1 Low Pressure systems (Longest Length/Branch Method)

Sizing of the following systems is done by section. Each section is sized by determining the total gas load for all appliances and the maximum distance (longest length) over which a section delivers gas.

In this facility, a small number of devices are placed near a natural gas source. Ideal for series deployments due to short runs and low appliance loads.

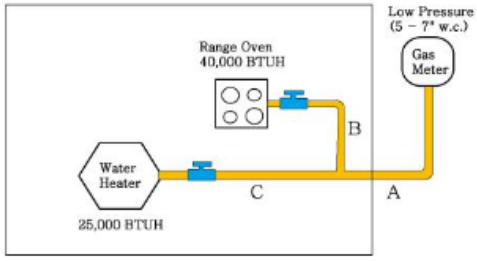


figure 3.4 Low Pressure System - Series Arrangement

Step 1 Size Section A: Determine the longest run from the meter to any appliance:

- Meter to range oven is 20 feet (A + B).
- Meter to water heater is 27 feet (A + C).
- Maximum load carried by section A is 65,000 BTUH. Convert to CFH by dividing by 1000 (for natural gas with a specific gravity of 0.60, 1 CFH = 1,000 BTUH). Maximum load is 65 CFH.
- Find the maximum capacity table that matches the system characteristics, in this case, natural gas with a minimum gas pressure of 6-7 inches w.c. and a pressure drop of 0.5 inches w.c. Table 7.1 is the correct table.
- Find the column in the length row that is greater than or equal to the longest run in the system. The longest run in this system is 27 feet and the table has columns for 25 and 30 feet. Never round down when sizing. The correct column is 30 feet.
- We then scan down the 30 feet column to find a CFH value that is greater than or equal to the total load of the system. At 30 feet, ½" tubing has a maximum load of 42 CFH so it is not suitable for this system. The next size is ¾" with a maximum load of 116 CFH. ¾" tubing is the correct size for section A.

Step 2 Size Section B: Determine the length of the run from the meter to the range oven and the load delivered.

- The length from the meter to the range oven is 20 feet (A + B), and the load is 40 CFH (40,000 BTUH divided by 1000 CF per BTU).
- Consulting Table 7.1, we see that for a 20-foot run, ½" tubing will supply up to 51 CFH. The correct size tubing for section B is ½".

Step 3 Size Section C : Determine the length of the run from the meter to the water heater and the load delivered.

- The length is 27 feet (A + C) and the load is 25 CFH (25,000 BTU).
- Consulting Table 7.1, we see that for a 30-foot run, ½" tubing will supply up to 42 CFH. The correct size for section C is ½".

Example 2: Medium Pressure in a Parallel Arrangement

This system is typical of a single family residential installation with several appliances. As it is a medium-pressure system, the allowable pressure drop of 6 inches w.c. is greater than what would have been permissible in a low pressure system.

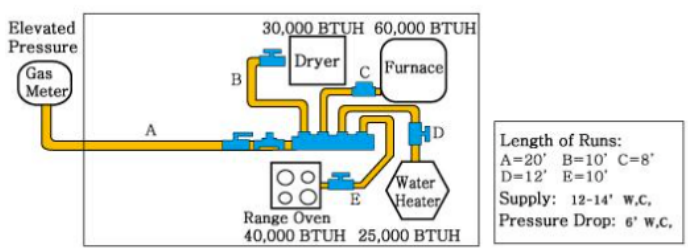


figure 3.5 Medium Pressure System—-Parallel Arrangement

Step 1 Size Section A: Determine the longest run from the meter to any appliance

- Meter (A) to water heater (D) is the longest run at 32 feet.
- The maximum load transported by section A is the total load of all appliances:
  dryer + furnace + water heater + range oven = 155,000 BTU = 155 CFH..
- Consulting Table 7.4, the columns nearest 32' are 30' and a 40'. Because we must use the length value that is greater than or equal to the measured run, the 40' column is correct. Our total load is 155 CFH, and ½" tubing has a total maximum capacity of 116 CFH at 40 feet, which is not enough for this system. ¾" Tubing has a maximum capacity of 398 CFH. ¾" Tubing is the correct size.

Step 2 Size Section B : Determine the length from the meter to the dryer:

- A+B=30 feet and the total load is the load of the dryer is 30,000 BTUH = 30 CFH.

· Table 7.4 shows that ½" tubing has a total load capacity of 133 CFH at 30 feet, exceeding the load of the dryer, so ½" tubing is the correct size.

Step 3 Size Section C : Determine the length from the meter to the Furnace.
· A + C = 28 feet, and the total load is 60,000 BTUH = 60 CFH.
· Table 7.4 shows that ½" tubing has a total load of 133 CFH at 30 feet, so ½" tubing is the correct size

Step 4 Size Section D: Determine the length from the meter to the water heater.
· A + D = 32 feet, and the load of the water heater is 25,000 BTUH = 25 CFH.
· Table 7.4 shows that ½" tubing has a total load capacity of 116 CFH at 40 feet,
so ½" tubing is the correct size.

Step 5 Size Section E: Determine the length from the Range oven to the Furnace.
· A + E= 30 feet and the load of the furnace is 40,000 BTUH = 40 CFH.
· Table 7.4 shows that ½" tubing, with a maximum capacity of 133 CFH, is correct.

3.2.2 Elevated Pressure Systems

Example 3: Elevated Pressure System in a Parallel Arrangement
In this example, an extended tubing run is required from the gas meter to the desired appliance locations. This scenario is common in single and multifamily locations. 2 PSI elevated systems are ideal for the long runs required in multifamily buildings that have a central gas meter bank.

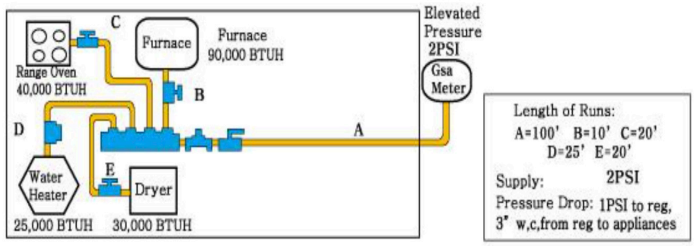


figure 3.6 Elevated Pressure System—-Parallel Arrangement

Step 1 Size Section A:
· Furnace + range oven + water heater + dryer = 190,000 BTU = 190 CFH and the
distance to the regulator is 100 feet.
· Supply pressure is 2 PSI and allowable drop is 1 PSI; Table 7.5 is the correct table.
· Scanning the 100' column, ½" has a maximum capacity of 129 CFH which is not adequate. ¾" Tubing has a maximum capacity of 471 CFH. As this meets or exceeds our required capacity of 190 CFH, ¾" tubing is the correct size.

Step 2 Size Sections B-E: From the regulator outlet, the system is supplying 8 inches w.c. with an allowable drop of 3 inches w.c. Table 7.3 is the correct table for this section of the system.
· Section B is 10 feet with a an appliance load of 90 CFH for the furnace. ½" Tubing has a maximum capacity of 160 CFH at 10 feet, so ½" is the correct size.
· Section C is 20 feet with an appliance load of 40 CFH for the range oven. ½" Tubing has a maximum capacity of 116 CFH at 20 feet, so ½" is the correct size.
· Section D has a length of 25 feet with an appliance load of 25 CFH. ½" Tubing has a maximum capacity of 104 CFH at 25 feet, so ½" is the correct size.
· Section E has a length of 20 feet with an appliance load of 35 CFH. ½" Tubing has a maximum capacity of 116 CFH at 20 feet, so ½" is the correct size.

Example 4: Medium Pressure Parallel Arrangement with a Series Branch
This installation has a barbecue installed near the water heater. Given the number of appliances, a parallel arrangement was selected for the system, with a single run supplying the barbecue and the water heater in series.

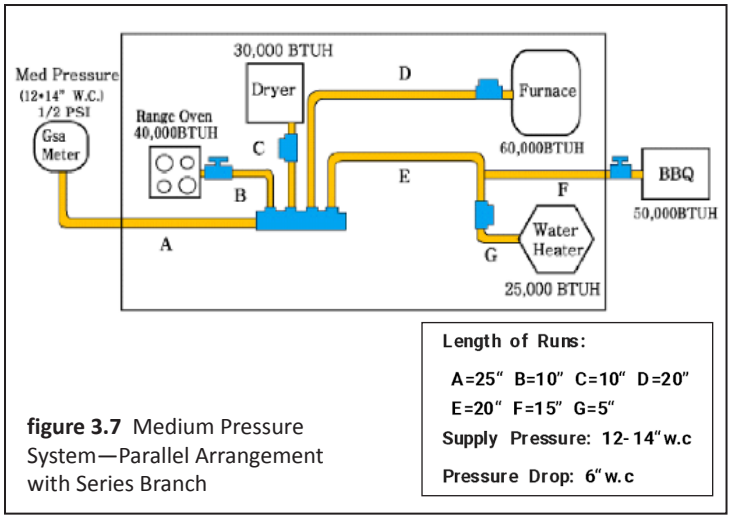


figure 3.7 Medium Pressure System—Parallel Arrangement with Series Branch

Step 1 Size Section A: Determine the length of the longest run (from gas meter to appliance) and total load required by the system.
· Total system load = range + dryer + furnace + water heater + BBQ = 205,000 BTUH = 205 CFH.
· Longest run is from meter to the BBQ: A + E + F = 60 feet.
· Supply pressure is 12-14 inches w.c. (1/2 PSI), and allowable pressure drop is 6 inches w.c., so Table 7.4 is the correct table.
· At a length of 60 feet, 1/2" tubing can supply a maximum of 96 CFH. The system requires at least 205 CFH, so 1/2" is too small. 3/4" Tubing can supply a maximum of 329 CFH. 3/4" Tubing is the correct size.

Step 2 Size Section B: Measure the length from the meter to the range to determine appropriate size.
· Total length is 35 feet (A + B), and appliance load is 40 CFH.
· 35 feet is not an option on the table, so we round up to 40 feet. ½" Tubing has a maximum capacity of 116 CFH at 40 feet, so ½" is the correct size for this run.

Step 3 Size Section C : Determine the length from meter to the dryer
- Total length is 35 feet (A+C) and appliance load is 30 CFH for the dryer.
- ½" Tubing has a maximum capacity of 116 CFH at 40 feet so ½" is the correct size.

Step 4 Size Section D : Determine the length from the meter to the furnace.
- Total Length is 45 feet (A + D) and appliance load is 60 CFH.
- ½" Tubing has a maximum capacity of 104 CFH at 50 feet so ½" is the correct size.

Step 5 Size Section E: Determine the longest length and total load for the section. As there are two appliances serviced by this run, it is calculated as a series layout.
- Section E serves both the water heater and BBQ, so total load is 75 CFH.
- The longest length is from the meter to the BBQ (A + E + F) = 60 feet.
- ½" Tubing has a maximum capacity of 96 CFH at 60 feet so ½" is the correct size.

Step 6 Size Section F: Determine the total length and load.
- The BBQ load is 50 CFH and the length is 60 feet (A + E + F).
- ½" Tubing has a maximum capacity of 96 CFH at 60 feet so ½" is the correct size.

Step 7 Size Section G: Determine the total length and load.
- The water heater load is 25 CFH and the length is 50 feet (A + E + G).
- ½" Tubing has a maximum capacity of 104 CFH at 50 feet, so ½" is the correct size

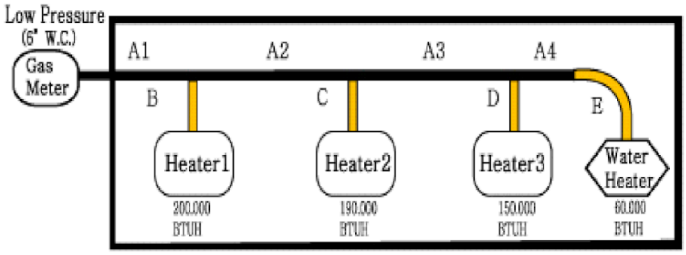
3.2.3 Mixed Steel & CSST Hybrid CSST & Steel Pipe System

It may be beneficial to use both steel and DooBon flexible piping to minimize pressure drop in low and medium pressure systems with high loads and / or long runs.

To determine the proper size of the hybrid DooBon Flexible CSST and black steel pipe, the standard gas piping capacity table used for the black steel pipe (this table can be found in many mechanical code tables besides the double fuel gas cords) should be used. For your convenience, the black steel capacity table for sizing is printed in Table 7.11 of this book, the black steel capacity table for sizing is printed in Table 7.11 of this book.

Example 5: Low pressure hybrid system in a series arrangement

Example 5 is a commercial building, with three unit heaters and a water heater. The source is a standard low pressure with a 6 inch w.c. supply and a 0.5 inch w.c. maximum allowable pressure drop. In order to adjust the size of this equipment, the size of the rigid black pipe part and the running of the DooBon Flexible CSST for the equipment are required.



Length of Runs:
A1=10" A2=20" A3=20" A4=5"
B=10" C=10" D=10" E=15"
Supply Pressure: 6" w.c.
Pressure Drop: 0.5" w.c.

figure 3.7 Low Pressure Hybrid System.Series Arrangement

Step 1 Size the rigid black steel pipe: Determine length of longest run and total load.
- The longest run from the meter is A1 + A2 + A3 + A4 + E = 70 feet.
- Total load is 600,000 BTUH = 600 CFH. Consulting Table 7.11, at a 70 foot length, the diameter of black steel pipe that can supply 600 CFH or greater is 1½" with a maximum capacity of 750 CFH. The correct size for section A1 is 1½".
- To size section A2, we can reduce the load already carried by A1, in this case 200 CFH from the first heater. The length, however, remains 70 feet. Total load then is 400 CFH, which at 70 feet can be supplied by 1¼" pipe with a maximum capacity of 490 CFH. 1¼" pipe is the correct size for section A2.
- To size section A3, we can reduce the load by another 190 CFH to 210 CFH for the remaining heater and the water heater. At 70-feet, 1" pipe can supply a maximum of 240 CFH, which is sufficient for the run. 1" pipe is the correct size.
- To size section A4, the load is reduced to just the 60 CFH of the water heater. At 70-feet, 1/2" pipe can provide a maximum capacity of 61 CFH. 1/2" pipe is the correct size for section A4.

Step 2 Size Section E: The length is the length of the black pipe plus the length of the Doobon Flexible run = 70 feet, and total load is 60 CFH. Referencing Table 7.1, 3/4" tubing provides a maximum capacity of 76 CFH at 70 feet. 3/4" Tubing is the correct size for section E.

Step 3 Size Section D: The length is the length of the black pipe up to the branch and the
length of the Doobon Flexible run = A1 + A2 + A3 + D = 60 feet. Load is the load of the heater, 150 CFH. At 60 feet, 1" inch CSST can provide a maximum capacity of 156 CFH. 1" is the correct size.

Step 4 Size Section C: The length is 40 feet and total load is 190 CFH. At 40 feet, 1" tubing provides a maximum of 195 CFH. 1" Tubing is the correct size.

Step 5 Size Section B: The length is 20 feet and total load is 200 CFH. At 20 feet, 1" tubing is required to provide at least 200 CFH, with a maximum capacity of 288 CFH.

4. Installation Practices

4.1 General Practices

DooBon Flexible tubing and fittings are engineered and tested to work in combination.

Using DooBonFlexible CSST tubing or fittings with the tubing or fittings of other CSST flexible gas piping manufacturers is strictly prohibited and could lead to serious bodily injury or property damage.

Exposure to high voltage electricity may cause damage to CSST systems. Strict adherence to section 4.10 will mitigate potential damage.

► The installation of DooBon Flexible gas piping must be installed by the installer with the installation qualification.

► The DooBon Flexible System Design and Installation Manual is to be used in conjunction with state and local building codes.

► Authorized installation card is required to purchase and install the DooBon Flexible gas tubing.

► The installer should take good care not to damage or treat any exposed piping during building or reconstruction work.

► All DooBon tubing and components should be stored such that they are not damaged or exposed to debris or chemicals, and so on.

► During the installation and construction process, care must be taken to ensure that exposed tubing is not damaged.

► Contact with hazardous objects or materials to CSST must be avoided. CSST should be kept in place as much as possible to protect the tubing from corrosive threats.

► During installation, CSST is to be temporarily plugged, taped, or otherwise sealed to prevent the entrance of dirt, dust, or other debris into the CSST.

► The United States and Canada restrict DooBon Flexible tubing and fittings to operating pressures no greater than 25 PSI. Doobon Flexible tubing has been tested and approved for pressures up to 125 PSI, but may only be used up to this pressure with consent of the local gas utility and code authority. Pressure tests up to 125 PSI are permitted.

► Using DooBon Flexible CSST or fittings with the tubing or fittings of other CSST flexible gas piping manufacturers is strictly prohibited and could lead to serious bodily injury or property damage. Connection between DooBon Flexible CSST and other brand CSST can be accomplished with standards malleable iron fitting.

►After contact with any chemical containing chloride or ammonia (flux or acid solution), be thoroughly rinsed and dried.

► Be careful not to cause unnecessary stress or deformation in the piping and fittings of DooBon Flexible. While the ability to bend DooBon Flexible tubing is a main feature in its installation convenience, there is a minimum bend radius that should never be exceeded as it could damage the tubing.

Multiple tight bends can restrict gas flow, leading the increased pressure drop.

4.1.1 Minimum Bend Radius

The bend should have a radius as large as possible to reduce the risk of damage to the DooBon Flexible CSST and maximize gas flow.

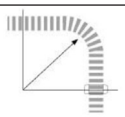
Bend Radius	Tubing Size	Absolute Minimum Bend Radius	Recommended Minimum Bend Radius
 Figure 4.1	1/2″	1.18″(30mm)	2" (50mm)
	3/4″	1.57″(40mm)	3" (75mm)
	1“	2″(51mm)	5" (125mm)
	1¼“	2.36″ (60mm)	6" (152mm)

Table 4.1 Recommended Minimum Bend Radius for DooBon Flexibe

4.1.2 Fragmentation Protection (supporter)

DooBon Flexible piping must be supported with pipe straps, bands or hangers suitable for the size and weight of the tubing, at intervals not to exceed those shown in Table 4.2. Tubing should not be supported by conductive metallic systems such as metallic appliance vents, ducting, or piping.

Electrical cables must be avoided and cannot be used as supports. Tubing is considered supported if it passes through or over a structural component of the building.

Tubing Size	Horizontal Support Spacing	Vertical Support Spacing
1/2″	6ft	10ft
3/4″	8ft.(USA) 6ft(CAN)	
1″	8ft.(USA) 6ft(CAN)	
8ft.(USA) 6ft(CAN)	8ft.(USA) 6ft(CAN)	

Table 4.2 Recommended Horizontal and Vertical Support Spacing for DooBon Flexible Tubing

4.2 Fitting Assembly

Note: DO NOT use sealing solution on parallel thread of fitting assembly.

4.2.1 Minimum Torsion

When assembling the NPT onto the CSST, the CSST must not be twisted more than 15°.

If the CSST is twisted, the force intended to be restored to its original position will continue to act on the parts of the NPT screw, which may result in loose screw tightening and possible gas leakage.

4.2.2 Tubing and Bending

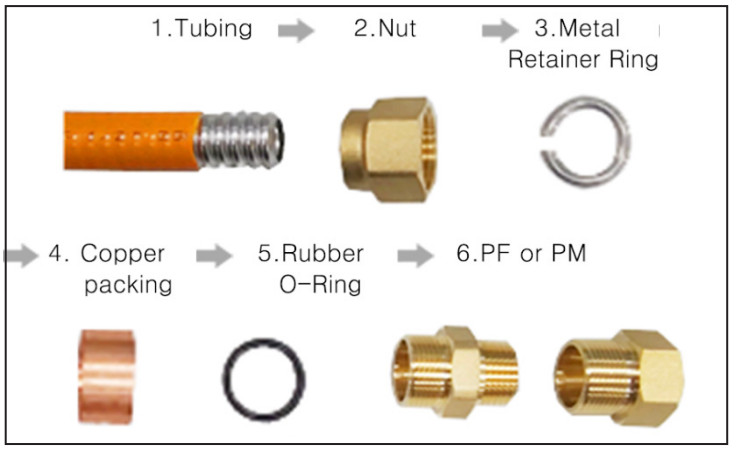
When bending the assembled CSST and NPT sections, bend at least 1″ (2.54 mm) straight from the assembled nut.

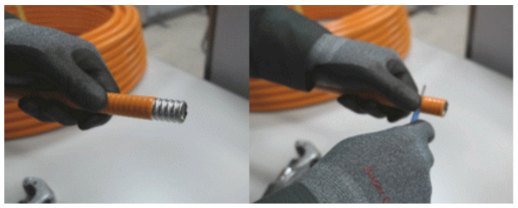
When the assembled CSS and NPT parts are bent within 1″, the force applied to the metal fix ring and copper packing inserted inside the NPT may cause gas leakage.

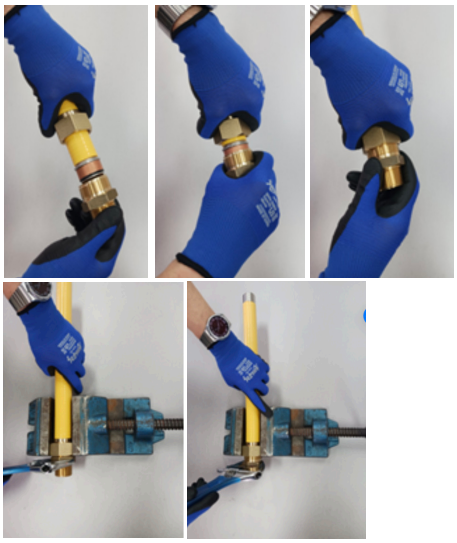
4.2.3 Required Tools for Assembly and Installation

Name	Picture	Description
Tube Cutter		Use to cut CSST to desired length. ※ Note: Turn knob slowly while rotating around the tubing to avoid bending or crushing the tubing.
Utility Knife		Use to remove extra yellow protective jacket at tubing end where the fitting is to be installed. ※ Remove the jacket from the 5th wrinkled bone.
Vise grip		Use to press washer in place on 4th corrugation (or valley) of the DooBon Flexible CSST.
Crescent Wrenches (×2)		Use in fitting assembly to fuse the CSST and NPT ends of the fitting. Tighten the fitting nut and the fitting PM or PF tightly using two crescent wrenches.
Gloves		To protect your hands when installing CSST piping.
Eye Protection		To protect your eyes when installing CSST piping.

4.2.4 Assembly and Reassembly Procedures



STEP	Picture and Description
1	Cut Stainless Steel  ·Using a stainless steel cutter, cut the CSST to fit the length of the installation and leave at least one inch longer for fitting. ·Trim smoothly the cut surface to prevent roughness. ·When cutting, tighten the cutter slowly, drawing a circle in one direction. ·Do not apply strong pressure when turning the cutter round, as flexible piping may become flat.
2	Remove CSST Jacket  ·Using a versatile knife, peel off the yellow pipe jacket from the end of the crown to the bone between 5 and 6. ·Never use tube cutters for this operation as this can damage the piping.
3	Insert nut  ·Insert the DooBon Flexible nut onto the CSST with the threaded end pointing towards the end of the pipe ·Nut should cover jackets.
4	Insert metal fix ring  . Insert the fix ring into the 4th crease (valley) of DooBon Flexible tubing. . Use pliers to secure the ring as far as possible in position as possible. . Turn and tighten with a vise plier so that the gap between both ends of the ring is within 1 mm.
5	Insert copper packing  . Insert the copper packing so that it contacts the fix ring inserted in step 4.

STEP	Picture and Description
7-1	connecting the fitting to the CSST 
	·Install Fitting in a Designation Location (manifold, pipe system, fixed appliance, etc.) ·Seal the threads(NPT) of the fitting and attach them to the gas piping system.
7-2	Connenting the fitting to installed pipe lines
	·Attach the flange nut to the DooBon Flexible installed fitting. ·Before assembly, make sure that all fix rings, copper packing, and O-rings are fitted to the fitting assembly. ·Check integrity that the assembly piece. If the fix ring, copper packing or O-ring is cracked or damaged, replace and assemble it. ·Before assembly, check if there is any obstruction in the assembly (dirt, shavings, jacket, etc.),then remove any obstruction. ·Push the metal packing firmly into the nipple (or socket) on the assembled CSST (because of the O-ring, apply force to the CSST) and then tighten the flange nut to the at least 51~118 N·M. (Tighten the concentric lines of the nut, CSST tube, and nipple match as much as possible when tightening the nut.)
Reassembly	▶ Resolution of Mounting Connection Problems. 1) Slowly tighten the fitting until the maximum torque is reached. 2) If the leakage does not stop after reaching the maximum torque, rework it from 1 to 5 in the CSST fitting assembly order. For safety reasons, the DooBon Flexible fitting cannot be separated once it has been tightened and re-used.

4.3 Routing

4.3.1 General Routing Practices

Routing requirements for CSST flexible gas pipe can vary by locality.

Be sure to confirm the requirements of the administrative authority for the location where DooBon Flexible CSST is to be installed before installing DooBon Flexible CSST. In general, DooBon Flexible can be routed:

▶ Beneath, through, and along side floor and ceiling joists. This is typical for residential and commercial installations with basements or multi-floor routing.

▶ Inside hollow interior wall cavities. Routing inside wall cavities is preferred for vertical sections of tubing.

▶ Horizontal runs through wall cavities should be avoided to minimize the need for striker protection from puncture hazards.

▶ Through approved conduit underground or under building slabs. Under no circumstances is DooBon Flexible CSST to be routed underground or under slab unless it is routed within a non-metallic water-tight conduit that is at least ½" larger than the outer diameter (OD) of the CSST tubing.

▶ Fittings and joints are not permissible in such runs—the run must be one unbroken line of tubing. Runs underneath slabs must be sleeved and vented per local codes.

▶ When installed outdoors, the jacketing of DooBon Flexible must be intact along the entire run. Any areas of exposed tubing are to be wrapped with self-bonding silicone tape or sleeved to prevent threats from acids or chlorides.

▶ Along the perimeter of a building. Care must be taken to protect DooBon Flexible from mechanical damage when installed along the exterior of a building. If installed within 6 feet of the ground, DooBon Flexible CSST must be routed within a conduit or chase.

※ Careful consideration should be given to route CSST in areas where mechanical damage is least likely.

4.3.2 Routing through vertical wall framing

Requirements for boring through vertical members of wall framing differ depending on whether the member is bearing or not. For non-bearing members (Figure 4.2), the size of the hole should be no larger than 60% of the width of the member. For bearing members, the size of such hole should be no more than 40% of the member (Figure 4.3)

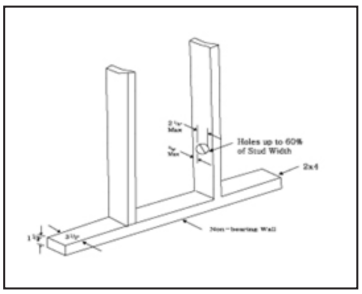


Figure 4.2
Holes in Non-Bearing Walls

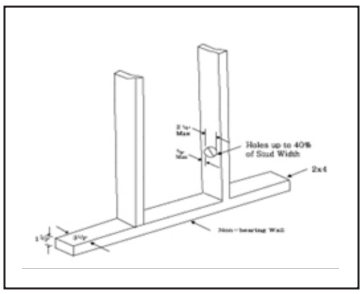


Figure 4.3
Holes in Bearing Walls

4.3.3 Horizontal movement

► Routing through holes in joists, rafters or similar wood structures

When tubing is installed through bored holes in joists, rafters, or other wood structures, the holes should be bored such that the edge of the hole is at least 2 inches from the nearest edge of the wood structure (Figure 4.4). If this criterion can't be met, the tubing must be protected by a striker plate of suitable size installed in accordance with section 4.4. The diameter of the hole should be no more than 1/3 the depth of the wood structure.

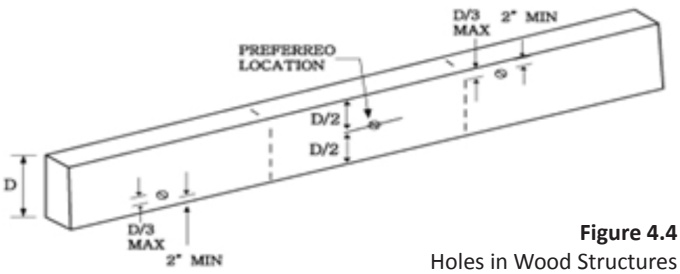


Figure 4.4
Holes in Wood Structures

► Holes and Cuts in Top and Sole Plates

Holes bored through top plates, top frame members and sole plates should not exceed ½ the width of the structure, and should be in the center of the structure. If a sole or plate is to be cut for the routing of DooBon Flexible tubing, the width of the cut should be ½" greater than the outside diameter of the tubing and no greater than 2 inches. Tubing must be protected with striker plates in accordance with Section 4.4. (See Figure 4.5)

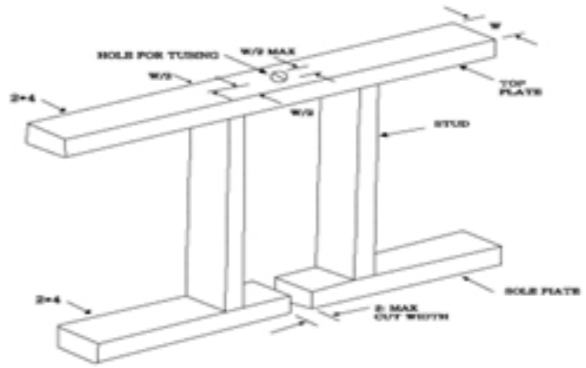


Figure 4.5 Holes and Cuts in Top and Sole Plates

4.3.4 Clearance Holes and Notching

Clearance holes for routing tubing through studs, joists, plates, etc. must have a diameter at least ½" larger than the outside diameter of the tubing (see Table 4.3). Local codes pertaining to structural members must be followed when drilling clearance holes—no structural members should be compromised, weakened or impaired by cutting, notching, drilling, or otherwise alternating the member

Table 4.3 Recommended Routing Holes for Installation of DooBon Flexible CSST

Tubing Size	Drill Hole Size
1/2″	3/8″(35mm)
3/4″	1/2″(38mm)
1″	1¾″(45mm)
1¼″	2¼(58mm)

4.3.5 Routing through metallic surfaces

When installing CSST through galvanized steel studs, plastic grommets (often supplied by the stud manufacturer) should be used to reduce potential damage to the yellow jacket of the DooBon Flexible tubing. When installing through holes in other metallic members, the tubing must be similarly protected from contact with the member to prevent mechanical wear on the yellow jacket and tubing. Acceptable means of protection include: rubber grommets, bushings, DooBon Flexible Flexible Protective Conduit, PVC tape, thermal contraction sleeve material, or a minimum of four wraps of 10 mil duct tape.

4.3.6 Concealed Locations for Fittings

DooBon Flexible mechanical attachment fittings have been tested and are listed per the requirements of ANSI LC1 and CSA 6.26 Standard (USA and Canada). This specification provides test requirements which certify fittings for concealed installations and connections to appliances where concealing the fittings is the only practical alternative These guidelines address some of the known situations which may require the use of a concealed fitting. While accessibility of fittings is always preferred, there are some situations where concealing the fittings is the only practical option. This guide cannot address all applications of concealed fittings, but instead provides general instructions to demonstrate the principles which apply to fittings, listed for installation in concealed locations (National Fuel Gas Code, NFPA 54 Chapter 7).

※ Manifold Stations which are composed of multiport manifold(s), shut off valve, and pressure regulator shall not be installed in concealed locations regardless of the qualifications of tubing fittings.

► New Installations

DooBon Flexibe can be connected to steel piping systems through threaded pipe connections. This can be a sub-out run to an appliance connection, be outdoors to a meter, etc. DooBon Flexible connections to fireplace key valves can be located in a concealed location, provided that accessibility is not readily provided. When multiple outlets are supplied from a single tubing run (like in a series arrangement), each downstream outlet branch can be connected to the main run using a tee fitting which can be located in a concealed location. (See Figure 4.6)

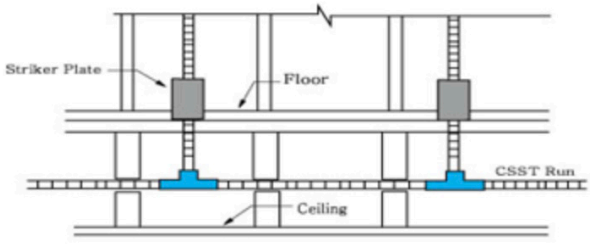


Figure 4.6 Multiple Outlets Along Main CSST Run

► Modifications to Existing Systems

New Ceilings: DooBon Flexible fittings originally installed in an unfinished ceiling location can be concealed in the event that a ceiling is installed at a later date.

► Extensions to Existing Tubing Runs

Extensions to existing tubing runs: A concealed run of tubing can be extended with a new pipe run to feed another appliance location,

so long as their is sufficient capacity to supply both appliances simultaneously. If an accessible location for the modification is not available, the existing run can be modified with a tee fitting, resulting in a concealed fitting (Figure 4.7).

Repairs to existing tubing runs: Damaged tubing runs should be repaired in accordance with Section 5.2 of this guide. The repair can result in a line splice that may be located in a concealed location.

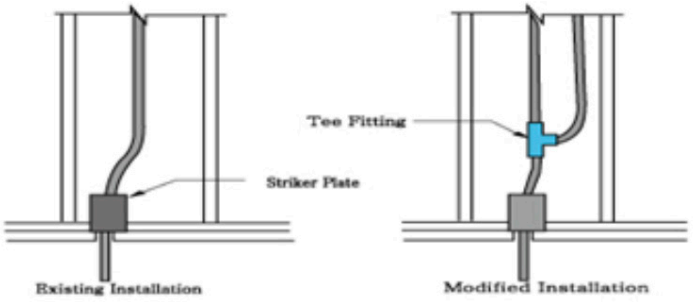


Figure 4.7 Extension of Existing Tubing Run

4.3.7 Indoor/Outdoor Installation Issues

► The DooBon Flexible jacket is UV resistant and able to withstand exposure to sunlight. ANSI LC1-CSA 6-26 contains test requirements determining suitability for exposure of CSST to outdoor environments. DooBon Flexible is certified to this standard and is fully qualified for outdoor installations. However, to attain maximum longevity of the jacket, it is recommended to avoid prolonged exposure to direct sunlight.

► When installed outdoors, the yellow jacketing of DooBon Flexible must be intact along the entire run. Any areas of exposed tubing are to be wrapped with self-bonding silicone tape or sleeved to prevent damage from acids and chlorides.

► If CSST is installed in the equipment room of a swimming pool or hot tub, or otherwise exposed to a corrosive environment which could be harmful to the tubing, the tubing shall be installed in a protective device, and any exposed portions of the stainless steel tubing should be wrapped with self-bonding silicone tape, beginning on the jacket and ending on the nut of the DooBon Flexible fitting.

► If DooBon Flexible CSST is installed in an exposed condition alongside a structure between the ground and a height of 6 feet, the tubing should be installed in a location such that it won't be subjected to mechanical damage, or be protected inside a conduit.

► DooBon Flexible CSST should never be buried directly underground. To route DooBon Flexible CSST underground, it must be protected within a non-metallic water-tight conduit that is at least ½" larger than the outer diameter (OD) of the CSST tubing. Fittings and joints are not permissible in such runs—the run must be one unbroken line of tubing. Runs underneath slabs must be sleeved and vented per local codes. (See Figures 4.7 and 4.8)

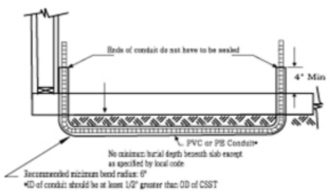


Figure 4.8
Installation in Non-Metallic Conduit Under Slab

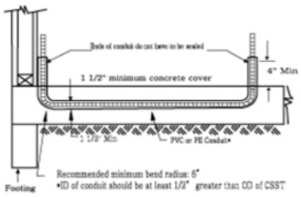


Figure 4.9
Installation in Non-Metallic Conduit In Slab

※ If installed underneath mobile homes or in crawl spaces, DooBon Flexible CSST should be installed in accordance with the above Indoor/Outdoor Installation Issues section.

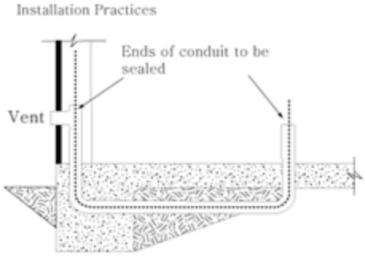


Figure 4.10
Installed in ventilated non-metallic conduits

4.4 Protection

Protection is required when DooBon Flexible CSST is concealed, constrained, and within 3 inches of a potential threat. DooBon Flexible CSST must be adequately protected wherever it is at risk of damage from puncture, shearing, crushing, or other physical threats. Tubing is to be protected at support points, and when passing through structural members of the building such as studs, joists, and plates as outlined in this section. If the tubing requires protection, the measures in this section should be followed.

4.4.1 Striker Plates

Shielding devices (striker plates) are used to protect the DooBon Flexible CSST from puncture threats such as drill bits, nails, screws, etc. Such devices are required when the tubing is concealed and is constrained such that the tubing would not be able to move if struck by a puncture threat.

A) At support points and areas of possible penetration less than 2 inches away from any edge of a stud, joist, plate, etc., shielding is required both at the area of support and within 5 inches of each side. (Figure 4.11)

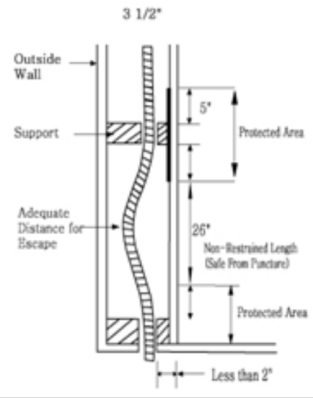


Figure 4.11
Elevated View of Unsupported Horizontal Tubing Run

B) At support points and points of possible penetration 2-3 inches from any edge of stud, joist plate, or other member, shielding is required throughout the area of support. (Figure 4.12)

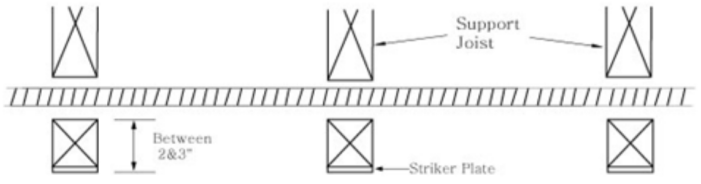


Figure 4.12
Shielding at Support Area When Penetration is 2-3 inches from Edge

C) At termination points using the DooBon Flexible CSST termination flange, DooBon Flexible CSST Protective Conduit should be installed to protect the CSST in the area between the striker plates and the outlet. (Figure 4.13)

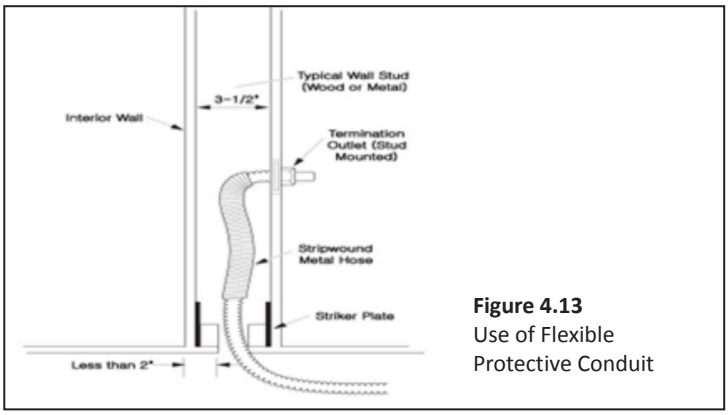


Figure 4.13
Use of Flexible
Protective Conduit

D) For tubing routed horizontally between studs,striker plates should be installed at each stud, and Flexible Protective Conduit, or other approved conduit, should be installed across the entire length of the run.

E) If striker plates can't reasonably be installed (like between floors with enclosed joist areas or installations when walls are already in place), schedule 40 steel pipe has been found acceptable by CSA International for puncture protection. Steel pipe must have an inner diameter at least ½" larger than the outer diameter of the DooBon Flexible tubing (See Table 4.4). Protection must extend 5 inches beyond the penetration of the structural members. A 12 inch pipe length is acceptable for penetration of a single stud. Despite this approval, the use of striker plates is recommended whenever possible.

Tubing Size(wrong info)	Drill Hole Size
1/2″	3/8″(35mm)
3/4″	1/2″(38mm)
1″	1¾″(45mm)
1¼″	2¼(58mm)

4.4.2 Avoiding Puncture Threats

The best way to protect from puncture threats (and potentially speed your installation) is to route tubing in areas of the structures where no added protection is necessary. The guidelines below will help the installer route DooBone Flexible CSST in areas where secondary puncture protection isn't required:

A) Support tubing such that it is more than 3 inches away from any outside edge of a stud, joist, plate, etc., or wall surface. (See Figure 4.14 compared to Figure 4.12)

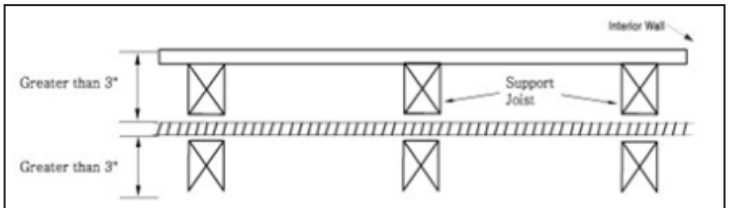


Figure 4.14
Penetration Point Greater than 3" from Edge of Stud, Joist, Plate, etc.)

B) In non-restrained installations, make sure that the tubing can move at least 3 inches from the direction of potential penetration.

C) Tubing supported under joists in basements or crawl spaces does not require added protection so long as it is not concealed by wallboard or ceilings and is at least 3" away from puncture threats through floors or ceilings .

D) Added protection is not necessary in unfinished garage walls where the tubing is clearly exposed so long as puncture threats do not exist from the outside wall.

4.4.2 Through-Wall Penetration (Outdoor appliance)

DooBon Flexible tubing and its polyethylene jacket have been tested to the flame spread and smoke density requirements of ASTM E84 and meets AGA and ANSI LC-1 limits imposed for this criteria. DooBon Flexible CSST is classified as NFPA Class A/IBC Class A with a flame spread value of 0 and a smoke density value of 80. Other requirements for fire rated resistive constructions may be imposed by local codes. The qualified installer must meet local building codes pertaining to flame and smoke density regulations for nonmetallic materials at all times.

4.5 Meter connections

Natural gas meters are generally supported independently of the building structure and piping system. When the gas meter is independently supported, DooBon Flexible CSST can, in some localities, be used to connect the meter to the building gas system. If the gas meter is not supported independent of the building structure or gas piping system, DooBon Flexible tubing cannot be used to connect directly to the meter.

4.5.1 Connection by Special Termination Fitting

Do not use DooBon Flexible CSST as a direct connection if the meter must be supported by the piping system. If the meter is supported by the building structure, common practice is to route the CSST system to a termination flange mounted to the exterior of the building, and to connect the meter to the termination flange with rigid pipe. Alternatively, rigid pipe can be used to penetrate the building, with an attachment to DooBon Flexible CSST inside the structure.

4.5.2 Direct Connection

If a direct connection from DooBon Flexible CSST to an independently supported gas meter is permitted by the local utility, the connection should include an extra 3-6" of length to allow for building settling and meter movement. Exposed sections of CSST are to be wrapped with self-bonding silicone tape, especially if the building is of masonry construction. For direct connections through masonry construction, a PVC sleeve is required, and also recommended for wood frame construction. (Figure 4.16)

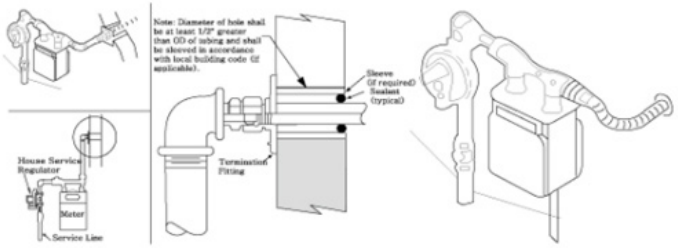


Figure 4.15
Connection to Building supported Meter

Figure 4.16
Independently Supported Meter

Note : Check with the local servicing utility prior to directly connecting DooBon Flexible CSST to the gas meter as utilities regulate connections to meter attachments.

4.6 Appliance Connections

4.6.1 Termination Fittings with Appliance Connectors

DooBon Flexible termination flange fitting is designed to be used for moveable appliances

and quick-connect devices at floor and hallow wall piping outlets (See Figure 4.17). The termination outlet minimizes the need for concealed fittings and makes the installation of gas connections for moveable appliances easy. The flange plate should be securely fastened in place during rough-in of the structure. It may be attached to a brace spanning between wall studs or directly to the floor.

As an alternative to the special termination flange, a termination can be made with rigid pipe connected to the main DooBon Flexible CSST system. The rigid stub-out must be

fastened to the wall or floor using a pipe flange or other rigid mounting object. Connections made between DooBon Flexible CSST and moveable appliances must be made with approved flexible appliance connectors.

Direct connections between DooBon Flexible CSST and moveable appliances are not allowed.

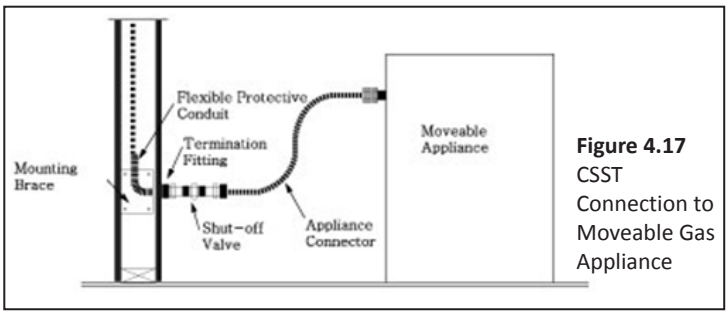


Figure 4.17
CSST Connection to Moveable Gas Appliance

4.6.2 Direct Connection

In most localities, fixed appliances may be directly connect to DooBon Flexible gas piping systems. When located in a secure dedicated place, like an attic or garage, the gas piping can be connected directly to the appliance shut-off valve without installing a special termination flange or flexible appliance connector.

4.6.3 Pad-Mounted Equipment

Gas equipment like pool heaters, generators, heat pumps, and gas air conditioners that are

mounted on concrete pads should connect to the DooBon Flexible CSST system at a termination fitting with either black steel pipe or an approved outdoor appliance connector. Direct connection of DooBon Flexible CSST to pad-mounted equipment is allowed when the CSST is securely supported and protected from physical damage, so long as such practice is permissible by local and state codes. Any exposed tubing should be wrapped with self-bonding silicone tape, sealing the fitting connection.

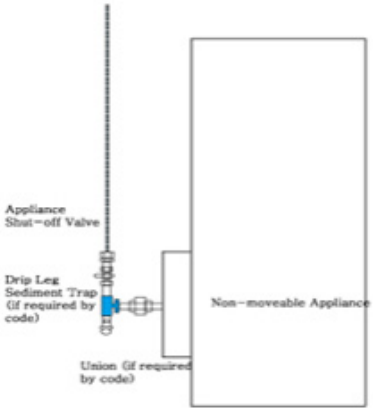


Figure 4.18
Direct Connection to Fixed Appliance

4.6.4 Roof Top Equipment

A) Special mechanical protection of DooBon Flexible tubing is not required unless the tubing may be subject to physical damage in the location. DooBon Flexible tubing should penetrate the roof within 6 feet of the equipment location, whenever possible. Long runs of tubing on the roof should be supported with non-metallic blocks at the intervals specific in Table 4.2, and raised above the roof at the height dictated by local code. (Figure 4.19)

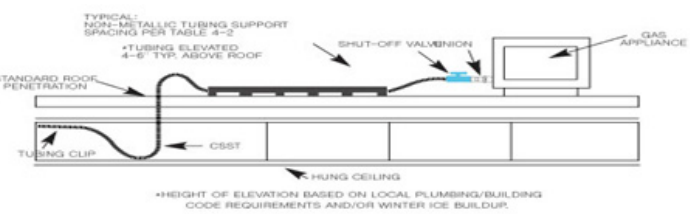


Figure 4.19 Roof Top Equipment Installation

B) In addition to non-metallic blocks, DooBon Flexible CSST can be supported with a strut or channel running from block to block. This provides a secure, damage resistant track for the CSST and allows for the block spacing to be set at every 8 feet. The channel run should be a 13/16" galvanized shallow channel with splice plates at joints and bends.

DooBon Flexible tubing should be firmly attached to each block with metallic clamps designed for the strut, or other appropriate fastener. Black UV resistant cable ties can be used at intermediate points to ease the rolling out of DooBon Flexible CSST.

Blocks should be attached to the roof surface in compliance with the roofing manufacturer's instructions. (See Figure 4.20)

Any DooBon Flexible tubing run vertically up the side of a building must be protected in accordance with "Indoor/Outdoor Installation Issues" in Section 4.3.

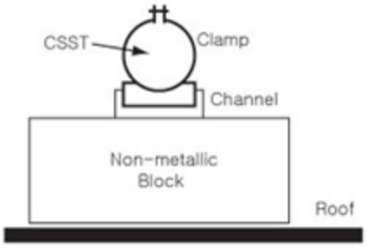


Figure 4.20 Rooftop Support with Strut

4.6.5 Outdoor Appliances: Barbecue Grills, Gaslights, and Heaters

► As with movable indoor appliances, movable barbecue grills, heaters, and other appliances should not be directly attached to DooBon Flexible CSST (Figure 4.21). An approved outdoor appliance connector should be used to make the connection from the BBQ to the piping system at a special termination flange, a steel nipple, or a quick-connect device as described in Section 2.6. Follow manufacturer's installation instructions.

► Non-movable outdoor appliances, such as fixed barbecues, gas lights, or heaters can be directly connected with DooBon Flexible CSST so long as such connections are permissible by local code. On a deck, the outdoor portion of the tubing run must be supported against the sides of joists. If the deck elevation is below the building foundation, exposed tubing must be routed through a protective water-tight non-metallic conduit. Tubing runs under ground must follow the guidelines in Section 4.9. The exposed end of conduit must be sealed to prevent foreign objects (dirt, water, pests, etc.) from entering.
(See Figures 4.22 and 4.23)

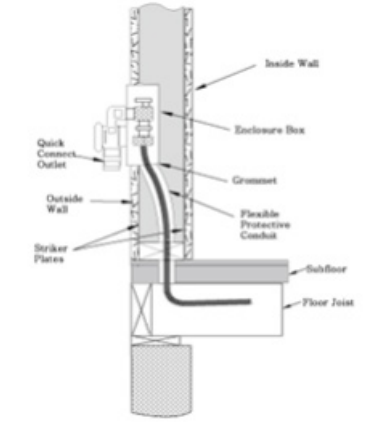


Figure 4.21 Quick Connect Outlet

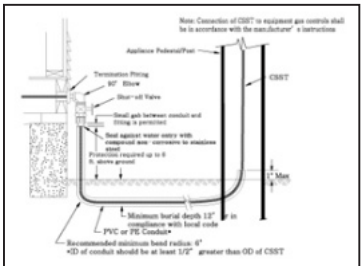


Figure 4.22 Fixed Outdoor Appliance (Underground Routing)

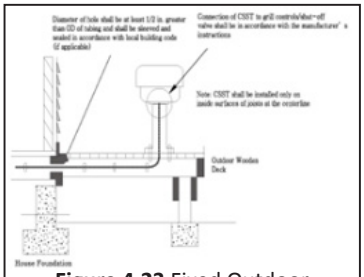


Figure 4.23 Fixed Outdoor Appliance (Deck Mounted)

4.6.6 Fireplace Installations

Most gas fireplaces and gas logs are considered fixed appliances which can be directly connected with DooBon Flexible CSST without a special termination flange (ANSI Z24.50). Direct delivery of gas is approved for decorative and heat generating fireplaces and for gas logs used in masonry and pre-fabricated fireplaces. (Figure 4.24)

DO NOT use DooBon Flexible CSST to connect gas log lighter or gas wands for use in all-fuel (wood burning) fireplaces. For gas log lighter installations in all-fuel fireplaces, DooBon Flexible CSST must be terminated at the key valve or another location outside the fireplace. The final attachment to the lighter should be made using black steel pipe.

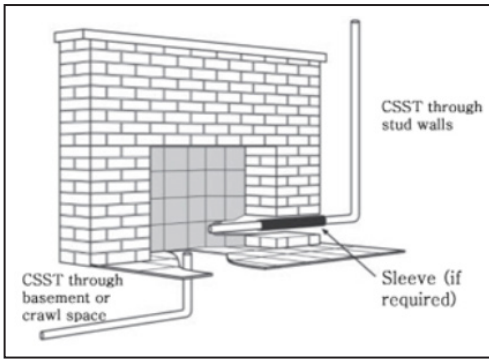


Figure 4.24 Routing to Masonry Fireplace

4.7 Manifold Stations

In elevated pressure systems (typically installed in a parallel arrangement), it is recommended to use a central manifold and regulator station to take best advantage of regulator capacity (Figure 4.25).

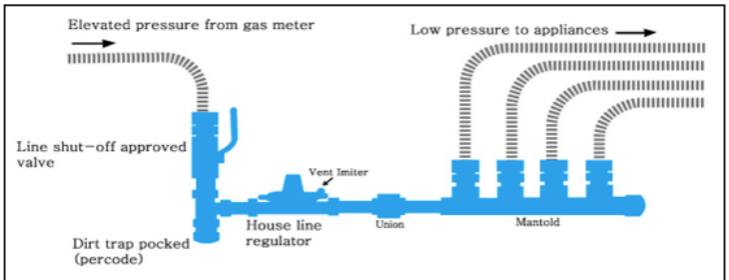


Figure 4.25 Example of Manifold Station Layout

4.7.1 Acceptable Location

The manifold and regulator station MUST be located in an accessible location to maintain access to the shut-off valves and regulator. The station may be housed in a gas load center enclosure (Figure 4.26). Optional shut-off valves can be mounted on the manifold to control each appliance run in addition to the main line shut-off valve.

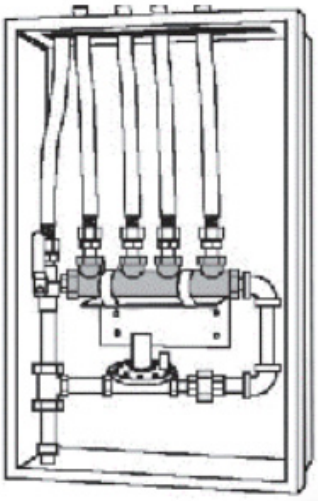


Figure 4.26 Gas Load Center

Manifolds may be concealed when used in low pressure systems, or when the ma Anifold is installed in a location removed from the regulator.

4.7.2 Arrangement

Stainless steel manifolds are available from DooBon Flexible Co., Ltd. or can be assembled through the use of rigid black steel pipe and fabricated tee manifolds. It is recommended that the station be located near the appliance(s) with the highest load in the system to allow for shorter runs to those appliances.

4.8 Pressure Regulators

4.8.1 Installation Requirements

The DooBon Flexible CSST system used with inlet gas pressures in excess of ½ PSI, but servicing appliances rated for a maximum of ½ PSI, must contain a pounds-to-inches regulator to limit the downstream pressure to no more than ½ PSI. Gas pressure regulators must comply with a nationally recognized standard for pressure regulators such as ANSI Z21.80/CSA 6.22. Regulators must also conform to the following:

► Regulators must be sized in accordance with the total appliance load (maximum flow rate), largest single appliance flow rate, inlet pressure range at the regulator inlet, and the desired outlet pressure. (Tables 4.5 and 4.6)

► Regulators must be installed in accordance with the manufacturer's instructions. Ensure the flow of gas is correct, as indicated by the flow markings on the regulator casing.

► The regulator must be installed in a fully accessible area with an approved shut-off valve upstream. A union can be used to allow for removal of the regulator if the location doesn't allow proper room for regulator servicing.

► The regulator with OPD must be assembled and listed by the regulator manufacturer in accordance with ANSI Z21.80, Standard for Line Pressure Regulators.

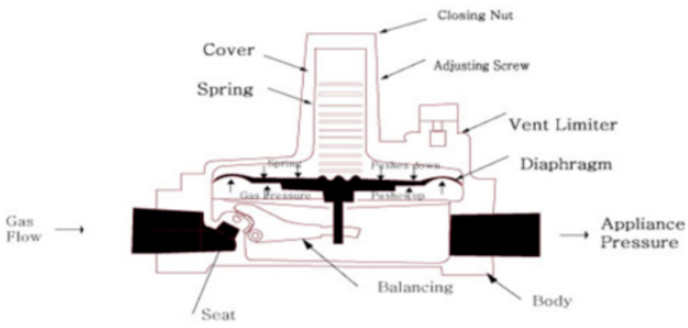


Figure 4.27 Pressure Regulator Diagram

Table 4.5 Pressure Drop for Natural Gas in CFH (m^3/hr)

Model	½ PSI (34 mbar)	¾ PSI (52 mbar)	1 PSI (69 mbar)
325-3L	204(5.8)	250(7.0)	289(8.2)
325-5L	476(13.5)	583(16.5)	673(19.1)

Table 4.6 Regulator Capacity Tables In CFH(m^3/hr)

(MBTU/hr values based on LP Gas with heating value of 2520 BTU per ft^3)								
Part No.	Gas Type	Max. Single Appliance Load	Max. Total Load	Outlet pressure Set Point	Operating Inlet Pressure			
					½ PSI	¾PSI	1PSI	1½PSI
325-3L	Natural (0.64 sp. gr.)	140CFH	250CFH	8″w.c.	145(4.1)	200(5.7)	250(7.1)	250(7.1)
				11″w.c.	93(2.6)	172(4.9)	225(6.4)	250(7.1)
	LP (1.53 sp. gr.)	91 CFH (229 MBTU/hr)	163CFH (410 MBTU/hr)	11″w.c.	60(1.7) (152 MBTU/hr)	112(3.2) (281 MBTU/hr)	146(4.1) (368 MBTU/hr)	162(4.6) (409 MBTU/hr)
325-5L	Natural (0.64 sp. gr.)	300CFH	550CFH	8″w.c.	335(9.5)	475(13.5)	550(15.6)	550(15.6)
				11″w.c.	211(6.0)	391(11.1)	511(14.5)	550(15.6)
	LP (0.64 sp. gr.)	195CFH (483 MBTU/hr)	358CFH (901 MBTU/hr)	11″w.c.	286(8.1) (345 MBTU/hr)	254(7.2) (639 MBTU/hr)	332(9.4) (836 MBTU/hr)	357(10.1) (899 MBTU/hr)

4.8.2 Vent Limiters Options

Regulators must be equipped with a manufacturer-supplied vent limiting device, or be capable of being vented to the outdoors. When installed inside, the vent-limiting device is to be used. When a vent-limiter is used, the regulator must be mounted in an upright position for proper function. For outdoor venting, the vent line must be at least the same size as the regulator vent connection and not exceed a length of 30 feet.

4.8.3 Vent Line

The vent must be designed to prevent entry of water or other foreign materials that could clock the line. DO NOT vent to an appliance flue, building exhaust system, or pilot light.

If installing the regulator outdoors, remove the vent limiter and mount the regulator with the vent outlet pointing toward the ground to prevent water from entering. If the manufacturer provides a cap for outdoor installations, this can be used and the regulator can be mounted right side up.

Gas line regulators do not vent gas under normal operating conditions. A regulator that is venting gas should be replaced immediately.

4.8.4. Regulator Adjustments

Regulators can be adjusted to deliver different outlet pressures downstream of the regulator. To adjust a regulator, remove the seal cap to expose the adjusting screw. Turn the screw clockwise to increase outlet pressure, or counter-clockwise to decrease pressure. (See Figure 4.27)

If the spring adjustment doesn't lead to the desired pressure, make sure the supply pressure is at least equal to the desired outlet pressure plus the pressure drop of the regulator. If this pressure is adequate, contact to the manufacturer. DO NOT continue to turn the screw clockwise if the outlet pressure reading doesn't increase as this may result in over-firing due to the loss of pressure control should

there be an increase in inlet pressure.

4.8.5 Protection from Excessive Pressure

A performance test of the regulator should be conducted to confirm that adequate pressure reaches all appliances. During the test, all appliances should be running at full load to make sure that adequate pressure is maintained under full-load conditions for the gas piping system. The inlet pressure for gas appliances should be equal to, but not greater than, the appliance's recommended inlet pressure range. If the pressure is not within this range, adjustments to the service regulator or the pounds-to-inches gas line regulator may be required to adjust line pressure.

4.9 Underground Installations

Acceptable Limit

Building codes require that gas piping runs that come in contact with earth or other material that could corrode the piping be protected from corrosion. Piping installed beneath
(underground) or within the slab of a building must be encased in a non-metallic watertight conduit that is vented. Fittings and couplings are not permitted when CSST is installed underground.

DooBon Flexible CSST should never be buried directly underground without a conduit. To route DooBon Flexible CSST underground, it must be protected within a non-metallic water-tight conduit that is at least ½" larger than the outer diameter of the CSST tubing. Fittings and joints are not permissible in such runs; the run must be one unbroken line of tubing. Runs underneath slabs must be sleeved and vented per local codes.
(See Figures 4.7 and 4.8)
Note: If installed underneath mobile homes or in crawl spaces, DooBon Flexible CSST should be installed in accordance with Section 4.3, Indoor/Outdoor Installation Issues.

4.10 Electrical bonding/grounding

Proper bonding and grounding may reduce the risk of damage and fire from electrical arcing to CSST as a result of a lightning strike. Lightning does not have to strike a structure directly to cause damage. Conductive systems, like piping or wiring, can become energized indirectly by a lightning strike. When systems are not properly bonded, the current from the energized line can cause electricity to arc or jump from one system to another and damage the CSST. Proper adherence to the bonding instructions should lower the risk of electrical arcing and related damages.

Guideline for Bonding Installation

In accordance NFPA 54 Section 7.13, DooBon Flexible Co., Ltd. requires proper bonding of DooBon Flexible gas piping to the electrical grounding system of any structure in which DooBon Flexible CSST is installed. Electrical work must be performed by a qualified person recognized by the local jurisdictional authority as being capable of performing such work. All installations of CSST for use in natural and propane (LP) gas piping systems in single and multi-family structures, whether or not the connected gas equipment is electrically powered, require direct bonding. Bonding of commercial systems are to be designed by qualified persons according to the local electrical code. DooBon Flexible CSST installations inside or attached to building exteriors are to be electrically continuous and direct bonded to an effective ground-fault current path. Direct bonding of gas piping systems is achieved when the following guidelines are met:

► Direct and permanent connection of a bonding jumper to the electrical service grounding system by connecting to the: electrical service equipment enclosure, the grounding electrode conductor (if of sufficient size), the grounded conductor at the electrical service, or to one or more grounding electrodes. The piping system shall not be used as a grounding electrode for an electrical system.

► Direct and permanent connection of a bonding jumper to the electrical service grounding system by connecting to the: electrical service equipment enclosure, the grounding electrode conductor (if of sufficient size), the grounded conductor at the electrical service, or to one or more grounding electrodes. The piping system shall not be used as a grounding electrode for an electrical system.

► Bonding/grounding clamp specifications: conductors are to be no smaller than 6 AWG. Bonding clamps are to be listed to UL 467, and be attached in accordance with the National Electric Code (NEC) and the listing of the clamp. The attachment point for the bonding conductor is to be accessible. This bond is in addition to any bonding requirements as specified by local codes. Attachment between the CSST gas piping system and the bonding clamp must be made by connecting to an DooBon Flexible brass fitting (Figure 4.28), steel manifold (Figure 4.29), or any rigid pipe between the first CSST fitting in the system and the meter (Figure 4.30). Under no circumstance is DooBon Flexible CSST tubing of the gas piping system to be used as the attachment point for the bonding conductor.

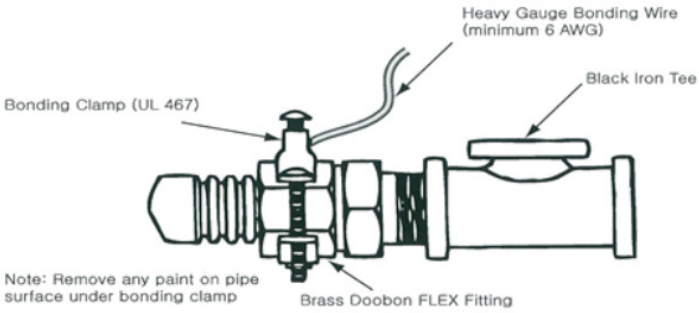


Figure 4.28 Bonding Connection to Brass Fitting

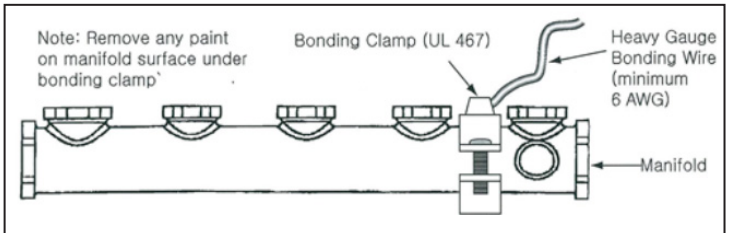


Figure 4.29 Bonding Connection to Steel Manifold

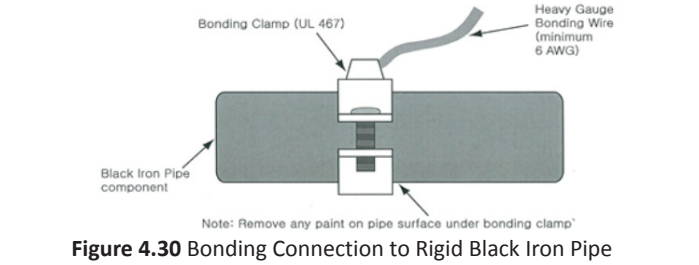


Figure 4.30 Bonding Connection to Rigid Black Iron Pipe

5. Inspection, Repair, and Replacement

5.1 Minimum Inspection Requirements Checklist

All installations shall be inspected by the authority having jurisdiction in accordance with state and local mechanical, electric, and/or plumbing codes, or in the absence of such codes, the National Fuel Gas Code (NFPA 54/ANSI Z 223.1), the International Fuel Gas Code (IFGC), the National Electric Code (NFPA 70), and/or the Uniform Plumbing Code (UPC), as applicable.

□ Inspection and pressure test completed at rough-in (Chapter 6)

□ Only fixed appliances are directly connected to the DooBon Flexible system (Section 4.6)

□ Connections to moveable appliances made with flexible appliance connectors (Section 4.6)

□ System properly sized to deliver pressure required for all appliances (Section 3.2 and Chapter 7)

□ Regulator, if required, is installed in an accessible location with a shut-off valve mounted ahead of it (Section 4.8)

□ Striker plate protection in place where required (Section 4.4)

□ If routed underground or through masonry, DooBon Flexible tubing is properly sleeved (Section 4.3)

□ Direct bond to the electrical service grounding electrode system (Section 4.10)

□ No damaged tubing dents or defects (Section 5.2)

□ DooBon Flexible tubing is supported at proper interval (Section 4.1 and Table 4.2)

5.2 Repair of Damaged Tubing

If tubing is damaged before, during, or after installation, refer to these guidelines to determine the proper course of repair.

A) Available but Recommended piping replacement

he portion of the tube that is slightly recessed due to the impact is defined as less than 1/3 of the diameter of the pipe and can be used in this case, but it is recommended to replace it for safety in long-term use. (Figure 5.1)

Figure 5.1 Available but recommended replacement for safety

B) Pipe Replacement Necessary

The DooBon Flexible CSST must be replaced under the following circumstances :

1) The tubing has been significantly crushed or dented (a dent greater than 1/2 the diameter of the pipe). (Figure 5.2)

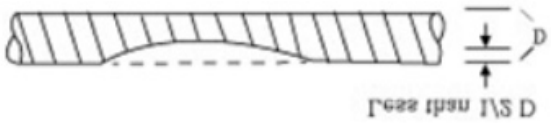


Figure 5.2 Replacement Necessary

2) The tubing has been damaged by puncture of ANY kind (nails, screws, drill bits, etc.).

3) The tubing has been bent beyond its minimum bend radius such that a crease or kink remains. (Figure 5.3)

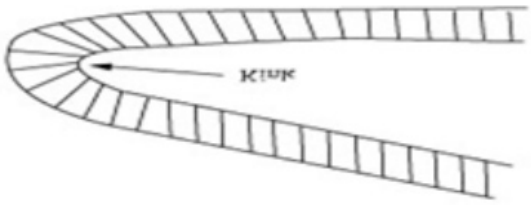


Figure 5.3 Repair Necessar Due to Exceeding Minimum Bend Radius

Repair methods : Splice or Replace

DooBon Flexible CSST can be repaired by splicing through the use of Doobon Flexible fittings, but if the tubing run is short and easily accessible, the preferred repair method is to replace the entire length of tubing. This is often a speedier repair than a splice, and does not add additional fitting joints to the system, avoiding increased pressure loss and simplifying the piping system. The existing DooBon Flexible fittings can be reused on the new run, so long as they are undamaged.

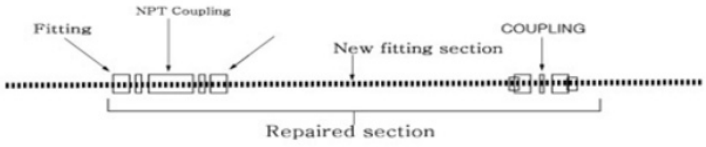


Figure 5.4 Repair of Damaged Tubing with a Spliced New Section

6. Pressure / Leak Test

The final installation must be inspected and tested for leaks in accordance with local and/ or state codes. In the absence of local guidelines, test the system at 1½ times the maximum working pressure, but not less than 3 PSI, using the procedures specified in Chapter 8 "Inspection, Testing and Purging" of the National Fuel Gas Code (NFPA 54/ANSI Z223). When local codes are more stringent, local codes must be followed. If no local codes apply, test according to the National Fuel Gas Code, IFGC, or UPC. The installer should never pressure test with the pounds-to-inches regulator installed as this may damage the regulator.

6.1 Low Pressure System Requirements

► Pressure testing should be performed during rough construction of the facility, before interior walls are finished. This will permit a more complete inspection of the piping system during the pressure testing,

and save costly rework in the event of leaks or other problems. DooBon Flexible Co., Ltd. is not responsible for repairs necessary to correct defects discovered after interior walls are finished.

► Do not connect appliances or pressurize the system with fuel gas until after the pressure test is completed.

► All gas outlets for appliance connections should be capped during pressure testing.

► Use only non-corrosive leak check solutions. Rinse with water and dry the tubing thoroughly after leak detection.

► Most utilities perform a leak test after setting the gas meter and prior to turning on the gas.

► This test is performed after the final construction is complete and finished interior walls are in place. This test is performed to assure no damage was done to the tubing during the closing-in construction process.

6.2 Elevated Pressure Systems requirements

Systems above ½ PSI require a two-part pressure test. The first part is performed on the elevated pressure section, between the meter connection and the pounds-to-inches line gas pressure regulator (Figure 6.1). The second part is performed on the low pressure section, between the pounds-to-inches line gas pressure regulator and the gas appliance outlet. If a steel pipe "jumper" is inserted in place of the line gas pressure regulator the entire system can be pressure tested in one step.

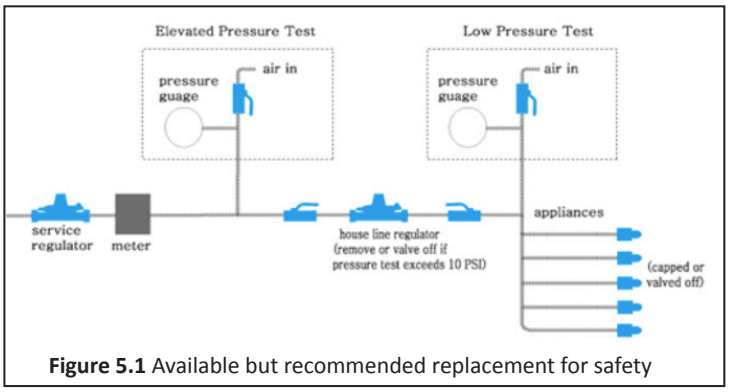


Figure 5.1 Available but recommended replacement for safety

6.3. Leakage test

After the final pressure test, inspection, and final construction are complete, appliances may be connected to the DooBon Flexible gas piping system.

This final connection can be accomplished by a stainless steel flexible connector, direct connection with CSST tubing, or with rigid black pipe, depending on the appliance .

Turn the gas on at the meter and inspect for leakage before operating the appliances.

Connections made at the appliances should be leak checked with a bubble solution. Before placing the appliances in operation the tubing system should be purged. This displaces the air in the system with fuel gas.

Be sure to bleed tubing system into a well ventilated area.

※ : Leak test solutions may cause corrosion to some types of material in the gas tubing system. Be sure to water rinse after the test and thoroughly dry all contacted material. Also, the vent limiter should not be leak tested with a liquid test solution. This could contaminate the internal ball check mechanism, or plug the breathing hole, resulting in erratic regulator operation.

7. Sizing/Capacity Tables(Natural Gas and LP Gas)

7.1 Steel Pipe Capacity Chart

Equivalent Hydraulic Diameter (EHD) : A theoretical sizing which is used to compare the hydraulic performance between manufacturers. A higher EHD number indicates greater flow capacity of piping.

Tables includes losses for four 90 degree bends and two (2) end fittings. Tubing runs with larger numbers of bends and/or fitting shall be increased by an equivalent length of tubing according to the following formula: L = 1.3 x (n) where L is the additional length of tubing necessary and n is the number of additional fittings and/or bends.

7.2 Natural Gas Sizing Tables

7.2 Natural Gas Sizing Tables

Table 7.1 Low Pressure (6 - 7 in w.c. with 0.5 in drop)

Maximum Capacity of DooBon Flexible CSST in Cubic Feet per Hour(CFH) of Natural Gas (Approximate 1000BTU per cubic foot)
Minimum Gas Pressure 6-7in w.c (¼ PSI) Pressure Drop 0.5in w.c. Based on a 0.6 specific gravity of gas

tube size	EHD	Tubing Length (ft)																			
		5	10	15	20	25	30	40	50	60	70	75	80	90	100	125	150	200	300	400	500
½″	18	100	71	59	51	46	42	37	33	30	28	27	26	25	24	21	19	17	14	12	11
¾″	25	283	200	163	141	127	116	100	89	82	76	73	71	67	63	57	52	45	37	32	28
1″	31	626	425	338	288	254	230	195	172	156	143	137	133	124	117	103	93	79	63	54	47

Table 7.2 Low Pressure (6 - 7 in w.c. with 1 in drop)

Maximum Capacity of DooBon Flexible CSST in Cubic Feet per Hour(CFH) of Natural Gas (Approximate 1000BTU per cubic foot)
Minimum Gas Pressure 6-7in w.c (¼ PSI) Pressure Drop 1in w.c. Based on a 0.6 specific gravity of gas

tube size	EHD	Tubing Length (ft)																			
		5	10	15	20	25	30	40	50	60	70	75	80	90	100	125	150	200	300	400	500
½″	18	132	95	79	69	62	57	50	45	41	38	37	36	34	32	29	27	23	19	17	15
¾″	25	406	287	234	203	182	166	143	128	117	108	105	101	96	91	81	74	64	52	45	41
1″	31	925	627	500	426	376	339	289	255	230	211	203	196	183	173	153	138	117	93	80	70

Table 7.3 Regulator Outlet (8 - 10 in w.c. with 3 in drop)

Maximum Capacity of DooBon Flexible CSST in Cubic Feet per Hour(CFH) of Natural Gas (Approximate 1000BTU per cubic foot)
Minimum Gas Pressure 8-10in w.c Pressure Drop 3in w.c. Based on a 0.6 specific gravity of gas

tube size	EHD	Tubing Length (ft)																			
		5	10	15	20	25	30	40	50	60	70	75	80	90	100	125	150	200	300	400	500
½″	18	222	160	132	116	104	96	84	75	69	64	62	60	57	54	49	45	39	32	28	25
¾″	25	692	493	404	351	314	288	250	224	205	190	1847	178	168	159	143	131	114	93	81	72
1″	31	1717	1165	928	790	697	630	536	473	427	392	377	363	340	321	283	256	218	173	148	130

Table 7.4 Medium Pressure (12 - 14 in w.c. with 6 in drop)

Maximum Capacity of DooBon Flexible CSST in Cubic Feet per Hour(CFH) of Natural Gas (Approximate 1000BTU per cubic foot)
Minimum Gas Pressure 12-14in w.c (½ PSI) Pressure Drop 6in w.c. Based on a 0.6 specific gravity of gas

tube size	EHD	Tubing Length (ft)																			
		5	10	15	20	25	30	40	50	60	70	75	80	90	100	125	150	200	300	400	500
½″	18	308	222	184	161	145	133	116	104	96	89	86	84	79	75	68	62	54	45	39	35
¾″	25	1058	764	631	552	497	456	398	359	329	306	296	287	272	259	233	214	187	154	135	121
1″	31	2536	1720	1371	1167	1030	930	791	698	631	579	557	537	503	474	418	378	321	256	218	192

Table 7.5 Elevated Pressure (2 PSI with 1 PSI drop)

Maximum Capacity of DooBon Flexible CSST in Cubic Feet per Hour(CFH) of Natural Gas (Approximate 1000BTU per cubic foot)
Minimum Gas Pressure 2 PSI Pressure Drop 1 PSI Based on a 0.6 specific gravity of gas

tube size	EHD	Tubing Length (ft)																			
		5	10	15	20	25	30	40	50	60	70	75	80	90	100	125	150	200	300	400	500
½″	18	577	408	333	289	258	236	204	183	167	154	149	144	136	129	115	105	91	75	65	58
¾″	25	1982	1421	1170	1019	915	839	730	656	601	558	540	524	495	471	423	387	337	278	242	217
1″	31	5870	4065	3279	2815	2501	2271	1950	1732	1573	1449	1397	1350	1269	1200	1066	968	831	670	575	511

Table 7.6 Elevated Pressure (5 PSI with 3.5 PSI drop)

Maximum Capacity of DooBon Flexible CSST in Cubic Feet per Hour(CFH) of Natural Gas (Approximate 1000BTU per cubic foot)
Minimum Gas Pressure 5 PSI Pressure Drop 3.5 PSI Based on a 0.6 specific gravity of gas

tube size	EHD	Tubing Length (ft)																			
		5	10	15	20	25	30	40	50	60	70	75	80	90	100	125	150	200	300	400	500
½″	18	1131	828	690	606	548	505	444	401	370	345	334	325	308	294	266	245	215	179	179	142
¾″	25	3855	2783	2300	2009	1809	1661	1451	1306	1199	1115	1080	1047	991	943	849	779	681	563	492	443
1″	31	1188	8228	6637	5698	5063	4596	3946	3506	3183	2934	2828	2733	2568	2428	2157	1959	1959	1357	1165	1035

Table 7.7 Propane Low Pressure (11 in w.c. with 0.5 in drop)

Maximum Capacity of DooBon Flexible CSST in Cubic Feet per Hour(CFH) of Natural Gas (Approximate 1000BTU per cubic foot)
Minimum Gas Pressure 11 in w.c (¼ PSI) Pressure Drop 0.5in w.c. Based on a 0.6 specific gravity of gas

tube size	EHD	Tubing Length (ft)																			
		5	10	15	20	25	30	40	50	60	70	75	80	90	100	125	150	200	300	400	500
½″	18	150	108	90	78	70	65	56	51	47	43	42	41	39	37	33	30	26	22	19	17
¾″	25	447	316	258	223	200	182	158	141	129	119	115	112	105	100	89	82	71	58	50	45
1″	31	990	672	535	455	402	363	309	273	246	226	217	210	196	185	163	147	125	100	85	75

Table 7.8 Propane Medium Pressure (13 - 14 in w.c. with 2.5 in drop)

Maximum Capacity of DooBon Flexible CSST in Cubic Feet per Hour(CFH) of Natural Gas (Approximate 1000BTU per cubic foot)
Minimum Gas Pressure 3-14 in w.c Pressure Drop 2.5in w.c. Based on a 0.6 specific gravity of gas

tube size	EHD	Tubing Length (ft)																			
		5	10	15	20	25	30	40	50	60	70	75	80	90	100	125	150	200	300	400	500
½″	18	322	232	192	168	151	139	121	109	100	93	90	87	83	79	71	65	57	47	41	37
¾″	25	1000	712	584	507	454	416	361	324	296	274	265	257	243	230	207	189	164	134	117	105
1″	31	2449	2449	1324	1127	994	898	764	675	609	559	537	518	485	458	404	365	310	247	211	186

Table 7.9 Propane Elevated Pressure (2 PSI with 1 PSI drop)

Maximum Capacity of DooBon Flexible CSST in Cubic Feet per Hour(CFH) of Natural Gas (Approximate 1000BTU per cubic foot)
Minimum Gas Pressure 2 PSI Pressure Drop 1 PSI Based on a 0.6 specific gravity of gas

tube size	EHD	Tubing Length (ft)																			
		5	10	15	20	25	30	40	50	60	70	75	80	90	100	125	150	200	300	400	500
½″	18	908	637	518	448	399	364	314	280	256	236	228	221	208	197	176	160	138	112	97	87
¾″	25	3259	2353	1945	1699	1530	1404	1226	1104	1014	943	913	885	838	797	718	659	576	476	416	374
1″	31	9279	6426	5183	4450	3954	3590	3082	2738	2486	2291	2209	2135	2005	1896	1685	1530	1313	1059	910	808

Table 7.10 Propane Elevated Pressure (5 PSI with 3.5 PSI drop)

Maximum Capacity of DooBon Flexible CSST in Cubic Feet per Hour(CFH) of Natural Gas (Approximate 1000BTU per cubic foot)
Minimum Gas Pressure 5 PSI Pressure Drop 3.5 PSI Based on a 0.6 specific gravity of gas

tube size	EHD	Tubing Length (ft)																			
		5	10	15	20	25	30	40	50	60	70	75	80	90	100	125	150	200	300	400	500
½″	18	2108	1491	1217	1054	943	861	745	667	609	563	544	527	497	471	422	385	333	272	236	211
¾″	25	7734	5469	4465	3867	3459	3157	2734	2446	2233	2067	1997	1934	1823	1729	1547	1412	1223	998	865	773
1″	31	20369	13912	11131	9502	8405	7603	6490	5741	5193	4771	4593	4433	4155	3921	3468	3137	2678	2143	1829	1618

Table 7.11 Gas with a Pressure of ½ PSI or less and a pressure drop of 0.5 in w.c.														
Maximum Capacity of Schedule 40 Metallic Pipe in Cubic Feet per Hour(CFH) of Natural Gas (Approximate 1000BTU per cubic foot) Minimum Gas Pressure 0.5 PSI Pressure Drop 0.5 in w.c. Based on a 0.6 specific gravity of gas														
tube size														
	10	20	30	40	50	60	70	80	90	100	125	150	170	200
¼″	43	29	24	20	18	16	15	14	13	12	11	10	9	8
⅜″	95	65	52	45	40	36	33	31	29	27	24	22	20	19
½″	175	120	97	82	73	66	61	57	53	50	44	40	37	35
¾″	360	250	200	170	151	138	125	118	110	103	93	84	77	72
1″	680	465	375	320	285	260	240	220	205	195	175	160	145	135
1¼″	1400	950	770	660	580	530	490	460	130	400	360	325	300	280
1½″	2100	1460	1180	990	900	810	750	690	950	620	550	500	460	430
2″	3950	2750	2200	1900	1680	1520	1400	1300	1220	1150	1020	950	850	800
2½″	6300	4350	3520	3000	2650	2400	2250	2050	1950	1850	1650	1500	1370	1280
3″	11000	7700	6250	5300	4750	4300	3900	3700	3450	3250	2950	2650	2450	2280
4″	23000	15800	12800	10900	9700	8800	8100	7500	7200	6700	6000	5500	5000	

8. Definitions

CSST : Stainless steel corrugated pipe for gas
A.G.A : American Gas Association
C.S.A : Canadian Standards Association
ANSI Z223.1 1988 : The 1988 edition of the National Fuel Gas Code published by American National Standard Institute. Also known as NFPA 54 (National Fire Protection Association).
Appliance (Equipment) : Any device which utilizes natural gas or propane as a fuel or raw material to produce light, heat, power, refrigeration or air conditioning.
Approved : Acceptable to the authorities having jurisdiction.
Authority Having Jurisdiction : The organization, office or individual responsible for "approving" equipment, an installation or a procedure.
BTU : Abbreviation for British Thermal Unit, which is the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit.
CFH : Gas flow rate stated in cubic feet per hour.
Design Pressure : The maximum operating pressure permitted by this document, as determined by the design procedures applicable to the materials involved.
Drip Leg : The container (dirt trap pocket) placed at a low point in a system of piping to collect and remove foreign material or condensation.
EHD (Effective Hydraulic Diameter) : A relative measure of flow capacity used to compare individual sizes between different manufacturers. The higher the EHD number the greater flow capacity of the piping.
Full Lockup : The capability of totally stopping the flow of gas if the load goes to zero, thus preventing the downstream pressure from increasing more than a certain upper limit pressure above the set point.
Header (manifold) : A pipe or fitting to which a number of branch lines are connected.
ID : Inside diameter of pipe or tubing.
Inches (") w.c. : Method of stating pressure measured in inches of water column by a manometer or pressure gauge. Commonly used in the gas industry when the pressure is less than one (1) PSI.
1 PSI = 28 in. w.c. ½ PSI = 14 in. W.C. ¼ PSI = 7 in. w.c.
Load : The amount of gas in CFH required by an appliance, or group of appliances, per their rating plate.
LP Gas : Liquefied petroleum. Fuel gas that is stored and transported in a liquid state, i.e., propane, butane, and mixtures of these and other heavier hydrocarbons.
MBTU : 1,000 BTUs. See BTU above.
Meter : An instrument installed to measure the volume of gas delivered through a piping system.
OD : Outside Diameter of pipe or tubing.
Piping : As used in this document, either pipe or tubing, or both. Pipe is a rigid conduit of iron, steel, copper, brass or aluminum, while tubing is a semi-rigid conduit of corrugated stainless steel.
Pressure : Unless otherwise stated, is expressed in pounds per square inch (PSI) above atmospheric pressure (i.e. gauge pressure).
Pressure Drop : The loss in static pressure of gas due to friction or obstruction in tubing, valves, fittings, regulators and burners.
Pressure Regulator : A device that reduces and controls pressure. It automatically opens and closes in response to changing pressure conditions in the downstream piping.
PSI : Pounds per square inch gauge. The pressure, as read from a measurement gage or device. Gauge pressure is pressure above atmospheric pressure.
Purge : To displace the original air, or gas, or a mixture of gas and air in a gas conduit with a new air/gas mixture.
Regulator, Appliance : A device for controlling and maintaining a uniform pressure to the manifold of gas burning equipment. This valve is typically part of the appliance. It reduces the pressure from 5.5" w.c. to the manifold pressure in the appliance.

Regulator, Line Gas Pressure (PSI to inches w.c.) : A device placed in a gas line between the service regulator and the appliance regulator for controlling, maintaining or reducing the pressure in that portion of the piping system downstream of the device. This valve reduces the house line pressure (typically 2 PSI) to the regulator manifold pressure (typically 8-10" w.c.).

Regulator, Service (PSI or inches w.c.) : A device installed by the serving gas supplier to reduce and limit the service line gas pressure. This valve reduces the service pressure to the metering pressure. It is located upstream of the gas meter.

Regulator Vent : The opening in the atmospheric side of the regulator housing permitting the in and out movement of air to compensate for the movement of the regulator diaphragm.

Specific Gravity : As applied to gas, the ratio of the weight of a given volume to that of the same volume of air, both measured under the same conditions.

Valve, Manual Shut-off : A valve (located in the piping system and readily accessible and operable by the consumer) used to shut off individual equipment.

Vent Limiter Device Restriction/orifice type device in the vent outlet of a pressure regulator that controls or limits leakage, in the event of a diaphragm leak. It also allows the diaphragm to move freely to control pressure.

I, _____, have read the DooBon Flexible
Please PRINT Your Name Here

System Design & Installation Manual, and understand the DooBon Flexible CSST installation requirements.

I am a Qualified Installer of gas plumbing per the governing local authority at the location where DooBon Flexible CSST is to be installed, and am aware of all local. plumbing and/or building codes applicable to this location.

Signed this day ____ / ____ / _____
MM DD YYYY

Installer No :

Signature of Qualified Installer

Company : _____

Address : _____

Phone : _____

E-Mail : _____

- Please send this document to
  (1) FEX number ' 00-00-000-0000 ' or
  (2) E-mail ' info@iflexcsst.com '

- I will send you an authentication card by E-mail.

Warranty and Contact Information

1) Warranty