



# **Diamondback**

**FLEXIBLE GAS PIPING**

## **DESIGN GUIDE & INSTALLATION INSTRUCTION MANUAL**

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## CHAPTER 1.0: INTRODUCTION

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**USER WARNING! Please read all instructions before starting installation. Improper installation can result in serious damage, injury and/or death.**

The words "SHALL" or "MUST" indicate a requirement which is essential to satisfactory and safe product performance. The words "SHOULD" or "MAY" indicate a recommendation or advice which is not essential and not required, but which may be useful or helpful.

DIAMONDBACK™ flexible gas piping, by Tecvalco Ltd., must only be installed by a person who is qualified through the DIAMONDBACK™ Gas Piping Installation Program. Any installer must also meet qualifications in accordance with provincial, state, and/or local requirements as established by the administrative authority which enforces the plumbing or mechanical code which the gas piping is installed.

Due to the explosive nature of fuel gas, it can be dangerous. It may cause injury to persons or damage to property. Improper installation of fuel gas piping could cause explosions, fires, or death. Sound engineering practices and principles must be exercised, as well as diligent adherence to the proper installation procedures for the safe operation of the piping system.

Precautions must be taken by the installer to ensure that the tubing is not damaged or abused during the construction process. The tubing ends must be plugged or sealed prior to installation to prevent moisture, dirt or debris from entering. Contact with sharp objects or harmful substances, including, but not limited to, acids and solvents, must be avoided. Sharp bends, stretching, kinks, twisting or undue stress or strain on the tubing and fittings must be avoided. All installed systems must pass customary installation inspections by the local building official having authority prior to being placed into service. If the piping system installation requires components in addition to those supplied by Tecvalco Ltd., the installation instructions shall specify the specific components required. The instructions shall state that the only components provided or specified by Tecvalco Ltd. are to be used in the installation.

The use of DIAMONDBACK™ flexible gas piping with any other flexible gas tubing system is inappropriate. The guidelines set forth must be used in conjunction with provincial, state and local building codes. **Local codes will take precedence in the event of a conflict between this manual and the local code.** In the absence of local codes, installation must be in accordance with the current edition of NATIONAL FUEL GAS CODE, ANSI Z223.1/NFPA 54 (USA), or INSTALLATION CODES CAN/CGA-B149.1 & B149.2 (Canada).

**WARNING:** The Installer Must Follow the Installation Instructions Exactly

**This system must be installed with strict adherence to this guide as well as local building codes.** Tecvalco Ltd. shall have no responsibility for any misinterpretation of the information contained in this guide or any improper installation or repair work or for other deviation from the procedures recommended in this manual, whether pursuant to local building codes or engineering specifications or otherwise.

This system and related components must be used only with fuel gases, only where the operating gas pressure does not exceed 5 PSI. The maximum actual operating pressure including transients shall not in any case exceed 6.5 PSI.

## LIMITATIONS OF MANUAL

This document is intended to aid the user in the design, installation and testing of DIAMONDBACK™ Corrugated Stainless Steel Tubing (CSST) that is used to distribute fuel gas in residential housing units and light commercial applications. It is not possible for this guide to anticipate and cover every possible variation in housing configurations and construction styles, appliance loads and local restrictions. Therefore, there will be applications which are not covered in this guide. For applications beyond the scope of this guide, contact the DIAMONDBACK™ distributor for the area or Tecvalco Ltd. for assistance. The techniques included within this guide are recommended practice for generic applications. These practices must be reviewed for compliance with all applicable local fuel gas and building codes. Where conflict exists between the recommended practice and local requirements, local requirement must take precedence unless a variance is obtained from the local authority having jurisdiction. This system and related components must be used only as fuel gas piping where the operating gas pressure does not exceed 5 PSI (34.48 kPa).

## DIAMONDBACK™ APPLICATIONS

The use of DIAMONDBACK™ is not restricted by the style, size, age, type of construction, height, or physical layout of the building where fuel gas service is to be installed. DIAMONDBACK™ can be used in both residential and light commercial applications, as well as new construction and retrofitting applications. The requirements of this guide, in regard to system design, installation, inspection and testing, are the same regardless of building application.

- The installer must meet local building codes with respect to flame spread and smoke density regulations for non-metallic materials. DIAMONDBACK™ must not be routed in or through heating and cooling ductwork.
- DIAMONDBACK™ flexible gas piping can be used to provide outdoor connections to appliances that are attached to, or in close proximity to the building.
- DIAMONDBACK™ flexible gas piping can be routed in most locations where traditional gas piping materials are installed: inside hollow wall cavities, along or through floor joists in basements, on top of the joists in attics, on roof tops or along soffits or in chases outside of buildings.
- DIAMONDBACK™ flexible gas piping can be run directly to the shut off valves of most fixed appliances without installing an appliance connector. For movable appliances such as ranges or dryers, the use of an approved flexible appliance connector is required. DIAMONDBACK™ cannot be substituted as a connector for this use when the appliance is free to move for cleaning, etc.
- DIAMONDBACK™ flexible gas piping can be used for Natural gas and propane (Liquefied Petroleum gas) and other fuel gases recognized in ANSI Z223.1/NFPA 54 National Fuel Gas Code.
- For underground or concrete burial, the flexible gas piping run must be encased in a sleeve of PVC, polyethylene, or other approved water resistant material
- DIAMONDBACK™ flexible gas piping can be used in conjunction with black iron pipe in either new construction or renovation and replacement piping to interface with appliances , valves, tees, unions and couplings.

## LISTING OF APPLICABLE CODES & STANDARDS

REGIONAL/MODEL CODES LISTING CSST AS AN ACCEPTABLE GAS PIPING MATERIAL:

- ANSI LCI • CSA 6.26 Standard
- CANADA – CAN B149.1 Natural GAS AND B149.2 Propane
- NFPA 54/ANSI Z 223.1 National Fuel Gas Code
- ICBO – Uniform Mechanical Code
- BOCA – National Mechanical Code
- CABO – and 2 Family Dwelling Code
- SBOCCI – Standard Gas Code
- ICC – International Mechanical Code
- IAPMO – Uniform Plumbing Code
- IAPMO – File Listing #C-3859
- City of Los Angeles Research Report #RR5506

In Canada, the installation of ANSI/CSA certified DIAMONDBACK™ flexible gas tubing for natural and propane gas piping systems must be in accordance with the applicable sections of the current CAN/CGA-B149.1 or .2 installation codes, and the requirements or codes of the local utility or other authority having jurisdiction. All gas components used in conjunction with the gas tubing must be certified for use in Canada.

DIAMONDBACK™ has been tested to the ANSI standard for Fuel Gas Piping Systems using Corrugated Stainless Steel Tubing. ANSI LC1 • CSA 6.26-1997 Addendum ANSI LC1a • CSA 6.26a-1999; LC1b-2001 and the CAN/CGA Certification Laboratories Requirements LAB-009. "FLEXIBLE GAS TUBING FOR NATURAL AND PROPANE PIPING SYSTEMS."



### CODE CAUTION

This document is intended only to provide the installer with general guidance and assistance when designing and installing a DIAMONDBACK™ corrugated stainless steel tubing (CSST) fuel gas system. While every effort has been made to prepare this document in accordance with the regional model codes in effect at its printing, Tecvalco Ltd. assumes no responsibility for labor or materials which have been installed without prior determination of local code authority acceptance.

## CHAPTER 2.0: DESCRIPTION OF SYSTEM & COMPONENTS

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### SYSTEM DESCRIPTION

A. **The DIAMONDBACK™ system has a number of hardware and design differences from conventional gas piping system using black iron pipe.** These differences can be described as follows:

- The DIAMONDBACK™ system uses flexible annular corrugated tubing made of 300 series stainless steel.
- The tubing is connected using special mechanical fittings designed for Tecvalco Ltd.'s DIAMONDBACK™
- In many applications, the tubing is sized for individual gas appliance loads and is, therefore, usually smaller in diameter. The tubing is often piped in parallel from a central distribution manifold rather than in series, as is common with black iron systems.
- The system can be used for elevated pressure systems up to 5 PSI (34.48kPa).
- Different handling and installation procedures are required during installation.
- DIAMONDBACK™ can be used for a both low pressure (below 0.5 PSI (3.45kPa)) system and an elevated (5.0 PSI (34.48kPa)) pressure system design. It complies with eh ANSI/CSA LC-1 standard and is approved for fuel gas applications.

B. **DIAMONDBACK™ Corrugated tubing may be installed in combination with other approved fuel gas piping materials using approved threaded couplings, unions, elbows, tees or terminations at the inter-face.**

- DIAMONDBACK™ may be used like black iron pipe in low pressure gas piping systems (12 in w.c. (22.42 mmHg) or less). However, an elevated pressure system will allow the use of smaller tubing sizes. An elevated pressure system typically operates at 2-5 PSI (13.79 – 34.48 kPa) gas pressure from the meter regulator to an intermediate line regulator/central distribution manifold. At that point, the pressure is reduced to a lower pressure (7 in w.c. (13.07 mmHg)). Independent tubing runs, operated at low pressure, connect each appliance to the distribution manifold.

C. **Using FIG. 2-1 as a guide, the elevated pressure system can be described as follows:**

- An elevated pressure DIAMONDBACK™ system uses a distribution arrangement consisting of a shut-off valve, pressure regulator and multi-port manifold.
- Gas is delivered to the housing unit or building at street pressure which is then reduced at the service regulator.
- The entire gas load is piped by a single line through an approved shut off valve, then through an approved line regulator where the pressure is reduced. At this point it enters a centrally located distribution manifold where the gas is distributed to each individual appliance (or small group of appliances) through independent DIAMONDBACK™ tubing lines.
- The tubing is then connected to each appliance according to local codes (e.g. drip legs, flexible appliance connector, hard piping).
- Any extra ports in the manifold are plugged until additional gas appliances are added. It is advisable to put a valve in the extra ports and then plug the valve outlet. This extra port can then be used for future expansion without turning off the existing system.

D. **The choice of system configuration is dependent on local piping restrictions, structural arrangement, availability of elevated pressure, and the total gas load.**



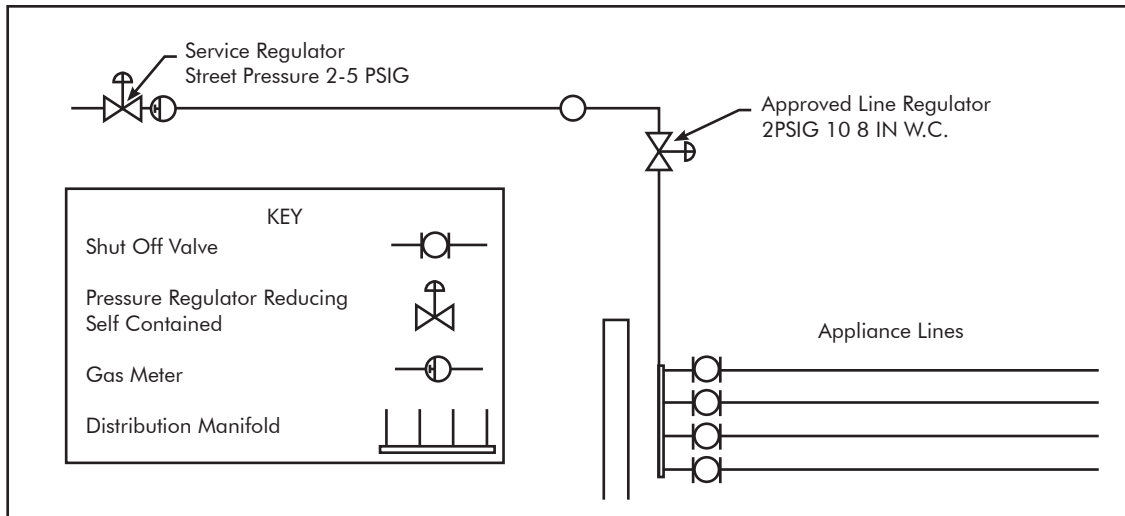


FIG. 2-1 Elevated Pressure System Arrangement

## HARDWARE DESCRIPTION

This gas piping system using DIAMONDBACK™ corrugated stainless steel tubing consists of the following components:

- DIAMONDBACK™ Corrugated Stainless Steel Tubing (CSST)
- Mechanical Joint Fittings
- Steel Indoor Termination Fittings
- Brass outdoor Termination Fittings
- Mechanical Couplings
- Manifolds
- Striker Plates
- Gas Pressure Regulators (For Dual/Elevated Pressure System)
- Shut-Off Valves
- Black Iron Pipe, Fittings and Nipples (if selected)
- Strip Wound Metal Conduit
- Termination Brackets
- Manifold Brackets

The tubing is jacketed with yellow polyethylene sleeve which provides ease of running through joists, studs, and other building components. The jacket is marked at one foot intervals with the amount of tubing left on the reel, for quick measurement. The yellow colour is the international designation for fuel gas.

The regulator, for reducing pressure from Pounds Per Square Inch (PSI) to inches of water column is used in elevated pressure system installations over 12 in. w.c. (22.42 mmHg).

Elevated pressure shut off valves are used in systems with supply gas pressures ranging from 2 PSI (13.79 kPa) up to 5 PSI (34.48kPa). Use only valves which comply with IAS U.S. Requirement 3-88 and/or CR 91-002. Valves complying with this requirement but not complying with ASME B16.33 and/or CGA 3.11 shall not be installed outdoors.

The Four-Port Manifold allows parallel installations with individual runs or “home runs” to each appliance. Protection devices (striker plates and spiral wound conduit) are used where DIAMONDBACK™ piping passes through studs, joist and other building materials and is restricted from moving to avoid nails, screws and other puncture threats. There are four striker plate configurations made from specially hardened steel to resist penetration from screws and pneumatic nail guns. In addition, spiral wound steel “floppy” conduit is available for use in areas where striker plates cannot be used.

## TUBING

### DIAMONDBACK™ Flexible Gas Tubing

Material: 300 Series Corrugated Stainless Steel with Polyethylene Jacket.



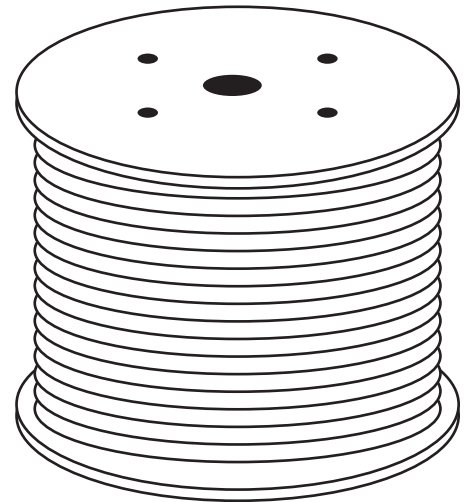
Part No.	375 DFT	500DFT	750DFT	1000DFT	1250DFT
Size	3/8" (10)	1/2" (13)	3/4" (19)	1" (25)	1 1/4" (32)
EHD*	15	19	25	31	37
Jacket O.D. (max)	.617"	.781"	1.050"	1.346"	1.606"
I.D. (nominal)	0.464"	0.610"	0.844"	1.092"	1.327"
O.D. (nominal)	0.585"	0.748"	1.023"	1.307"	1.582"

\*EHD (Effective Hydraulic Diameter): A relative measure of flow capacity.

### DIAMONDBACK™ On Reels

Material: 300 Series Corrugated Stainless Steel with Polyethylene Jacket. Packaged on Plywood Reels  
Used to convey gas.

Part No.	375 DFT	500DFT	750DFT	1000DFT	1250DFT
Size	3/8" (10)	1/2" (13)	3/4" (19)	1" (25)	1 1/4" (32)
Reel Length	250 ft. (76.20m)	250 ft. (76.20m)	250 ft. (76.20m)	150 ft. (45.72m)	125 ft. (38.10m)
Weight	30 lbs. (13.61kg)	40 lbs. (18.14kg)	58 lbs. (26.31kg)	48 lbs. (21.77kg)	70 lbs. (31.75kg)

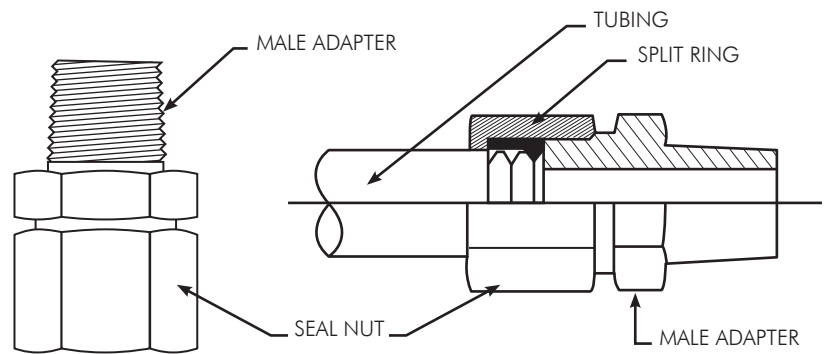


## FITTINGS

### Straight Mechanical Joint Fitting

Material: CA360 Brass

Used to connect DIAMONDBACK™ tubing to a manifold or gas outlet.

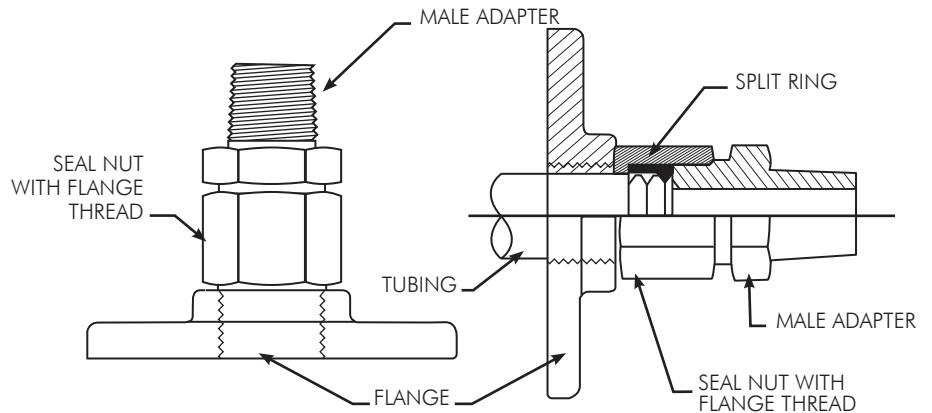


Part No.	375 DFT	500DFT	750DFT	1000DFT	1250DFT
Size	3/8" (10)	1/2" (13)	3/4" (19)	1" (25)	1 1/4" (32)
Pipe Thread (NPT)	1/2	1/2	3/4	1	1 1/4

### Straight Flange Mount Termination Fitting

Material: CA360 Brass Fitting  
Indoor: Black Iron Flange  
Outdoor: Brass Flange

Used for wall/floor termination for appliance connector

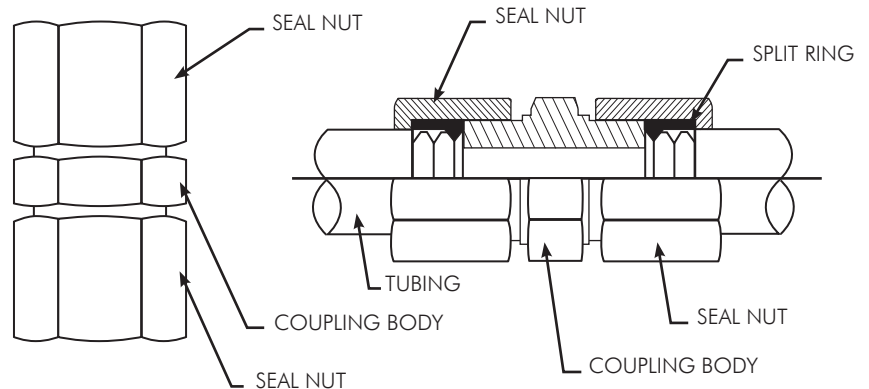


CA360 Brass Part No's.	375DBFF	500DBFF	750DBFF	1000DBFF	1250DBFF
Black Iron Part No's.	375DBFF	500DBFF	750DBFF	1000DBFF	1250DBFF
Fitting Size	3/8"(10)	1/2"(13)	3/4"(19)	1"(25)	1 1/4"(32)
Pipe Thread (NPT)	1/2	1/2	3/4	1	1 1/4

### Mechanical Coupling

Material: CA360 Brass

Used to connect two DIAMONDBACK™ tubes of the same size

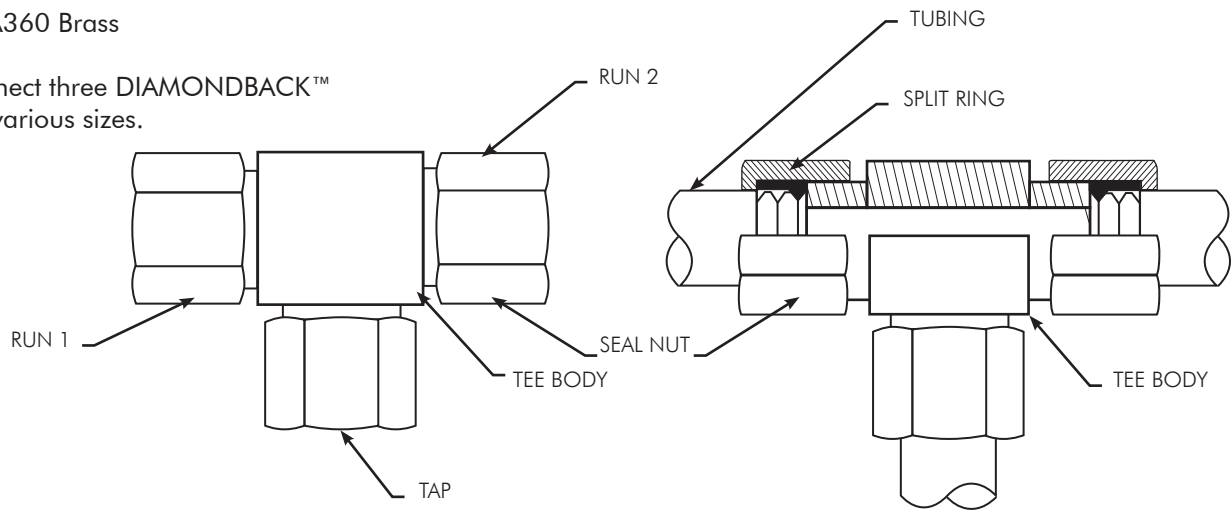


Part No.	375 DFT	500DFT	750DFT	1000DFT
Fitting Size	3/8"(10)	1/2"(13)	3/4"(19)	1"(25)

## Tee Fittings

Material: CA360 Brass

Used to connect three DIAMONDBACK™ tubes of the various sizes.

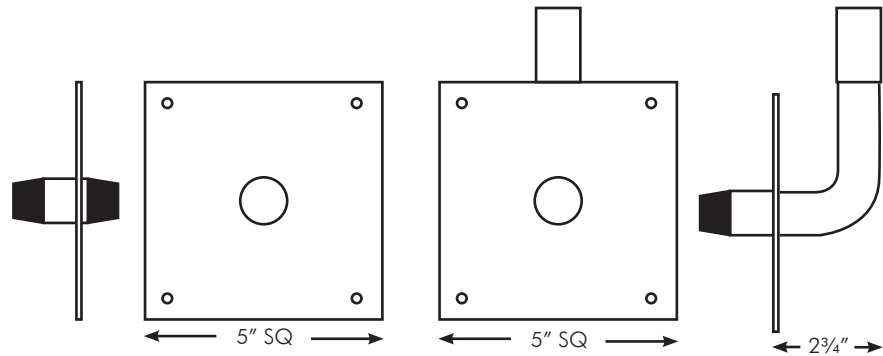


Part No.	DT555	DT7555	DT75575	DT17575	DT151	DT1751
Run 1 Size	1/2" NPT	3/4" NPT	3/4" NPT	1" NPT	1" NPT	1" NPT
Tap Size	1/2" NPT	1/2" NPT	1/2" NPT	3/4" NPT	1/2" NPT	3/4" NPT
Run Size 2	1/2" NPT	1/2" NPT	3/4" NPT	3/4" NPT	1" NPT	1" NPT

## Stub-Out Fitting

Material: Black Iron

Used for the termination of gas line.

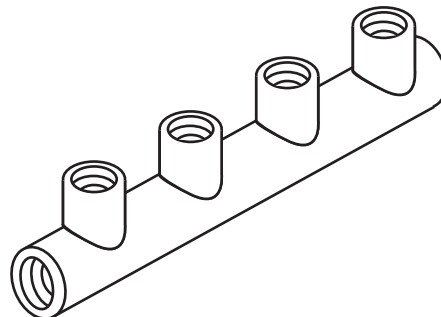


Part No.	500DTF	500D90TF	750DTF
Fitting Size	1/2"(13)	1/2"(13)	3/4"(13)
Piping Thread (NPT)	1/2	1/2	3/4

## Multi-port Manifolds

Materials: Carbon Steel

Used to route DIAMONDBACK™ tubing to multiple appliances.



Part No.	500DSM	750DSM
Outlet	4 Port 1/2" NPT Female	4 Port 1" NPT Female
Inlet	3/4" NPT Female	1 1/4" NPT Female

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### Line Pressure Regulator

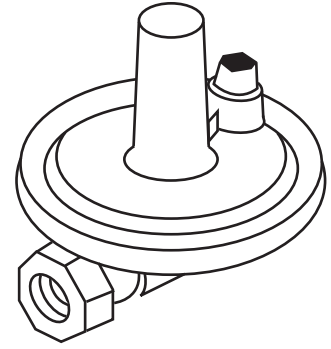
0.5 PSI - 2.0 PSI (3.45 kPa - 13.79 kPa) Per ANSI Z21.80

Materials: Cast Aluminum Housing Suitable for Outdoor Use

Used to control line pressure.

\* Must be vented outdoors

Part No.	500DR3N	500DR3P	750DR5A	~
Model No.	325-3L/Type90	325-3LP	325-5A/Type95	325-7L*
Port Size	1/2" x 1/2" NPT	1/2" x 1/2" NPT	3/4" x 3/4" NPT	1 1/4" x 1 1/4" NPT
Vent Size	1/5" NPT	1/8" NPT	3/8" NPT	1/2" NPT
Fuel Type	Natural Gas	Propane Gas	Natural Gas	Natural Gas



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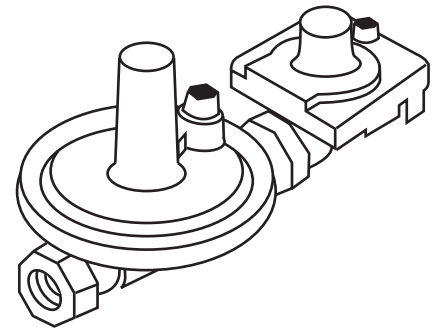
### Line Pressure Regulator w/ OPD

2.0 PSI - 5.0 PSI (13.79 kPa - 34.48 kPa) Per ANSI Z21.80

Materials: Cast Aluminum Housing Suitable for Outdoor Use

Used to control line pressure.

Part No.	500DR3XN	750DR5XA
Model No.	325-3L47	325-5AL48
Port Size	1/2" x 1/2" NPT	3/4" x 3/4" NPT
Vent Size	1/8" NPT	3/8" NPT
Fuel Type	Natural Gas	Natural Gas



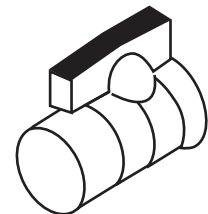
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### Elevated Pressure Shut-off Valves

Materials: Brass housing with stainless steel ball.

Used to close supply of fuel to an appliance.

Part No.	500DBV	750DBV
Port Size	1/2" x 1/2" NPT	3/4" x 3/4" NPT
Tubing Sizes	3/8"(10) & 1/2"(13)	3/4" (19)



## STRIKER PLATES

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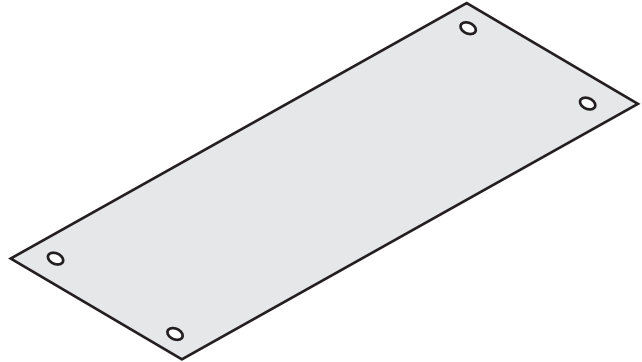
### Large Striker Plate

Part No. DSPX

Materials: 16 Gauge Hardened Steel

Size: 6 1/2" x 17" (165 x 432)

Used to protect tubing from puncture at areas of support.



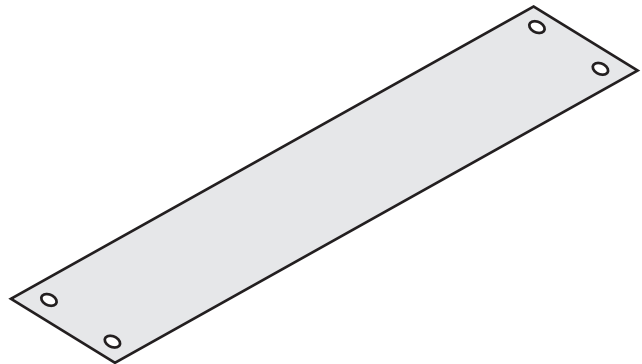
### Full Striker Plate

Part No. DSPF

Materials: 16 Gauge Hardened Steel

Size: 3 1/2" x 11 1/2" (89 x 292)

Used to protect tubing from puncture at areas of support.



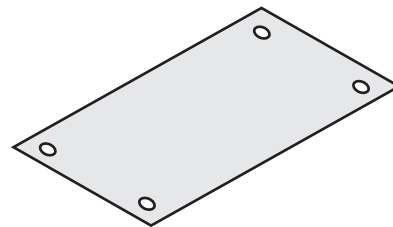
### Half Striker Plate

Part No. DSPH

Materials: 16 Gauge Hardened Steel

Size: 3 1/2" x 6 1/2" (89 x 165)

Used to protect tubing from puncture at areas of support.



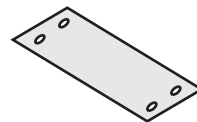
### Quarter Striker Plate

Part No. DSPQ

Materials: 16 Gauge Hardened Steel

Size: 3 1/2" x 1 1/2" (89 x 38)

Used to protect tubing from puncture at areas of support.

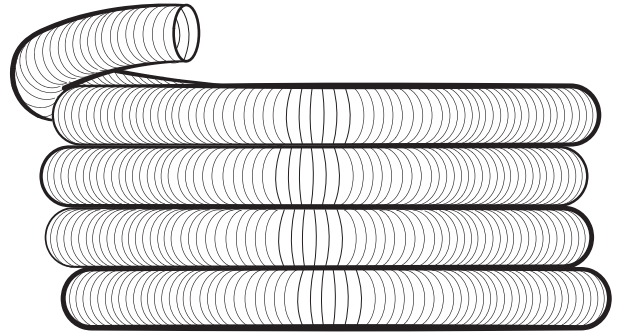


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## Floppy Strip Wound Conduit

Materials: Type RW Galvanized Steel

Used to protect tubing from puncture in area of support.



Part No.	375DFC	500DFC	750DFC	1000DFC	1250DFC
Fits Sizes	3/8" (10)	1/2" (13)	3/4" (19)	1" (25)	1 1/4" (32)
Length	50' Roll (15.24m)	50' Roll (15.24m)	50' Roll (15.24m)	25' Roll (7.62m)	25' Roll (7.62m)

Part No.	375DFC	500DFC	750DFC	1000DFC	1250DFC
Fits Sizes	3/8" (10)	1/2" (13)	3/4" (19)	1" (25)	1 1/4" (32)
Length	50' Roll (15.24m)	50' Roll (15.24m)	50' Roll (15.24m)	25' Roll (7.62m)	25' Roll (7.62m)

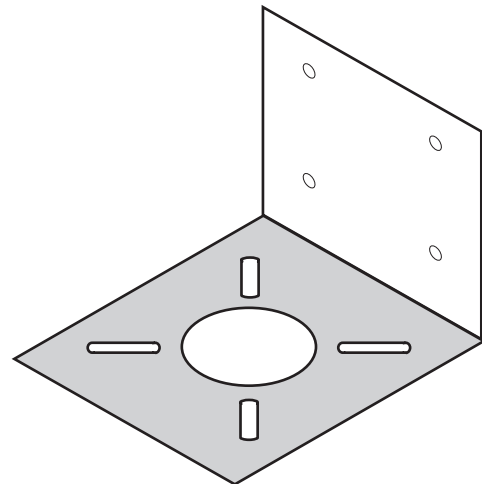
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## Termination Outlet Bracket

Part No. DTMB

Materials: 16 gauge galvanized steel.

Used for mounting all flange adapter fittings to studs during rough installation.



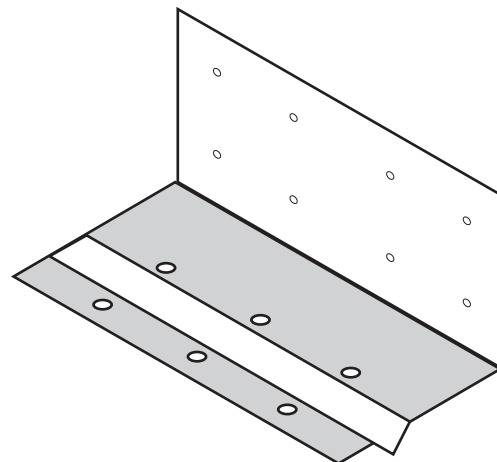
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## Manifold Mount Bracket

Part No. DMB

Materials: 16 gauge galvanized steel.

Used for mounting manifolds to studs during rough installation.



# CHAPTER 3.0: SYSTEM CONFIGURATIONS & SIZING

## 3.1 CONFIGURATIONS

- Series & Parallel Low Pressure Systems

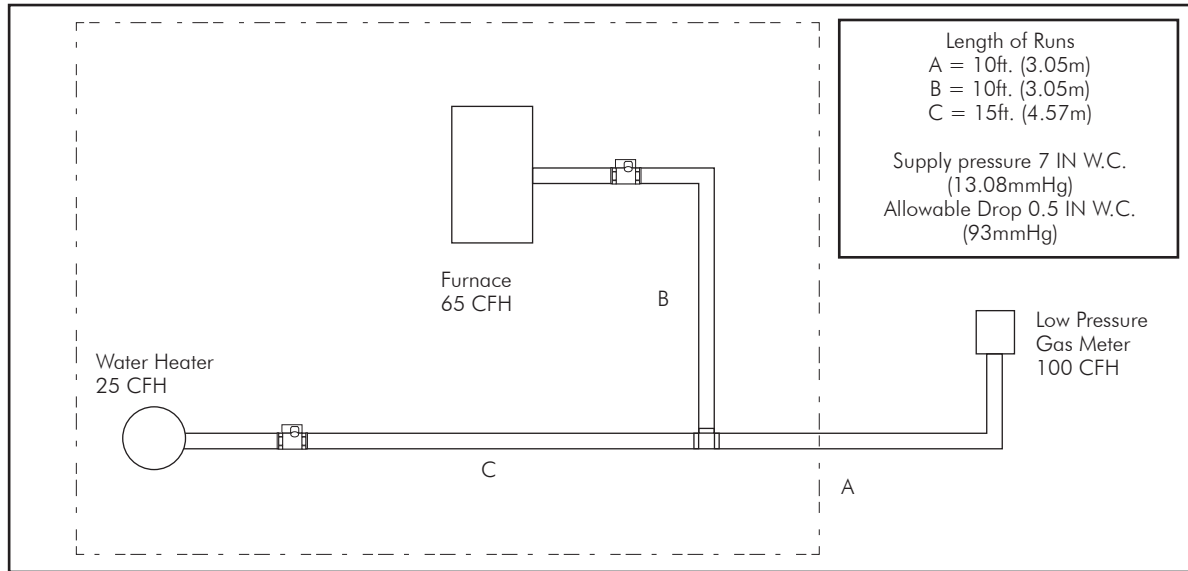
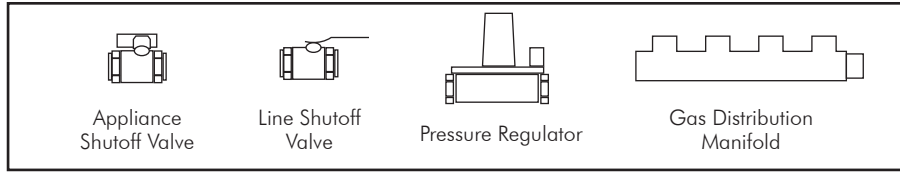


FIG. 3-3 Example Pressure System, 7 IN. W.C. (13.08mmHg), Series Arrangement

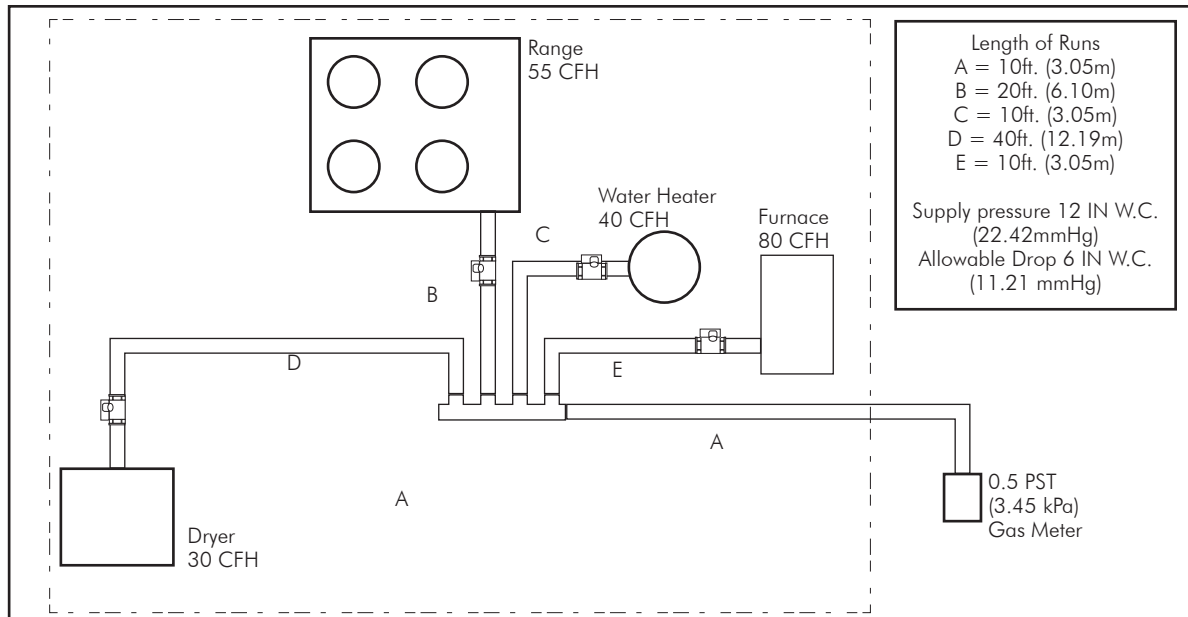


FIG. 3-3 Example 2 - Low Pressure System, 12 IN. W.C. (22.42mmHg) Parallel Arrangement



- **Dual Pressure Systems**

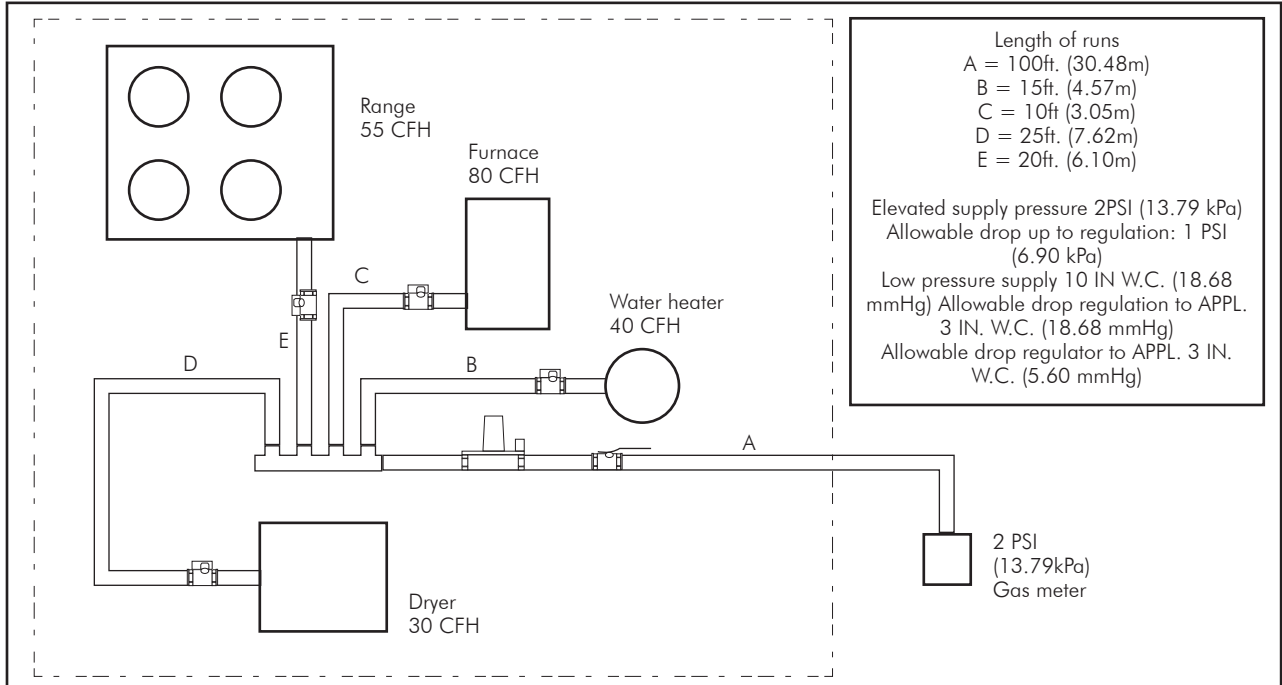


FIG. 3-4 Example 3 - Elevated/Dual Pressure System, 2PSI (13.79 kPa), Parallel Arrangement

### 3.2 SIZING METHODS AND EXAMPLES

This chapter includes flexible gas piping sizing procedures for both low pressure and elevated pressure systems. Every piping system introduces pressure loss to the fuel gas flowing within. The amount of loss depends on the piping size and the flow, expressed in cubic feet per hour (CFH), and converted to BTU's. The objective of the sizing exercise is to determine the allowed pressure loss or drop within the length of piping required.

#### Use of Sizing Tables

Chapter 7 of this manual consists of fuel gas pipe sizing tables. These tables are required to determine the minimum size fuel gas pipe for each part of a fuel gas system. To use these tables you will need to know the supply gas pressure, the CFH requirement on the section of the system and the length, in feet, of the piping run.

The tables are listed by the supply gas pressure and the allowable gas pressure drop. For example, the low pressure system call out a 7 in. w.c. (13.08mmHg) supply pressure with a 0.5 in. w.c. (.93mmHg) pressure drop.

Find the correct table. On the table, find the column with the "length in feet" of the gas pipe run you are looking for. (if the length you are looking for is not on the list go to the next longer length.) Check the CFH ratings of the fuel gas pipe until you find which one will handle the CFH requirement at the determined length. Match that CFH rating to the corresponding size of pipe.

Chapter 3.2 of this manual gives examples of this procedure.

#### **Longest Run Method (Low/Medium Pressure Systems) – FIG. 3-2 and 3-3**

The low pressure series system (conventional arrangement) is sized in the same way as a conventional low pressure black iron pipe system using the sizing tables. This method is known as the **longest run method**. Pressure drop in a low pressure system is usually limited to 0.5 in. w.c. (.93mmHg) over the system. Medium pressure systems can have pressure drops of up to 6 in. w.c. (11.21 mmHg).

### Elevated/Dual Pressure Systems – FIG. 3-4

Elevated pressure systems incorporate two operating pressures downstream of the gas utility meter set. The first pressure, set by the service regulator at the meter, is usually 2 PSI (13.79kPa). This part of the system is sized separately and ends at the pounds-to-inches line regulator. The allowable pressure loss for this part of the system must be added to the effect of the regulator to determine the available pressure at the regulator outlet. Table 3-5 below shows pressure losses for maximum loads through the regulator.

For a PSI (13.79 kPa) system, the proper drop is usually 1 PSI (6.90 kPa) for this part of the system. This allows for the approximate 0.75 PSI (5.17 kPa) regulator to drop downstream and provides the 0.25 PSI (1.72 kPa) (6-7 in. w.c. (11.21 – 13.08 mmHg)) necessary for appliances. The regulator reduces the pressure from pounds per square inch to inched water column (in. w.c.). This part of the system is sized the same as a low pressure system, except that a special Table N-3 is used allowing 3 in. w.c. (5.60mmHg) drop. These lines are typically sized for only one appliance as a ‘home-run’ from the manifold.

**Note: At 250CFH gas flow the Maxitrol 325-3L or O.A.R.A. Type 90 regulator contributes 0.75 PSI (5.17 kPa) drop to the system (see Table 3-5). The low pressure part of the system downstream of the regulator requires the standard 0.25 PSI (1.72 kPa) to power appliances. Deducting the 0.75 PSI (5.17 kPa) drop for the regulator and the .025 PSI (1.72 kPa) load for the appliances, the maximum allowable drop[ for the gas meter run is 1 PSI (6.90 kPa).**

**For example, start with 2 PSI (13.79 kPa), 075. PSI (5.17 kPa) drop for regulator and 0.25 PSI (1.72 kPa) to run the appliances, this results in 1 PSI (6.90 kPa) drop for Section A.**

Model	7 in. w.c. (13.08mmHg)	0.5 PSI (3.45kPa)	0.75 PSI (5.17kPa)	1PSI (6.90kPa)
Maxitrol 325-3L	145CFH	204CFH	250CFH	289CFH
Maxitrol 325-5AL	338CFH	476CFH	583CFH	673CFH
Maxitrol 325-7L	690CFH	972CFH	1191CFH	1375CFH
O.A.R.A Type 90	155CFH	220CFH	280CFH	310CFH
O.A.R.A Type 95	359CFH	504CFH	627CFH	719CFH

### SIZING EXAMPLES

To size each of the following systems, determine the required size for each section and outlet. To size each section of the system, determine both the local gas load for all appliances and the maximum distance (longest run) in which a particular section delivers gas.

#### Example 1 – Low Pressure System, 7 in. w.c. (13.08 mmHg) Series Arrangement

- The system presented in FIG. 3-2 is typical of a single family installation in which there are a limited number of appliances located in one general area. The supply pressure is 7 in. w.c. (13.08 mmHg) and the allowable drop is 0.5 in. w.c. (.93mmHg).
- To size Section A, determine the longest run (the longest run is the length from the meter to the furthest appliance) and total gas load for each appliance in cubic feet per hour (CFH), 1 CFH = 1000 BTU:
  - Meter to Furnace = A + B = 10 + 10 = 20 ft. (3.05m +3.05m = 6.10m)
  - Meter to Water Heater = A + C = 10 + 15 = 25 ft. (3.05m + 4.57m = 7.62m) This is the longest run.
  - Total Load = Furnace + Water Heater = 65 + 35 = 100 CFH (100,000 BTU)
  - Select Table N-1 (Page ??) “7 in. w.c. with 0.5 in. w.c. drop (13.08mmHg with .93 mmHg drop).” Using the longest run method, select the column showing the measured length, or the next longest length if the table does not give the exact length. Referring to Table N-1, the column for 25 ft. (7.62m) of piping shows that sizes 3/8” (10) and 1/2” (13) are too small and the next available size is 3/4” (19) with a maximum capacity of 158 CFH. The correct size is 3/4” (19).

3. To size Section B, determine the length of run from the Meter to the Furnace and the load delivered:
  - Length = A + B = 10 + 10 = 20 ft. (3.05m + 3.05m = 6.10m), Load = 65 CFH (65,000 BTU)
  - Table N-1 shows that size ½" (13) supplies 77 CFH
  - The correct size is ½" (13)
4. To size Section C, determine the length of run from the Meter to the Water Heater and the load delivered:
  - Length = A + C = 10 + 15 = 25 ft. (3.05m + 4.57m = 7.62m). Load = 35 CFH (35,000 BTU)
  - Table N-1 shows that size ½" (13) is required, because size ¾" (10) has a maximum capacity of 33CFH
  - The correct size is ½" (10)

**Example 2 – Low Pressure System, 12 in. w.c. (22mmHg) Parallel Arrangement**

1. The system shown in FIG. 3-3 is typical of a single family installation with several appliances and medium loads. The appliances are installed apart instead of all together, and the arrangement chosen is parallel. The higher supply pressure of 12 in. w.c. (22.42mmHg) allows a higher pressure drop, 6 in. w.c. (11.21mmHg) than is available with low pressure systems.

2. To size Section A, determine the longest run from the Meter to the furthest appliance and the total load:
  - Meter to Range = A + B = 10 + 20 = 30ft. (3.05m + 6.10m = 9.15m)
  - Meter to water heater = A + C = 10 + 10 = 20ft. (3.05m + 3.05m = 6.10m)
  - Meter to Furnace = A + E = 10 + 10 = 20ft. (3.05m + 3.05m = 6.10m)
  - Meter to Dryer = A + D = 10 + 40 = 50ft. (3.05m + 12.19m = 15.24m)
  - Load = Dryer + Range + Water Heater + Furnace = 30 + 55 + 40 + 80 = 205 CFH (205,000 BTU)
  - Select Table N-4 (Page ??) "Low Pressure 12 in. w.c. (22.42mmHg) with 6 in. w.c. (11.21mmHg drop)." It shows that ½" (13) size is too small for 205 CFH at 50 ft. (15.24m)., but size ¾" (19) can handle 365 CFH.
  - The correct size is ¾" (19)
3. To size Section B, determine the length of run from the Meter to the Range and the load delivered:
  - Length = A + B = 10 + 20 = 30ft. (3.05m + 6.10m = 9.15m) , Load = 55 CFH (55,000 BTU)
  - Table N-4 shows that size ¾" (10) can handle 106 CFH at 30 feet (9.15m)
  - The correct size is ¾" (10)
4. To size Section C, determine the length of run from the Meter to the water Heater and the load delivered:
  - Length = A + C = 10 + 10 = 20ft. (3.05m + 3.05m = 6.10m), Load = 40 CFH (40,000 BTU)
  - Table N-4 shows that size ¾" (10) can handle 131 CFH at 20 feet (6.10m)
  - The correct size is ¾" (10)
5. To size Section D, determine the length of run from the Meter to the Dryer and the load delivered:
  - Length = A + D = 10 + 40 = 50 (3.05m + 12.19m = 15.1m), Load = 30 CFH (30,000 BTU)
  - Table N-4 shows that size ¾" (10) can handle 82 CFH at 50 feet (15.1m)
  - The correct size is ¾" (10)
6. To size Section E, determine the length of run from the Meter to the Furnace and the load delivered:
  - Length = A + E = 10 + 10 = 20ft. (3.05m + 3.05m = 6.10m), Load = 80 CFH (80,000 BTU)
  - Table N-4 shows that size ¾" (10) can handle 131 CFH at 20 feet (6.10m)
  - The correct size is ¾" (10)

**Example 3 - Elevated Pressure System, 2 PSI (13.79 kPa), Parallel Arrangement**

1. The system shown in FIG. 3-4 is adapted for multifamily or single family application with an extended, 100 ft. (30.48m), tubing run from the meter to the regulator. The 2 PSI system is well adapted to handle the long runs required in multifamily buildings with centralized meter banks.

2. To size Section a, determine the total gas load it will deliver:

- Load = Furnace + Water heater + Dryer + Range = 80 + 40 + 30 + 55 = 205 CFH (205,000 BTU)
  - Select Table N-5 (Page ??) "Elevated Pressure 2 PSI (13.79 kPa) with 1 PSI (6.90 kPa) drop." This is the standard table chosen to stay within the Maxitrol 325-3L or O.A.R.A. Type 90 regulator capacity
  - Length = 100ft. (30.48m)
  - Table N-5 shows that 3/8" (10) is too small for 205 CFH, 1/2" (13) can handle 249 CFH
  - The correct size is 1/2" (13)
3. To size each of the other sections, select Table N-3 (Page ??) "Regulator Outlet 10 in. w.c. (18.68 mmHg) with a drop of 3 in. w.c. (5.60mmHg):
- Section B is 15ft. (4.57m) with a 40 CFH Load. The suitable size 3/8" (10) has 106 CFH capacity at 15 ft. (4.57m)
  - Section C is 10 ft. (3.05m) with a 80 CFH load. The suitable size 3/8" (10) has 131 CFH capacity at 10 ft. (3.05m)
  - Section D is 25ft. (7.62m) with a 40 CFH load. The suitable size 3/8" (10) has 82 CFH capacity at 25 ft. (7.62m)
  - Section E is 20 ft. (6.10m) with a 55 CFH load. The suitable size 3/8" (10) has 92 CFH capacity at 20 ft. (6.10m)
  - The correct size for all the above runs is 3/8" (10)

**Example 4 – Combination DIAMONDBACK™ CSST System in Conjunction with Other Approved Fuel Gas Piping Materials**

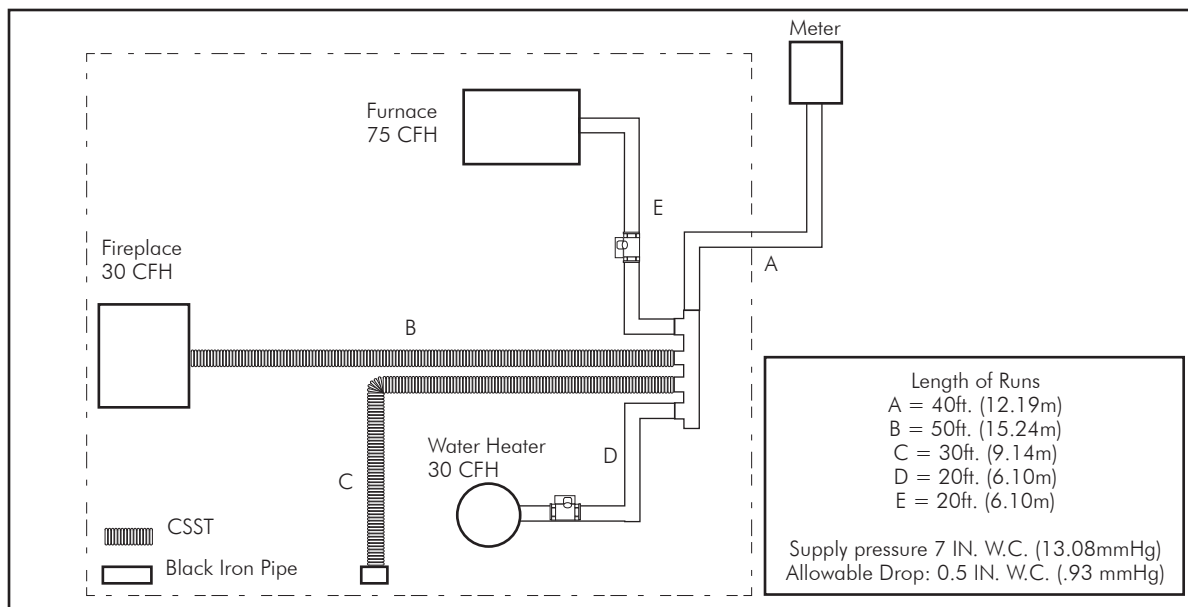


Fig. 3-6 Black Iron Pipe and CSST Systems

**Example 4 – Combination Black Iron Pipe and DIAMONDBACK™ CSST System**

1. When adding DIAMONDBACK™ to an existing black iron pipe system use the longest length method explained earlier in this chapter. In FIG. 3-6 the home has an existing supply line of one-inch black iron pipe. The supply pressure is 7 in. w.c. (13.08mmHg) with an allowable drop of 0.5 in. w.c. (.93mmHg).
2. To size Section A, determine the total load of the home (170 CFH) and the longest run, 90 ft. (27.43m). Table N-8 (Page ??) shows that 1" (25) dia. pipe has a capacity of 205 CFH at 90 ft. (27.43m) The 1" (25) dia. pipe (Section A) will handle the load.
3. To size Section B, determine the load of the fireplace (30 CFH) and the length of the run, 90 ft. (27.43m) Table N-1 (Page ??) shows the suitable size DIAMONDBACK™ is 1/2" (13).
4. To size Section C, determine the load of the quick connect (25 CFH) and the length of the run., 70 ft. (21.34m) Table N-1 shows the suitable size DIAMONDBACK™ is 1/2" (13).

**Note:** If the supply pressure was raised by the gas utility to 10 in. w.c. (18.68 mmHg) with allowable pressure drop of 3 in. w.c. (5.60mmHg), table N-3 (Page ??) shows Sections B & C could both be run with 3/8" (10) DIAMONDBACK™ CSST.

# CHAPTER 4.0: INSTALLATION PRACTICES

## 4.1 GENERAL INSTALLATION PRACTICES

### CODE COMPLIANCE

#### DESIGN LIMITATION

**DIAMONDBACK™ fuel gas systems shall not operate at pressures exceeding 5 PSI (34.48 kPa).** The design operating pressures for the elevated pressure systems are 2-5 PSI (13.79-34.48 kPa) from the meter to the pressure regulator, and 12 in. w.c. (22.42 mmHg) or less, from the pressure regulator to the inlet of the appliance regulator. The pressure regulator must be approved for operation for at least 5 PSI (34.48 kPa) inlet pressure. On low pressure systems, less than 0.5 PSI (3.45 kPa), where a pressure regulator is not necessary, the design operating pressure may be set by the local utility between 7 and 12 in. w.c. (13.08 and 22.42 mmHg).

#### PLANNING SYSTEM DESIGN

1. Confirm that the local building code authority has accepted the use of DIAMONDBACK™ CSST.
2. Check with the local gas utility or supplier to determine the metered gas supply pressure.
3. Prepare a dimensioned sketch of the installation showing the location of each appliance and possible piping routes.
4. Determine the load demand for each appliance. This data is commonly found on the manufacturer's nameplate on each gas appliance or is provided by the builder/contractor. Determine the type of piping layout and DIAMONDBACK™ size, which best fits, the installation.

**Natural Gas** – Supply pressure in the USA and Canada is typically 6 to 7 in. w.c. (0.25 PSI, 4 oz. or 1.72 kPa). Higher supply pressures 0.5 PSI (14 in. w.c./3.45 kPa), 1 PSI (28 in. w.c./6.90 kPa), and 2 PSI (56. In. w.c./13.79 kPa) will allow reduced tubing size in the CSST design plane. CSST can also be used in 5 PSI (34.48 kPa) supply pressure systems which are normally restricted to commercial installations.

**Propane Gas** (LPG – Liquid Petroleum Gas) – Typical propane supply pressure for residential building is 11 in. w.c. (20.55 mmHg) set at the regulator outside the building. Higher supply pressures will allow reduced tubing size. Check with your propane supplier and local building code authority.

Determine the total capacity for all appliances planned in the installation. The BTU equivalents for natural gas or propane flow (CFH) can be obtained from the local gas utility or propane supplier. For natural gas, one cubic foot per hour (1 CFH) is approximately 1,000 BTU per hour. For propane, one cubic foot per hour is approximately 2,500 BTU per hour. Check with the local utility for actual BTU content of the gas. The sizing tables in chapter 7 of this manual can be used for correctly sizing DIAMONDBACK™ CSST.

### TOOLS FOR INSTALLATION

Tool Name	Application
Open End Wrench	For Assembly Fittings
Adjustable Wrench	For gas outlet devices and manifold attachments
Pipe Wrench	For attachments of tubing to fittings and manifold body
Screw Driver	For mounting of termination fittings and striker plates
Hammer	For fastening supports, striker and termination
Drill	For boring holes through wood or metal framing
Tubing Cutter	To cut CSST to Proper Length
Utility Knife	To cut CSST Jacket to Proper Length

**PRECAUTIONS**

Precautions must be taken to ensure that any exposed flexible piping is not damaged or abused during building construction. All system hardware should be stored in a secure, dry location prior to installation.

1. Only components provided by “Tecvalco Ltd. or specified as part of the DIAMONDBACK™ piping system are to be used in the installation (black iron pipe is approved).

DO NOT use DIAMONDBACK™ tubing or fittings with tubing or fittings of any other CSST manufacturer when installing a new system. Intermixing CSST tubing and fitting components between CSST manufacturers is prohibited in a new installation.

2. Ends of the tubing are to be temporarily capped, plugged, or taped closed prior to installation and pulling through structure to prevent entrance of dirt, or other debris.

3. Contact with sharp objects or harmful substances such as fluxes used for soldering copper tubes and acid based cleaners such as muriatic acid used for cleaning brickwork is to be avoided. Contact with any chemicals containing chlorides must be followed by thorough rinse and wipe dry.

4. Undue stress or strain on the tubing or fittings is to be avoided.

- Bending flexible gas piping is one feature, which contributes to the speed of installation. The recommended bend radius for general routing is 3” (76), multiple tight bends can restrict the gas flow and increase pressure drop. Care must be taken to avoid sharp bends, stretching, kinking or twisting of tubing. The tightest bend allowed for each size of DIAMONDBACK™ is shown in Table 4-2. Typical locations requiring tight bends are termination mount installations in hollow stud walls.

Table 4-2 Bending Radii			
Part No.	Tubing Size	Absolute Minimum Bend Radius	Recommended Installed Bend Radius
375DFT	3/8" (10)	1 3/8" (21)	3" (76)
500DFT	1/2" (13)	1" (25)	3" (76)
750DFT	3/4" (19)	1 3/16" (30)	3" (76)
1000DFT	1" (25)	1 3/16" (46)	5" (76)
1250DFT	1 1/4" (32)	2 3/8" (60)	6" (76)

## HORIZONTAL RUNS AND SUPPORTING

- All horizontal runs shall be supported as specified in Table 4-3 below.
- Tubing that runs parallel to the joists should be supported to the center of the vertical face at least 3”(76) from the floor or ceiling. (FIG. 4-14 on Page ??)
- Is acceptable for CSST to lie directly on ceilings capable of supporting the CSST such as dropped ceilings and sheet rock.

Part No.	Pipe Size	Spacing of Supports
375DFT	3/4" (10)	4 ft. (1.22m)
500DFT	1/2" (13)	6 ft. (1.83m)
700DFT	3/4" (19)	6 ft. (1.83m) CAN, 8 ft. (2.44m) USA
1000DFT	1" (25)	6 ft. (1.83m) CAN, 8 ft. (2.44m) USA
1250DFT	1 1/4" (32)	6 ft. (1.83m) CAN, 8 ft. (2.44m) USA

## VERTICAL RUNS AND SUPPORT

- The spacing between supports on vertical runs shall not exceed 10 ft. (3.05m)
- **Unconcealed** – the tubing shall be supported in a workman like manner with piping straps, tubing clips, bands, brackets or hangers suitable for the size and weight of the tubing. Standard support materials such as metal, plastic and wood are acceptable.
- **Concealed** – it is recommended that concealed vertical tubing be as unconstrained as possible to avoid future puncture threat such as nails and screws.

## 4.2 FITTING ASSEMBLY

### Making Fitting Connections to Flexible Gas Piping

#### 1. Cut tubing to length:

Determine the proper length of the tubing and leave some extra in case it needs to be trimmed in the future. Use a standard tubing cutter equipped with a sharp (preferably hardened steel) cutting wheel. Whenever possible, cut a straight section of tubing that hasn't been bent too much. Remember that DIAMONDBACK™ is much thinner and much harder than copper tubing.

Cut through the polyethylene tubing jacket. The cut must be centered in the convolution (valley) between two corrugations. Use full, circular cutting strokes continuing in the same directions as starting in. When the wheel has cut through the jacket and is in contact with the stainless steel it is important to **slightly** tighten the cutting wheel after a revolution or two for an even cut around the circumference. The tubing may flatten out if the cutter is tightened too fast.

Taking a little time doing this procedure correctly can save time during later procedures.

When the majority of the tubing has been severed the tubing cutter will not make another revolution correctly and a small portion of the DIAMONDBACK™ will remain attached. Remove the tubing cutter, gently open and close the tubing where the cut was made. Within seconds the remaining CSST still attached will sever. If the cut is too deformed it can easily be trimmed back an inch or so following the directions above.

## 2. Strip Jacket:

Using a utility knife, strip the jacket back to the middle of the third convolution (valley) from the end of the tubing. The utility knife and the cut tubing ends are very sharp. Use caution when cutting the jacket and handling the tubing.

## 3. Install Split Rings:

Slide the seal nut over the end of the tubing, female side facing toward the tubing end. Place the split rings in the first convolution (valley) at the end of the tubing. If the tubing roundness doesn't match the round of the split rings, gently squeeze the split rings together with pliers; this will round out the tubing. The split rings may have a gap between them; this is acceptable since they do not form part of the seal. Pull the seal nut towards the end of the tubing and capture the split rings in the convolution. If the nut doesn't pass over the tubing, gently squeeze the split rings with pliers to round out the tubing or turn the split rings over for a cleaner edge. If the fitting is reattached more than three times or the nut cannot be pulled over the split rings then the split rings must be replaced. Packets of split rings are available and the remaining fitting parts can be reused.

## 5. Wrench Fitting:

Place the male adapter into the seal nut and engage the threads. (Notice that the DIAMONDBACK™ fittings are designed to form a leak proof seal on the stainless steel tubing as the fitting and seal nut are tightened.) Using the appropriate wrenches, tighten the fitting until the male adapter bottoms out and the resistance to tightening greatly increases. The flare has now been created on the tubing end. (Removing the male adapter will allow a visual confirmation.)

**Note:** If the fitting is to be connected to pipe thread, thread the pipe joint first. Then torque the fitting to the tubing by tightening the nut.

**Also:** When a fitting is connected to a termination outlet. First, slide the termination flange onto the tubing. Second, install and torque the termination fitting. Third, thread the termination flange onto the termination seal nut. Fourth, securely fasten the termination flange to the desired position. Always secure the termination seal nut to the termination flange tightly to avoid future twisting of the CSST.

## 5. Final Torque:

Tighten seal nut and fitting to the torque values in **Table 4-4** below. The actual seal is metal to metal (brass & stainless steel). If the fitting cannot be made to seal applying torque per **Table 4-4** below, **DO NOT CONTINUE TO TIGHTEN THE ASSEMBLY**. Disassemble the assembly and inspect the sealing surfaces. Clean both sealing surfaces and reassemble the fitting. If necessary, the tubing can be trimmed and the fitting reattached.

Tube Part No.	Pipe Size	Fitting Part No.	Required Torque
375DFT	3/8" (10)	375DMF	45 ft-lb.
500DFT	1/2" (13)	500DMF	50 ft-lb.
750DFT	3/4" (19)	750DMF	60 ft-lb.
1000DFT	1" (25)	1000DMF	70 ft-lb.
1250DFT	1 1/4" (32)	1250DMF	Pre-Assemble: 60 ft-lb. Final: 80 ft-lb.



### 4.3 ROUTING

#### RUN LOCATION

Runs can be located several places within the building codes. Depending on local building codes, DIAMONDBACK™ tubing can be routed:

- **Beneath, through, and along side floor joists** – Consideration should be given to future construction possibilities. In unfinished basements it is preferred to route CSST through rather than below or beneath joists for the protection of the DIAMONDBACK™.
- **On top of ceiling joists in attic spaces** – Considered choice location in areas where slab-on-grade construction is prevalent.
- **Inside wall cavities** – Preferred for vertical sections of piping rather than horizontal sections.
- **Through conduit embedded in concrete floors and walls** – When runs must be buried or embedded in concrete DIAMONDBACK™ shall be routed within a non-metallic, watertight conduit which has an inside diameter at least 1/2" (13) larger than the outside diameter of tubing. No DIAMONDBACK™ joints are permitted within the conduit.
- **To gas fireplaces** – DIAMONDBACK™ can be used to deliver gas directly to the valve of a gas fireplace. This is approved in decorative and heat generating gas fireplaces as well as in all fuel fireplaces utilizing gas logs only. The yellow polyethylene tubing jacket and rubber o-ring (if supplied) must be removed when DIAMONDBACK™ CSST is routed inside of a gas fireplace firebox.

**DIAMONDBACK™ CSST must not be routed inside the firebox of a fireplace that can be used for burning solid fuel (ie. Wood or coal).**

- Installation clearance holes routing the piping through studs, joists, plates etc. shall have a diameter 1/2" (13) larger than the outside diameter of the piping. When a structural member must be drilled, conformance to building codes must be followed. (see Table 4-5)

Tubing Size	Drill Hole Size
3/8" (10)	1 1/8" (29)
1/2" (13)	1 3/8" (35)
3/4" (19)	1 5/8" (41)
1" (25)	1 7/8" (48)
1 1/4" (32)	2 1/8" (54)

#### BRANCHING

- Avoid branching if possible. This minimizes the number of joints in the system. Instead, install individual runs to each appliance outlet.
- When branching is necessary, use a standard NPT class 150 malleable iron tee, the outlets of which can be connected to suitable sizes of DIAMONDBACK™ fittings.

## BORED HOLES

- In locations where DIAMONDBACK™ is installed through bored holes in joists, rafters, or wood members, holes shall be bored so that the edge of the hole is not less than 2" (51) from the nearest edge of the wood member. Where the distance cannot be maintained at any point, the tubing shall be protected by a DIAMONDBACK™ striker plate of the appropriate length and width installed in accordance with the striker plate instructions in this manual. The diameter of the bored holes shall be a minimum of 1/2" (13) larger than the outside diameter of the tubing jacket unless the hole size is in conflict with local building codes which shall prevail.
- The size of the hole drilled through **top plates, top frame members, and sole plates**, to allow the vertical passage of the tubing, shall not exceed 1/2 of the width of the member. The hole should be bored through the center of the member (See **FIG. 4-6 below**).
- Where sole plates are cut for tubing, the width of the cut shall be 1/2" (13) larger than the outside diameter of the tubing jacket but not greater than 2 1/8" (54), and the tubing must be protected with a DIAMONDBACK™ striker plate of the appropriate length and width installed in accordance with this manual (See **FIG. 4-6**).
- Where a hole is to be bored in a joist, the hole should be located at the centerline, otherwise no closer than 2" (51mm) from the nearest edge of the joist, and the hole diameter shall not exceed 1/3 the depth of the joist (see **FIG. 4-7**).
- Where holes are to be bored in non-bearing vertical members of the wall framing the size of such holes shall not be larger than 60 percent of the width of the member (See **FIG. 4-8**).
- Where holes are to be bored in load bearing vertical member of the wall framing, the size of such holes shall not be larger than 40 percent if the members are doubled. **No more than two successive double bored members are permitted** (See **FIG. 4-9 Page ??**).

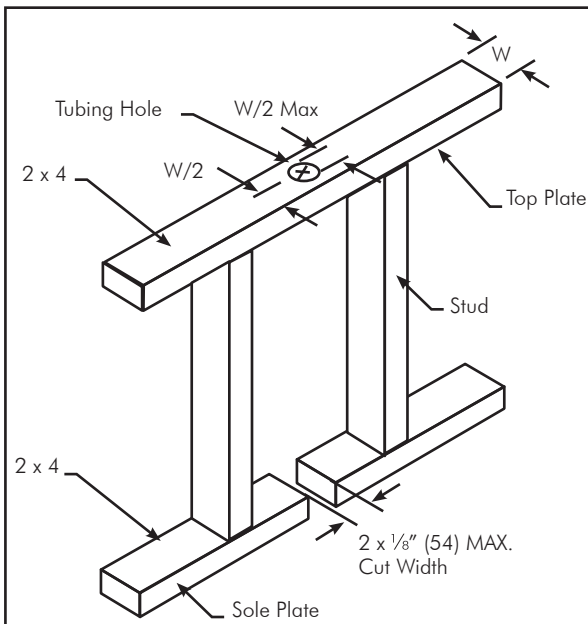


FIG. 4-6 Holes and Cuts in Top and Sole Plates

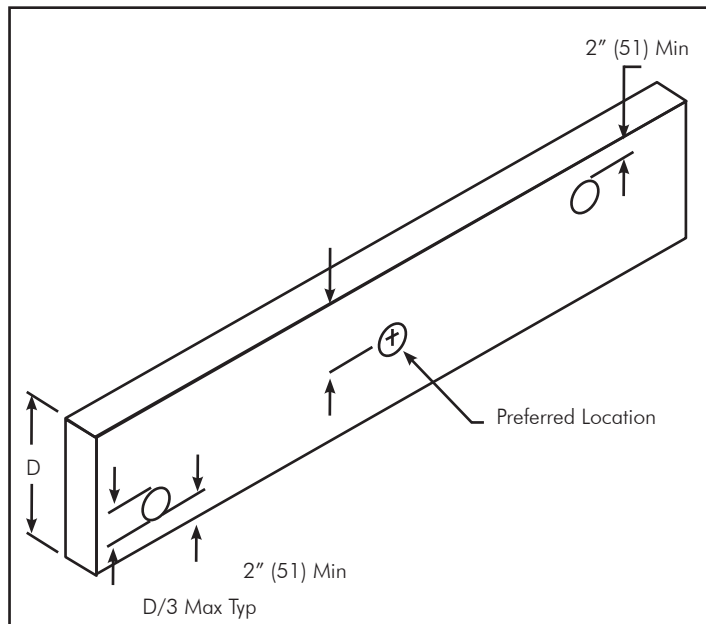


FIG. 4-7 Holes in Wood Joists

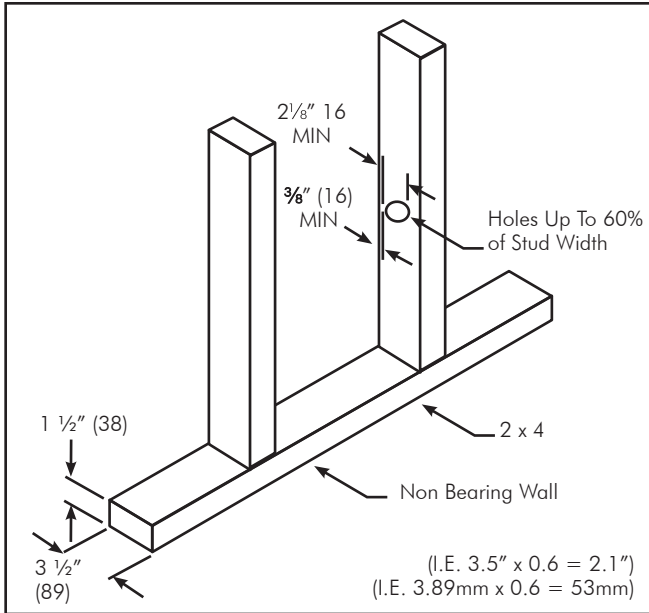


FIG. 4-8 Holes In Non-load Bearing Walls

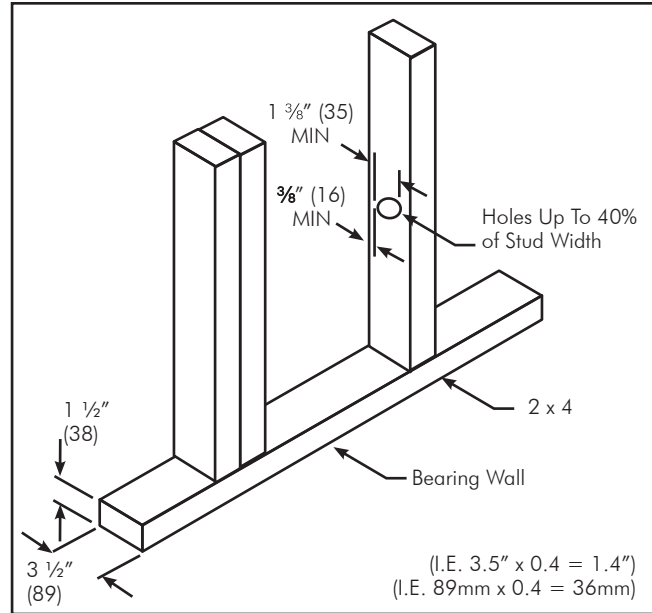


FIG. 4-9 Holes In Load Bearing Walls

**DIAMONDBACK™ Through Metal Framing** – The installation instructions for metal framed are the same as wood framed structures with the following exception.

When DIAMONDBACK™ CSST passes through metal members it shall be protected by one of the following methods:

1. Bushing securely fastened in the opening of the metal member.
2. Grommets securely fastened in the opening of the metal member.
3. A minimum of four wraps #10 mil. Duct tape.

The installer shall insure that no physical contact occurs between the metal member and the DIAMONDBACK™ tubing.

### Guidelines For Installation Of Concealed Csst Fitting

#### General Provisions

- It is not the intent of these guidelines to encourage the use of concealed tubing joints. Concealed joints should be avoided, and only used when the installation of a hidden fitting is the only "reasonable" solution to a difficult situation. Like black iron pipe system, any joint can be a potential leak site, and system designers and installers should strive to minimize the total number of joints in any piping system regardless of their location.
- These guidelines address known installation situations, which typically require the use of a concealed fitting. These guidelines do not supersede local building or plumbing codes, but rather offer alternative installation practices for consideration by the local authority having jurisdiction.

#### Definitions

The National Fuel Gas Code 2002 (NFPA 54) defines concealed gas piping as "Gas piping that, when in place in a finished building, would require removal of permanent construction to gain access to the piping".

NFPA 54 goes on in subsection 3.4.2, Connection in Original Installations, to define the limitations and exceptions on the use of concealed fittings:

- When installing gas piping that is to be concealed, unions, tubing fittings, running threads, right and left couplings, bushings, swing joints, and compression couplings made by combinations of fittings shall not be used.
- **Exception No. 1:** Joining tubing by brazing shall be permitted.
- **Exception No. 2:** Fittings listed for use in concealed spaces that have been demonstrated to sustain, without leakage, any forces due to temperature expansion or contraction, vibration or fatigue based on their geographical location, or operation shall be permitted to be used.

Subsection 3.4.6 stipulates a similar exception for **Reconnections**.

The American National Standard for Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST) ANSI/CSA LC-1 states under subsection 1.1.4 the following:

- This standard includes criteria to establish the suitability of concealed mechanical tube fittings for use with concealed gas piping

### EXCLUSIONS

- The termination fitting is not a concealed joint, and therefore, is not affected by these guidelines. The termination fitting shall be installed according to the instructions in this manual.
- Manifold stations, which include the multi-port manifold and pressure regulator, shall not be installed in a concealed location regardless of the qualifications of the tubing fittings.
- Fittings installed inside accessible enclosure boxes, for such items as quick connect gas outlets or fireplace shut-off valves, are exempted from these guidelines.

### EXAMPLES OF CONCEALED FITTINGS IN NEW INSTALLATIONS

#### Fireplace Logs

The connection to a valve controlling gas flow to a fireplace appliance can be hidden when installed as shown in **FIG. 4-10**. The concealed tubing fitting can be installed beneath the floor, or hearth, or inside the brick work of the fireplace. Automatic or remote control valves installed inside a hollow wall cavity adjacent to the fireplace shall require the use of an accessible enclosure box.

#### Multiple Gas Outlets

When multiple gas outlets are supplied from a single run of CSST, each downstream outlet branch can be connected to the main run using a tee-type fitting which can be located in a concealed location as shown in **FIG. 4-11**.

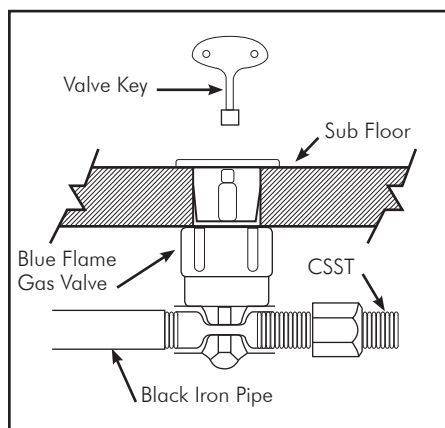


FIG. 4-10 Fireplace Valve Installation

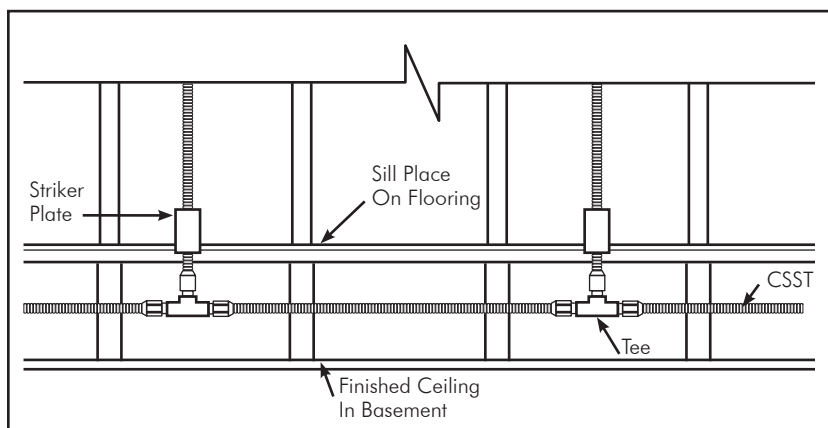


FIG. 4-11 Multiple Outlets Along Main Tubing Run

## Examples of Concealed Fittings in Modifications to Existing Installations

### New Ceilings in Unfinished Rooms/Basements

DIAMONDBACK™ fittings originally installed in accessible ceiling locations can be concealed at a later date in the event that a ceiling is installed. Precautions shall be taken to ensure that the newly concealed fittings and tubing are adequately protected from accidental puncture in accordance with Tecvalco Ltd.'s instructions for the installation of protective devices.

### Extensions to Existing Tubing Runs

A concealed tubing run may be modified to permit an extension of another appliance location provided there is sufficient capacity to safely supply both appliances at the same time. If an accessible location for the modification is not available, the existing tubing run can be modified as shown in FIG. 4-12, which will result in a concealed fitting behind the wallboard.

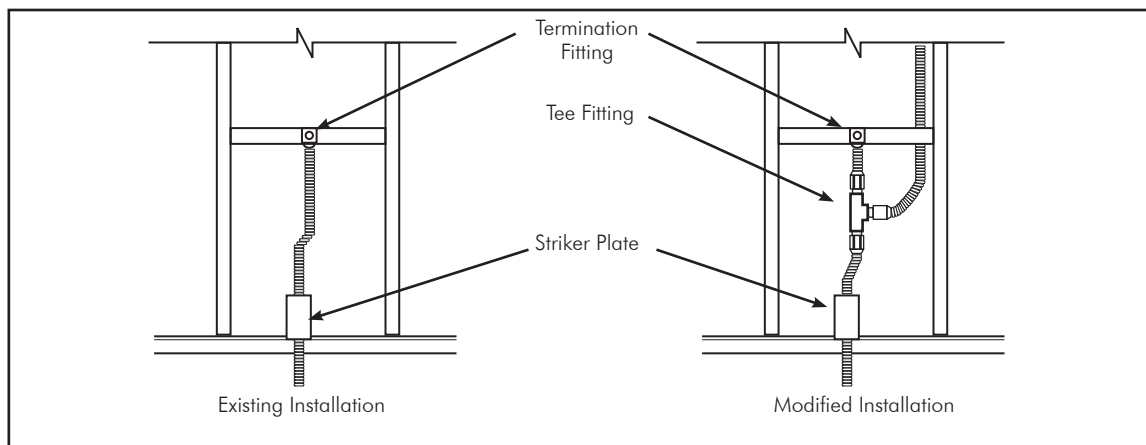


FIG. 4-12 Extension of Existing Tubing Run

## 4.4 PROTECTION

The flexible gas piping must be adequately protected from puncture, shear, crush, or other physical damage threats. The tubing shall be protected at points of support and when passing through structural members such as studs, joists and plates in accordance with this section. **Protection is required whenever the tubing is concealed and constrained and within 3" (76) of a potential threat.** If the tubing requires protection, the following measures should be taken.

1. Install shielding devices, ie. Striker plates to protect the tubing from penetration by drill bits, nails, screws, etc. (See **FIG 4-13**) in those areas where the tubing will be concealed and will not be free to move and avoid such puncture threats.
  - a. At support points and points of penetration less than 2" (51) away from any edge of a stud, joist, plate, etc. shielding is required at the area of support and within 5" (127) of each side (if appropriate). Use a half striker or a full striker plate in these locations.
  - b. At support points and points of penetration 2" (51) to 3" (76) from any edge of a stud, joist, plate, etc. Shielding is required throughout area of support. Use a quarter striker plate in these locations (See **FIG 4-15**).
  - c. Install floppy steel conduit in locations where striker plates are impractical such as termination outlets and stub outs, short tubing runs and where tubing is routed horizontally between studs (see **FIG 4-14**).

ALSO NOTE MINIMUM DISTANCES OF FLOPPY STEEL CONDUIT IN **FIG. 4-21 & 4-22**

2. **The best protection** is to install the tubing in those out of the way areas where testing has shown no protection is necessary, for example:

- a. Where the tubing is supported more than 3" (76) from any outside edge of a stud, joist, plate, etc. or wall surface (see FIG 4-16)
- b. Where any non-restrained tubing can be displaced from the direction of potential penetration at least 3" (76)
- c. When tubing is supported under the joists in basements or crawl spaces and is not concealed by wallboard or ceilings.

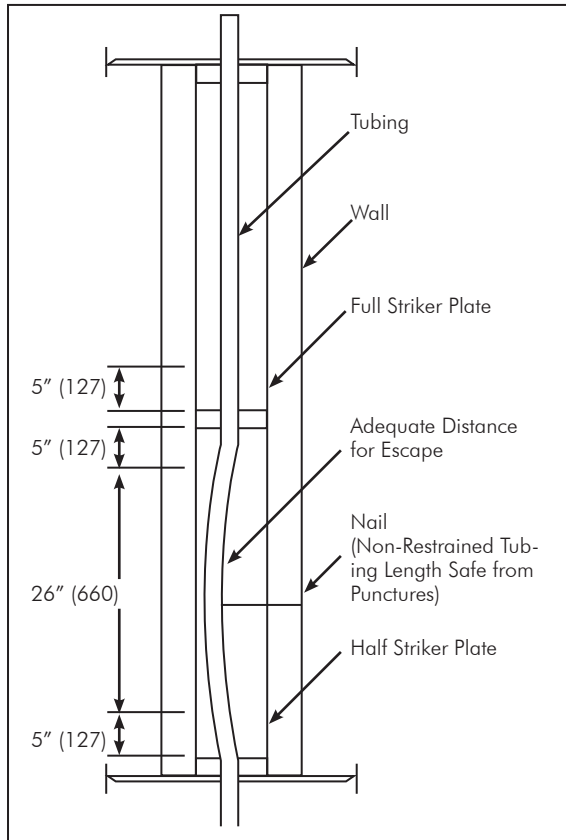


FIG. 4-13 Long Unsupported Tubing Runs, over 3 ft. (9.84m), Within an Interior Wall Partition

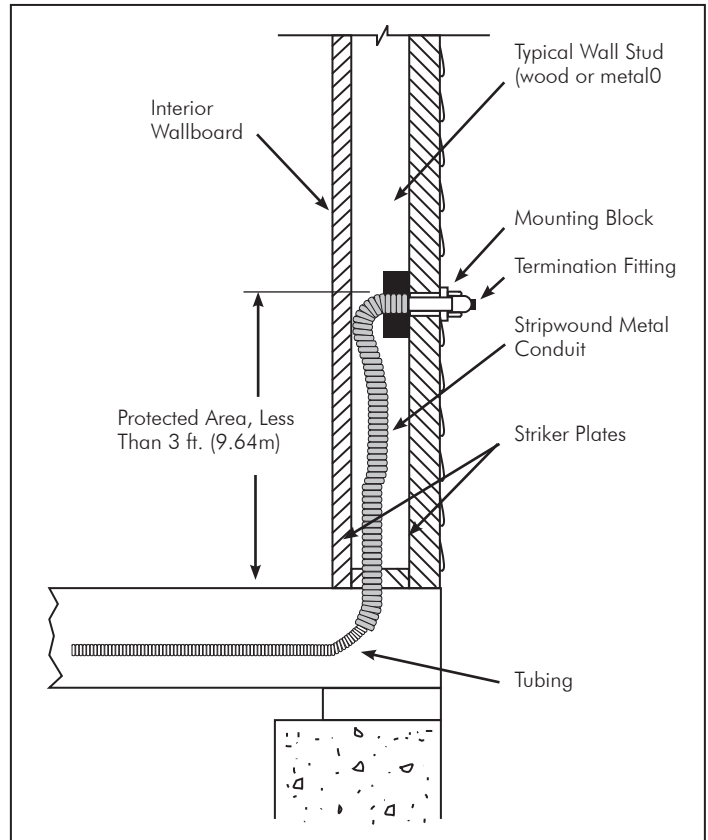


FIG. 4-14 Short Unsupported Tubing Run, under 3 ft. (9.84m), from an Outlet Device within a Wall Partition or Horizontal run between Studs

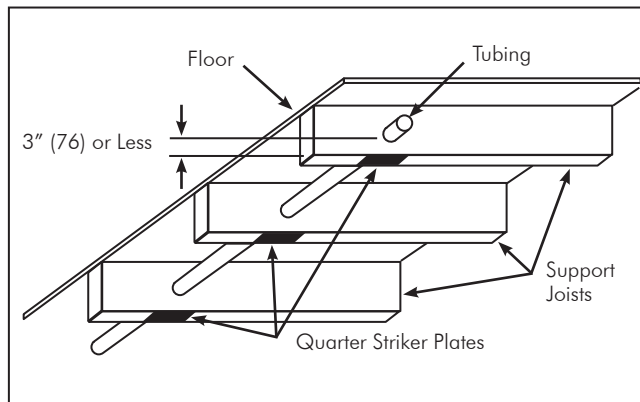


FIG. 4-15 Shielding Required for Tubing Running Through Joists Within 3" of a Potential Nailing Surface

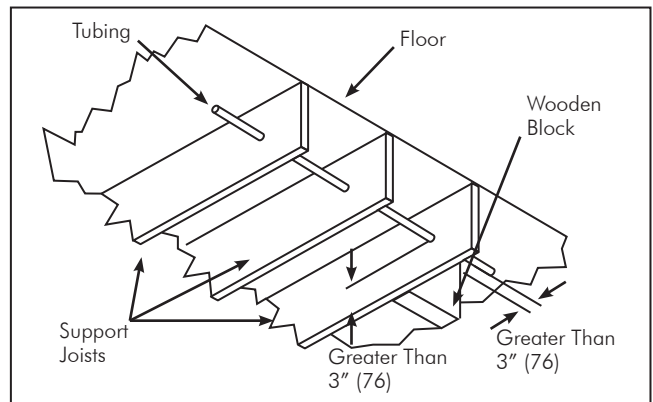


FIG. 4-16 No Shielding Required for Tubing Running Through Joists Greater than 3" from a Potential Nailing Surface

## OUTDOOR INSTALLATIONS

### General Provisions

- The following additional instructions regard the use of DIAMONDBACK™ in systems in which portions of the piping are exposed to the outdoors as required to make connections to gas meters or gas appliances, which are attached to, mounted on, or located in close proximity to the building structure.
- Where local code conflicts with this manual, local code takes precedence
- The external protective covering shall remain intact as much as practical for the given installation. Any portions of exposed stainless steel tubing shall be protected from the outdoor elements. Exposed tubing and fitting connection shall be wrapped with self-bonding silicone tape.
- When installed along the side of a structure (between the ground and 6 ft. (1.83m) in an exposed condition, the DIAMONDBACK™ CSST tubing must be protected inside a conduit or installed in a location which will not subject it to crushing or puncture damage.
- DIAMONDBACK™ shall not be buried directly in the ground or directly embedded in concrete (ie. Patio slabs, foundations and walkways). When burial or embedment is required, DIAMONDBACK™ shall be routed inside non-metallic (ie. PVC) conduit. The conduit shall be sealed at any exposed end to prevent water from entering.
- When installed in crawl spaces or underneath mobile homes, DIAMONDBACK™ shall be installed in accordance with Tecvalco Ltd.'s standard installation instructions. No special precautions are required beneath the structure.
- When using a termination plate for an outdoor application, all four mounting fasteners shall be secured and tight.

### 4.5 METER HOOK-UPS

- Meters which depend on the service and house piping for support shall not be directly connected outdoors with DIAMONDBACK™. As shown in **FIG 4-17 & 4-18**, steel pipe shall be used to connect the meter outlet to the Outdoor Termination Fitting or Stub-Put on the exterior wall of the structure or to a transition from pipe to DIAMONDBACK™ located inside the structure.
- Meters which are independently supported with a bracket can be directly connected outdoors with DIAMONDBACK™ as shown in **FIG 4-19**. If practical, direct connections shall include a 3" (76) to 6" (152) loop of tubing to accommodate differential settling and meter movement.

No mechanical protection is required for outdoor meter connections higher than 6 ft. (1.83m) **Note: consult local code authority.**

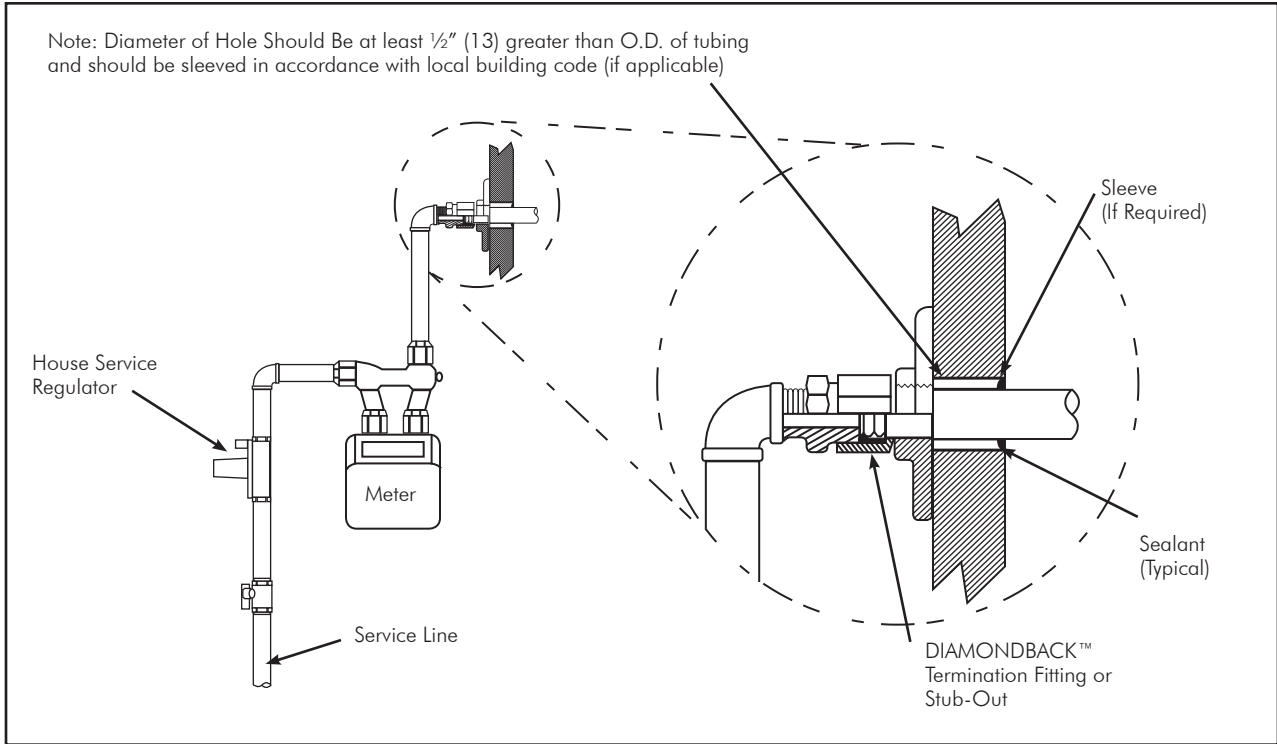


FIG. 4-17 Meter Connection for Pipe Supported Meter

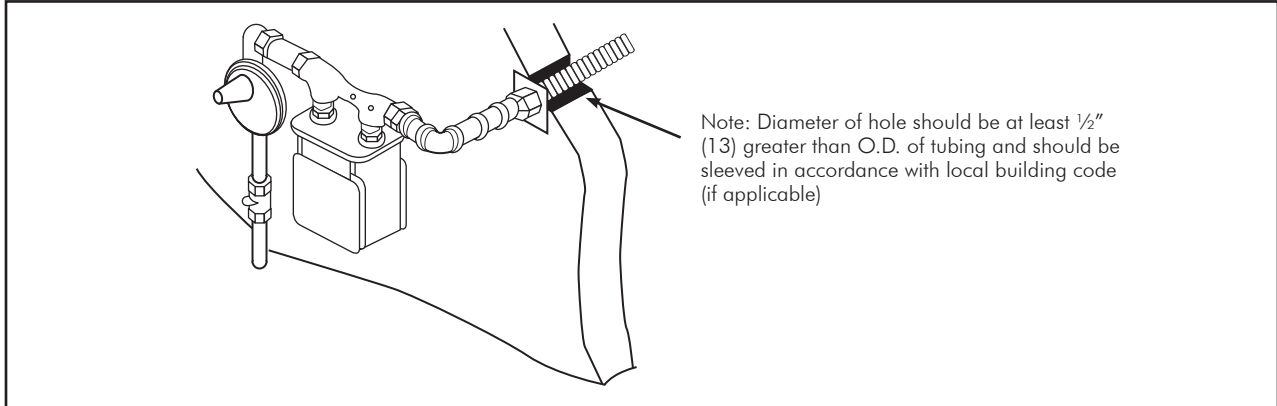


FIG. 4-18 Pipe Supported Meter

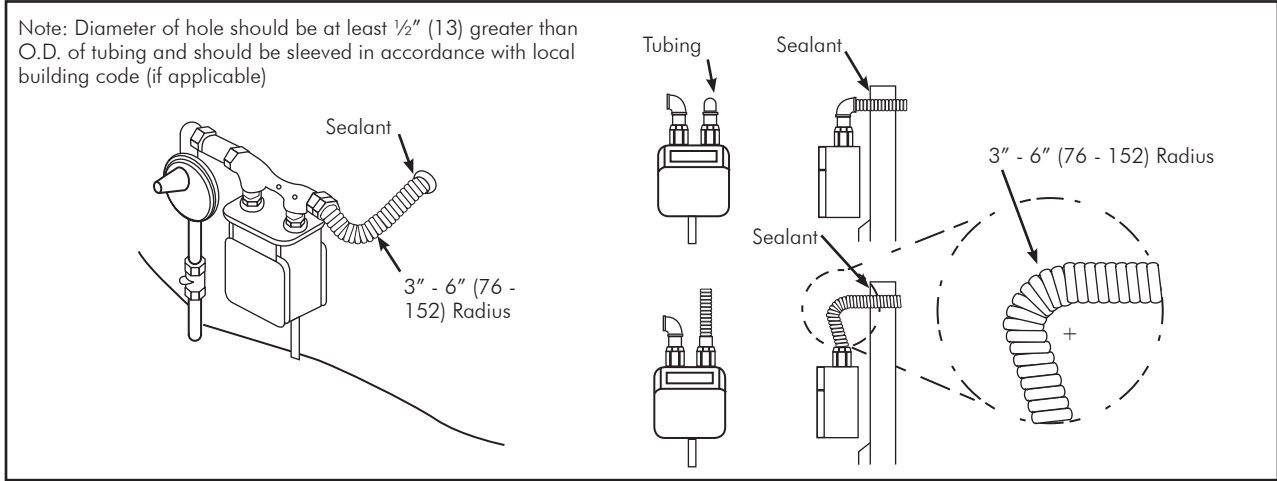


FIG. 4-19 Bracket Supported Meter



## 4.6 APPLIANCE CONNECTIONS

### INSTALLATION OF TERMINATION OUTLET

A DIAMONDBACK™ termination outlet fitting or stub-out fitting shall be installed and secured to the structure at all CSST outlets used for movable appliances and quick-disconnect devices. The fittings are designed to simplify the installation of gas connections for movable appliances and to minimize the need for concealed fittings. The fitting shall be securely fastened in place during rough-in. It may be attached to a brace spanning between studs for a wall location, or directly to the floor. It may also be mounted with a termination outlet bracket, which is nailed or screwed to the stud (See FIG. 4-20).

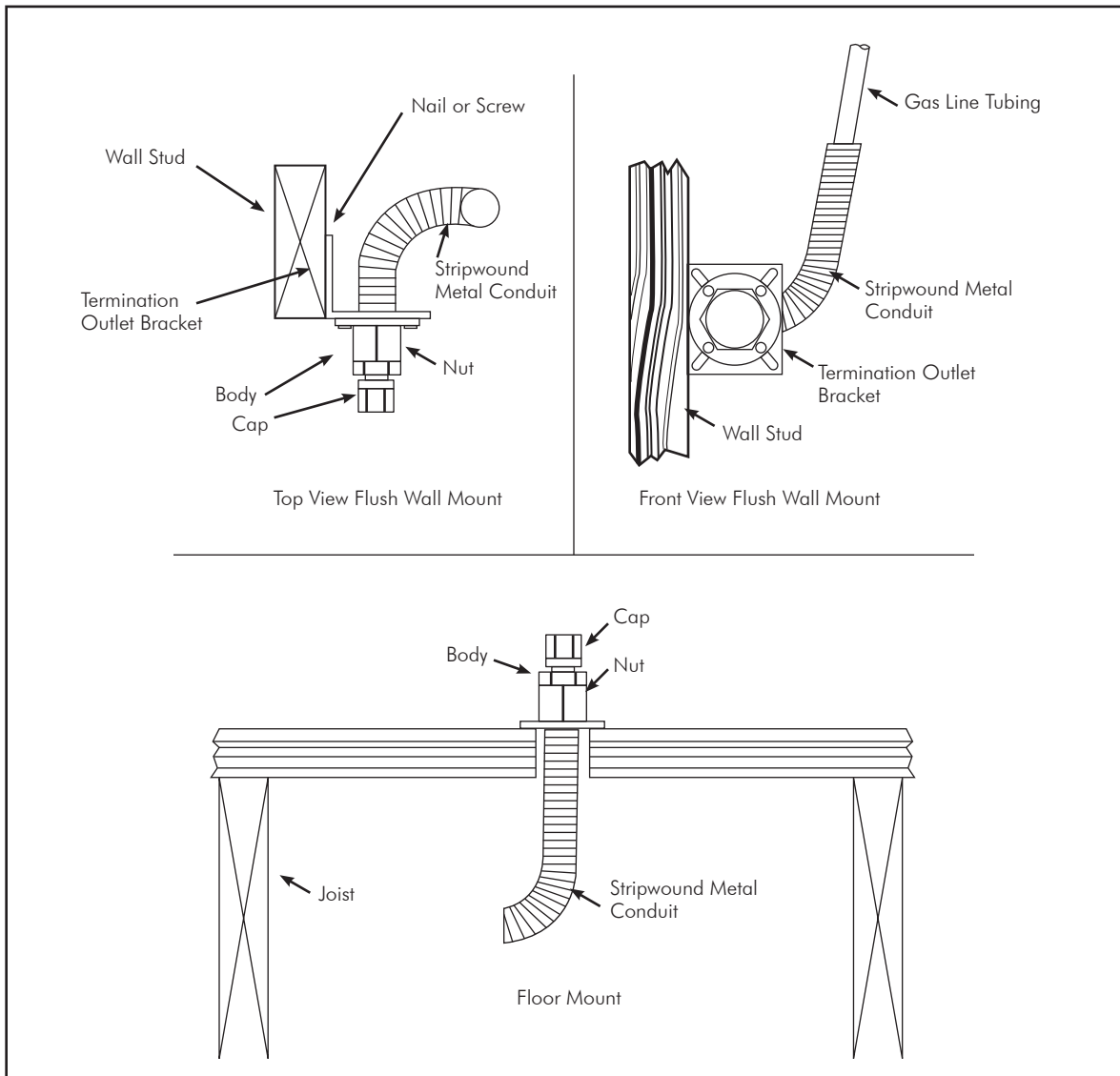


FIG. 4-20 Termination Fitting Mounting Method

### APPLIANCE CONNECTIONS

- **Movable appliance connections**, such as ranges and dryers, shall be made using approved flexible appliance connectors (See FIG. 4-21).
- **Fixed appliance connections** may be directly connected to the DIAMONDBACK™ tubing. When the fixed appliance is located in a secure, dedicated space, such as basement, attic, garage or utility closet, the flexible piping may be directly connected to the appliance shut-off valve without installation of a flange fitting or flexible appliance connector (See FIG. 4-22).

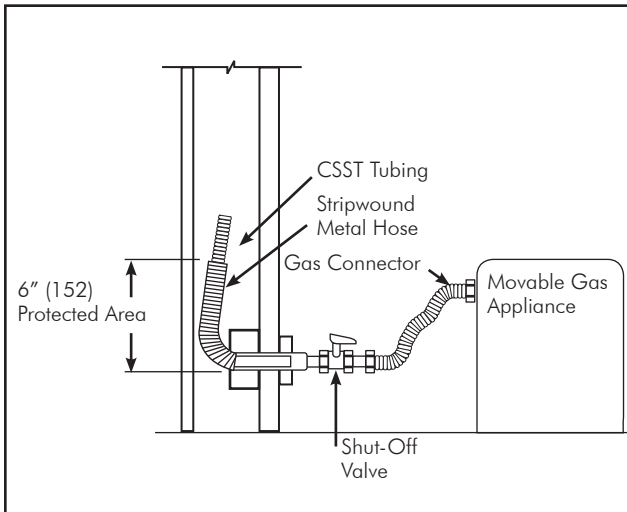


FIG. 4-21 Stainless Steel Gas Connector Connection to a Movable Gas Appliance

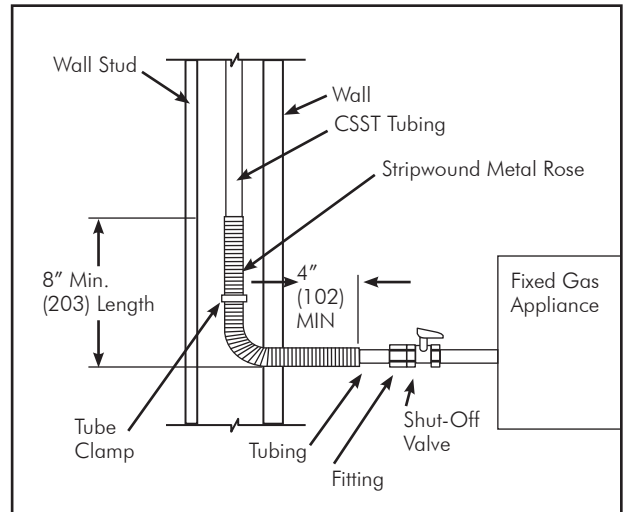


FIG. 4-22 Direct Tubing Connection to a Fixed Gas Appliance Shut off Valve

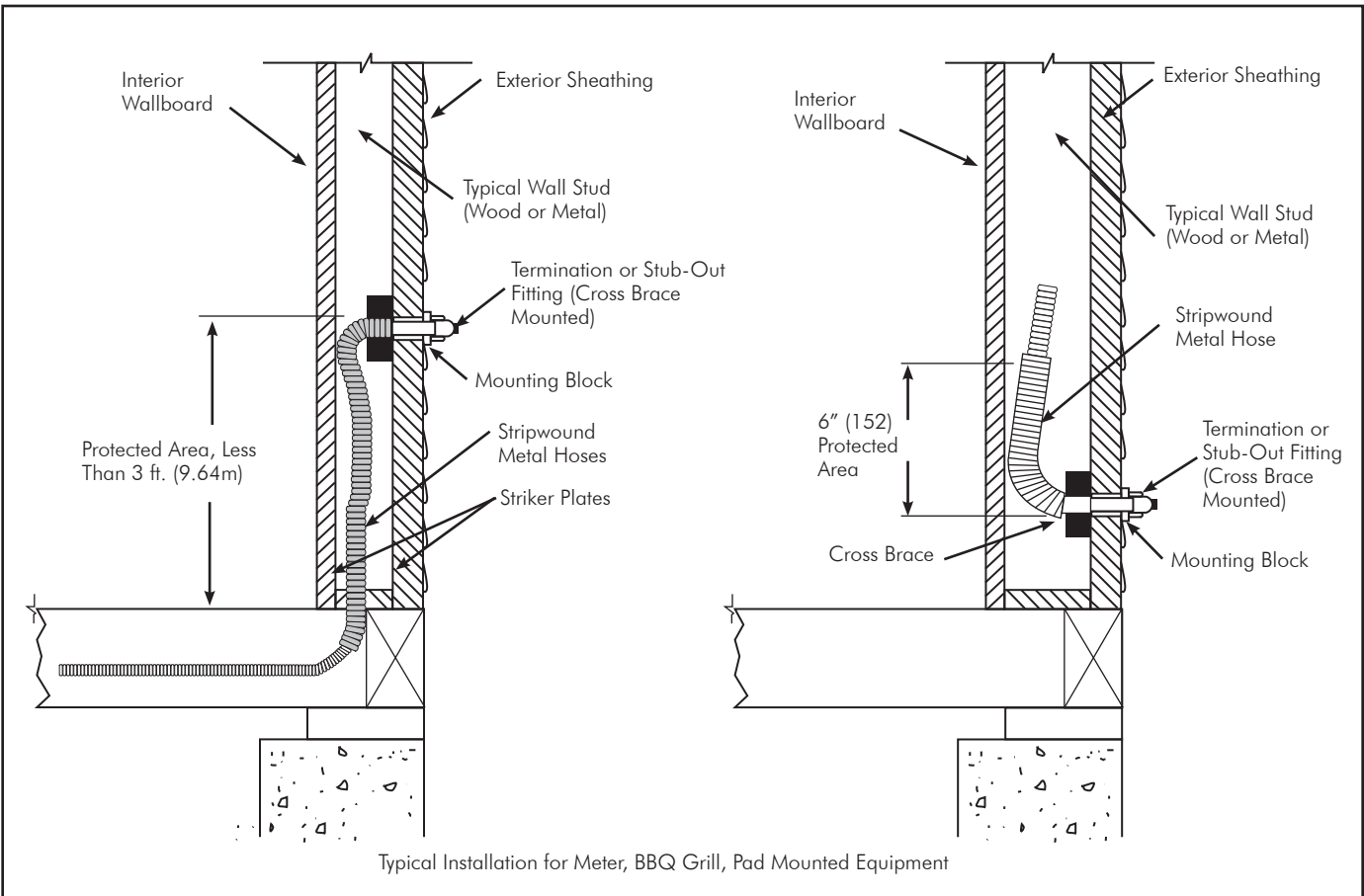


FIG. 4-23 Standard Termination or Stub-Out Fitting Mounted on Outside Wall

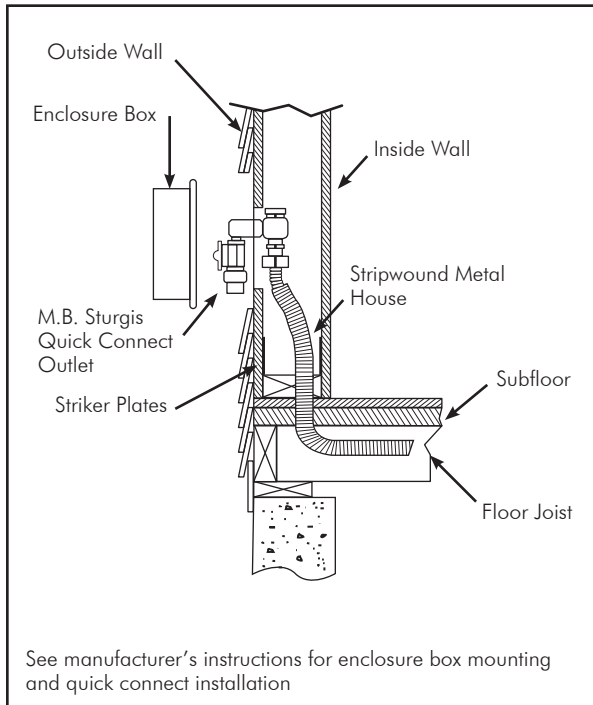


FIG. 4-24 BBQ Quick-Connect Outlet

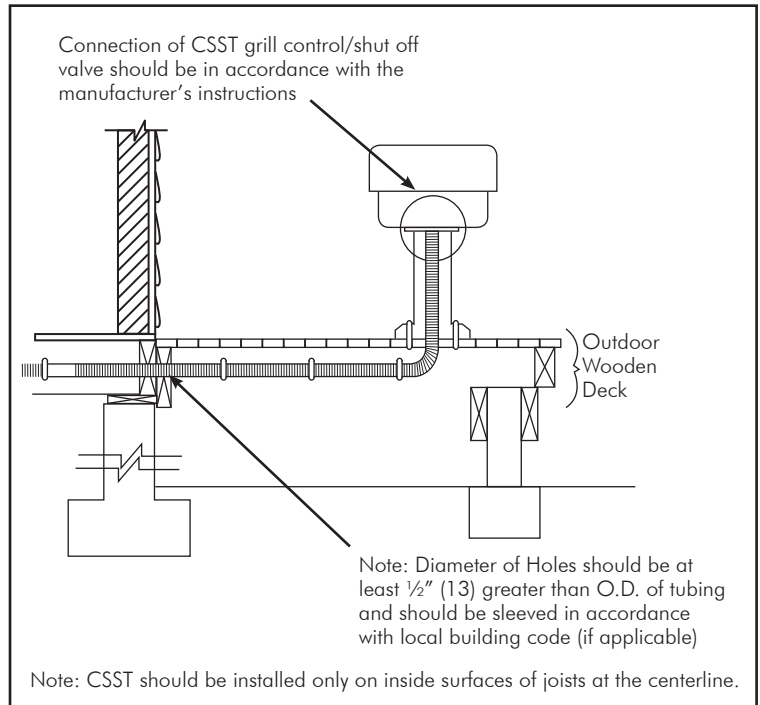


FIG. 4-25 Elevated deck direct connection

### Barbecue Grills

- Movable grills shall be connected using an approved outdoor appliance connector which shall be attached to the DIAMONDBACK™ system at either a termination or stub-out fitting as shown in **FIG. 4-23** or a quick-connect device, such as the M.B. Sturgis gas convenience outlet shown in **FIG. 4-24**. The M.B. Sturgis gas convenience outlet shall be installed in accordance with the manufacturer's instructions.
- Permanently mounted grills located on decks shall be connected to the DIAMONDBACK™ system as shown in **FIG. 4-25** and in accordance with Tecvalco Ltd.'s instructions. The outdoor portion of the DIAMONDBACK™ shall be supported against the side of any of the inside deck joists. If the elevation of the deck is below the top of the foundation, any exposed DIAMONDBACK™ shall be protected using conduit.

### Lights

- Permanently mounted gas powered lights located on decks shall be connected to the DIAMONDBACK™ system the same as permanently mounted grills as shown in **FIG. 4-25**, and in accordance with the manufacturer's instructions.
- Yard mounted gas powered lights shall be connected to the DIAMONDBACK™ system as shown in **FIG. 4-26**. All DIAMONDBACK™ installed below grade shall be protected by nonmetallic conduit. Exposed ends shall be sealed against water entry.

### Infrared Heaters

- Infrared heaters mounted from ceilings and from walls of structures shall be connected to the DIAMONDBACK™ system as shown in **FIG. 4-27**, and in accordance with Tecvalco Ltd.'s instructions.

### Pad Mounted Equipment

- Gas appliances mounted on concrete pads or bricks, such as heat pumps, air conditioners, pool heaters and NGV refueling systems, shall be connected to the DIAMONDBACK™ system at a termination or stub-out fitting using either rigid pipe or an approved outdoor appliance connector as shown in **FIG. 4-24 & 4-28**.

### Roof Top Equipment

- No special mechanical protection of the tubing is required for connections to roof top equipment. Whenever possible, roof penetrations shall include an outdoor termination or stub-out fitting and shall be located within 6 ft. (1.83m) of the equipment to be connected as shown in FIG. 4-29. Long runs of tubing shall be supported with nonmetallic blocks every 4 ft. (1.22m) along its outdoor length, and raised above the roof (as shown FIG. 4-30) a distance determined by local code/practice.
- DIAMONDBACK™ run vertically up the internal or external side of a building to the roof shall be protected in accordance with the General provisions of this manual. See vertical run section of this manual.

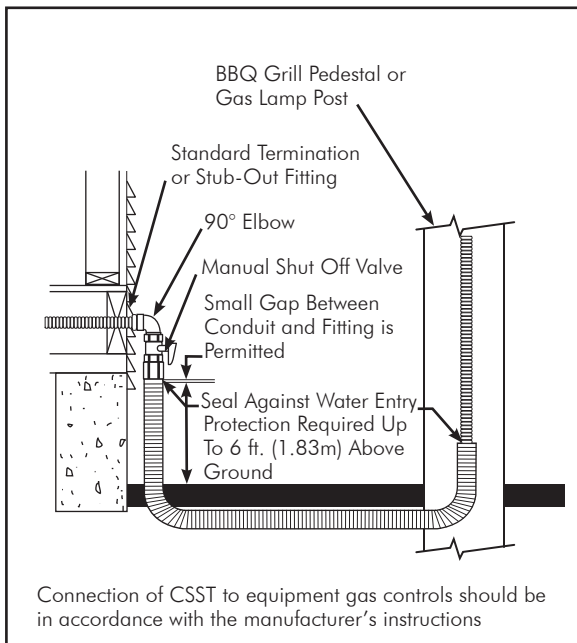


FIG. 4-26 Ground Level Buried Connection

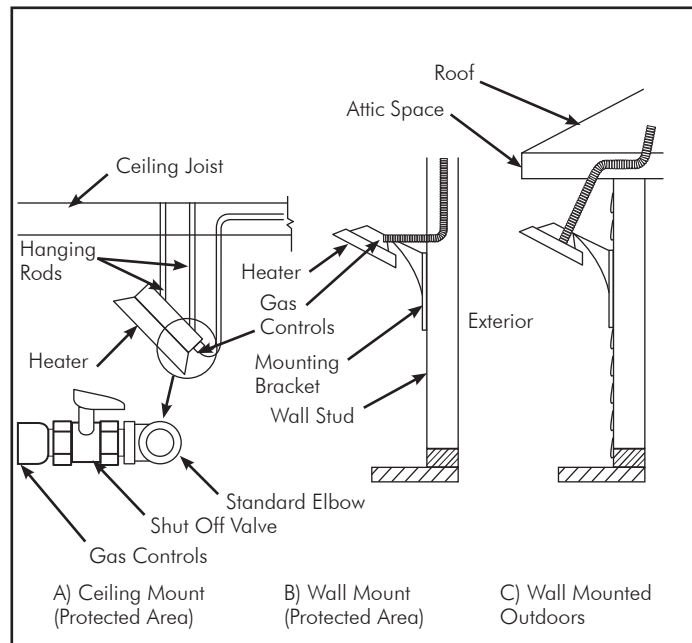


FIG. 4-27 Ceiling or wall hung infrared heater car ports/patios/decks

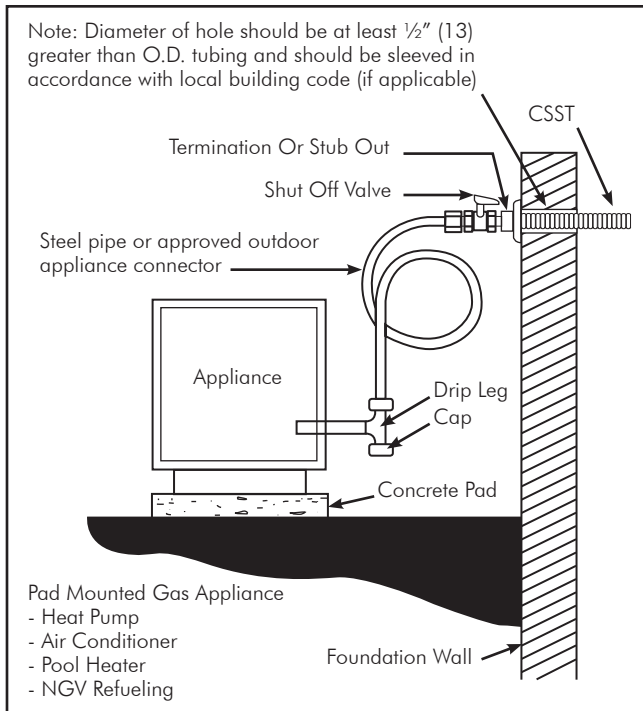


FIG. 4-28 Pad Mounted Gas Appliances

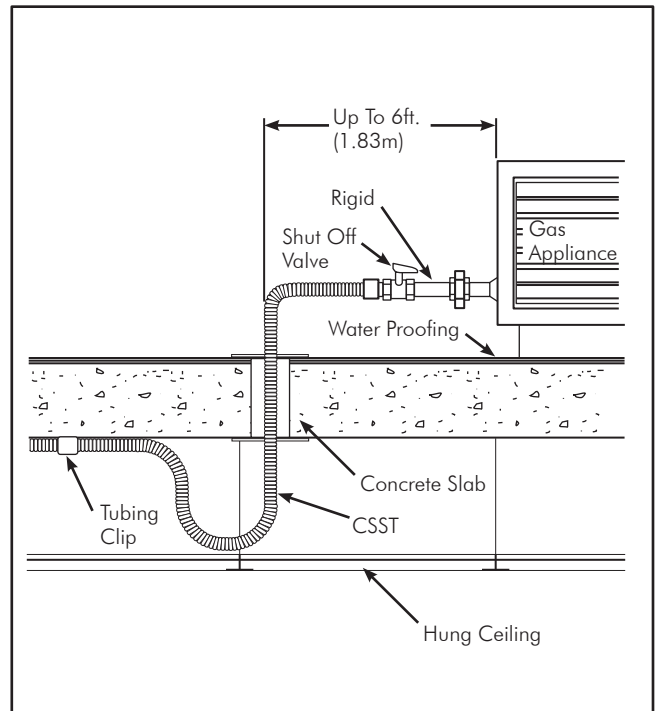


FIG. 4-29 Short, 1-6ft. (.30m-1.83m) Outdoor Connection to Roof Mounted Equipment

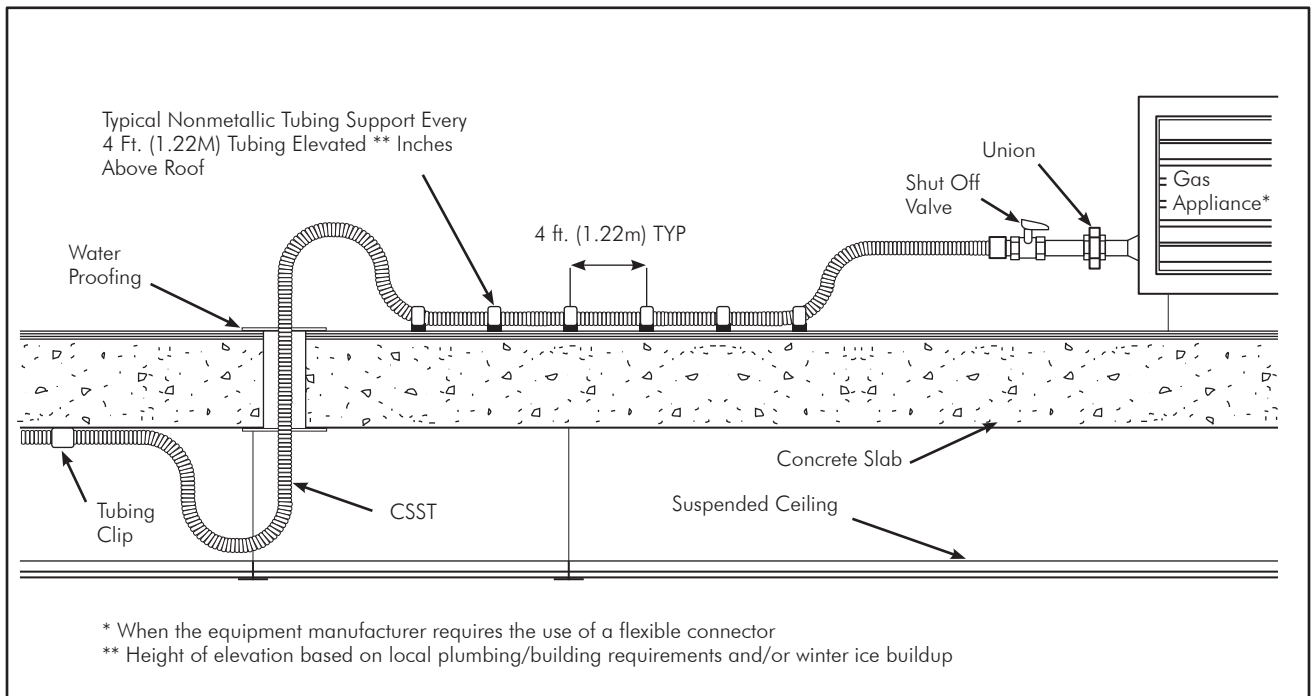


FIG. 4-30 Long Outdoor Connection To Mounted Equipment

## 4.7 MANIFOLD STATIONS

### Installation of Gas Distribution Manifold Assembly

Manifolds are installed where multiple tubing runs are made from a common location in a parallel arrangement. The manifold may be manufactured from a one piece black iron pipe or brass casting; or an all welded fabrication of carbon steel subcomponents or an assembly of approved, black iron pipe nipples and tees. Depending on the location and available space, different mounting arrangements are permitted. A manifold assembly may be mounted on the surface of an interior a wall, between open floor joists, in attic spaces, or within a partition wall inside a ventilated enclosure as shown in **FIG. 4-34**.

The manifold assembly shall be installed in an accessible location where it can be inspected, maintained and serviced if repair or replacement is required. If manifold is located between wall studs behind an access door, then all penetrations by CSST shall be caulked or made gas resistant with grommets. Ventilation of manifold enclosure shall be into living area and not into wall space. Examples of manifold arrangements are shown in **FIG. 4-31 through 4-33**.

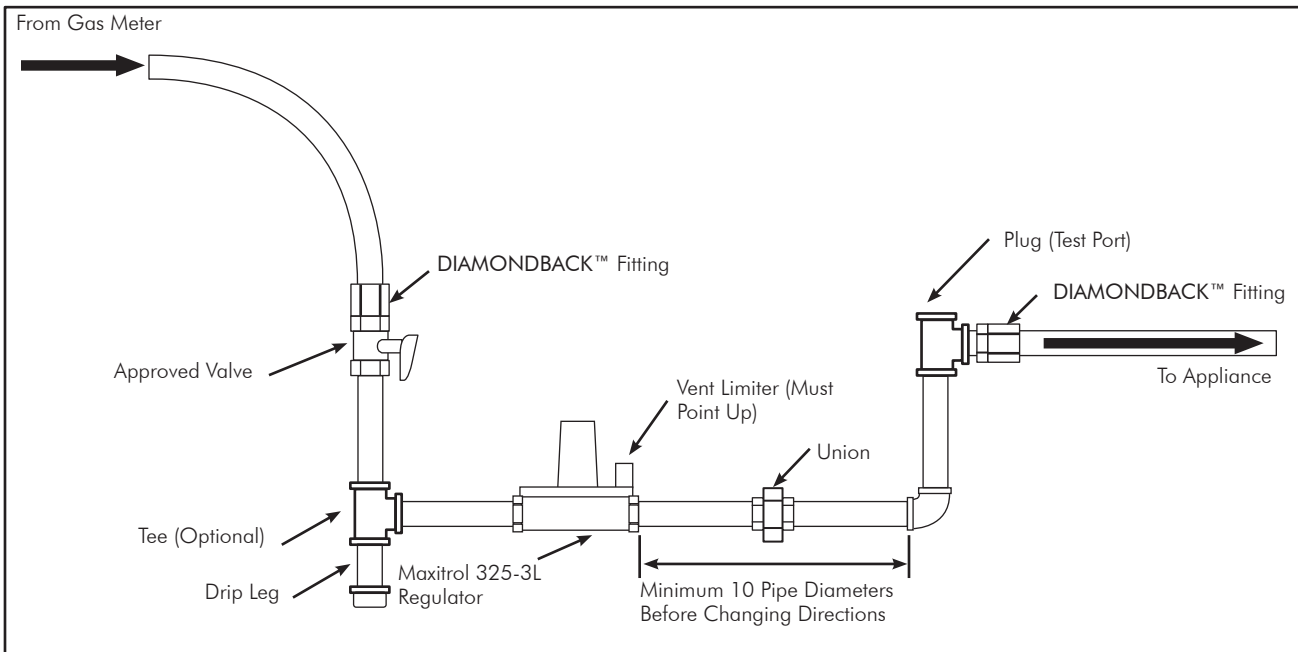


FIG. 4-31 Typical Regulator/Manifold Configuration When Using a Vent Limiter

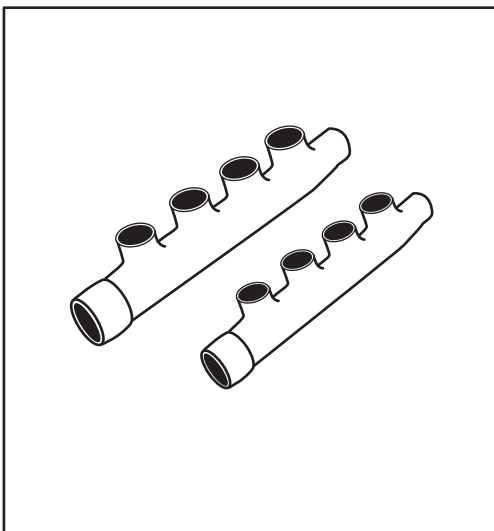


FIG. 4-32 Four-Port Manifold

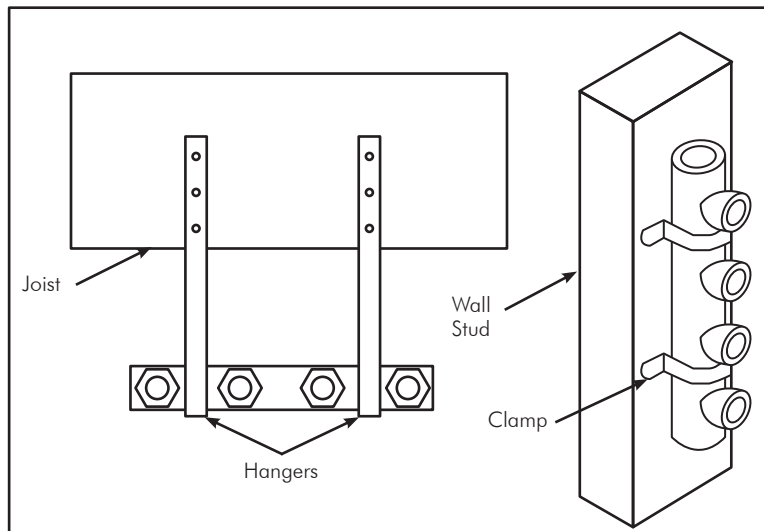


FIG. 4-33 Manifold Mounting Method

### Manifold and Regulator Station

The use of a central manifold and regulator station is recommended for elevated pressure systems which are typically installed in a parallel arrangement to take advantage of the capacity of the regulator, which is sufficient for several appliances. A four-port manifold is available with the DIAMONDBACK™ system, or the use of black iron pipe and tee fabricated manifolds is permitted with this system. The manifold/regulator station should be located near by the largest gas consuming appliances, typically the furnace or boiler and the water heater in order to allow short runs to these units. The manifold station may be contained in an enclosure box called a gas load center. Optional gas shut-off valves may be mounted on the manifold for each appliance run (See **FIG. 4-34**).

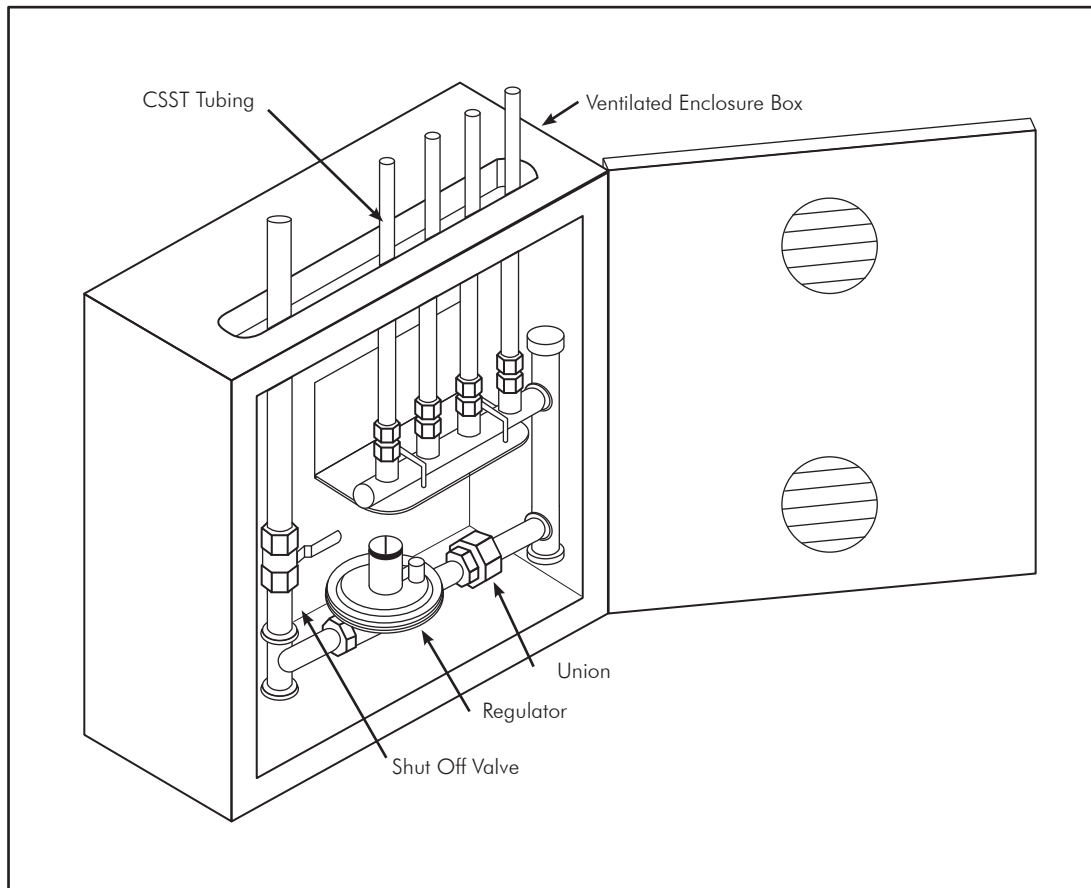


FIG. 4- 34 Gas Load Center

## 4.8 PRESSURE REGULATORS

### Regulators for Elevated Pressure Systems

A tubing system used at gas pressures exceeding 0.5 PSI (3.45 kPa) but serving appliances rated for 0.5 PSI (3.45 kPa) maximum, shall contain a pounds-to-inches regulator to limit the downstream pressure to no more than 0.5 PSI (3.45 kPa). The regulator must incorporate a lock-up feature limiting downstream pressure to 0.5 PSI (3.45 kPa). Under no flow conditions. The regulator shall comply with the applicable provisions of ANSI/Z21.80.

Regulators used to reduce elevated system pressures for use by appliances must also conform to the following:

1. Must be sized to supply the required appliance load (See **Table 4-35 or 3-5**).
2. Must be equipped with an acceptable vent limiting device, supplied by the manufacturer, or be capable of being vented to the outdoors. The vent-limiting device can be used when the regulator is installed in a ventilated area. DIAMONDBACK™ ships all regulators with vent-limiters installed.
3. Must be installed in accordance with manufacturer's instructions. When a vent-limiter is used, the regulator must be mounted in an upright position. Install the regulator properly with gas flowing as indicated by the arrow on the casting.
4. Must be installed in a fully accessible area with an approved shut-off valve ahead of regulator and a union provided to enable removal of regulator.
5. For outdoor installations, remove the vent-limiter and mount regulator with the vent outlet pointing down.

Model	7 in. w.c. (13.08mmHg)	0.5 PSI (3.45kPa)	0.75 PSI (5.17kPa)	1 PSI (5.9kPa)
Maxitrol 325-3L	145CFH	204CFH	250CFH	289CFH
Maxitrol 325-5AL	338CFH	476CFH	583CFH	673CFH
Maxitrol 325-7L	690CFH	972CFH	1191CFH	1375CFH
O.A.R.A Type 90	155CFH	220CFH	280CFH	310CFH
O.A.R.A Type 95	359CFH	504CFH	627CFH	719CFH

### Adjusting Maxitrol Regulator

The Maxitrol 325-3L, 325-5AL and O.A.R.A. Type 90 pressure regulators are AGA/CGA Design Certified for 2.0 PSIG (13.79 kPa) inlet pressure. The Maxitrol 325-3L47 and 325-5AL48 pressure regulators are AGA/CGA Design Certified for 5.0 PSIG (34.48 kPa) inlet pressure. Installations with a supply gas pressure exceeding 2 PSI (13.79 kPa) require a tested and approved over pressure protection device for use with this regulator. The regulator shall comply with the applicable provisions of ANSI/Z21.80.

The Maxitrol 325 pressure regulator's capacity limits depend upon inlet pressure. **Refer to FIG. 4-36A & 4-26B** for physical specifications for the Maxitrol 325 series pressure regulators.

1. Regulators can be adjusted to deliver different outlet pressures within a limited range. The range is determined by the spring installed.
2. Adjustment can be accomplished by first removing the regulator seal cap to expose the adjusting screw on the top. Turning the screw clockwise will increase outlet pressure, turning it counter clockwise will decrease outlet pressure.
3. If spring adjustment will not produce desired outlet pressure, check to make sure supply pressure is at least equal to desired outlet pressure plus pressure drop of the regulator. If supply pressure is adequate, consult factory if adjustment still cannot be made. **Do not continue to turn regulator adjusting screw clockwise if outlet pressure readings do not continue to increase. This may result in over-firing due to loss of pressure control, should there be a subsequent increase in inlet pressure.**



### Spring Adjustment

- The 2 PSI (13.79 kPa) system pounds-to-inches house line regulator can be adjusted with an outlet pressure ranging between 7 and 11 in. w.c. (13.08 and 20.55 mmHg). The regulator must be adjusted according to the manufacturer's recommended procedure. A pressure gauge mounted just downstream of the regulator can monitor the set pressure under various loads.
- The regulator is typically set when the system is operating at approximately 75 percent of maximum load.

The average natural gas appliance is designed to operate at 3 to 4 in. w.c. (5.60 to 7.47 mmHg) appliance manifold pressure, and a pressure difference of 1 to 2 in. w.c. (1.87 to 3.74 mmHg) across the appliance regulator which will prevent slow regulator response. Therefore, the appliance regulator will operate best at 5 to 6 in. w.c. (9.34 to 11.21 mmHg) inlet pressure. In this case, the 2 PSI (13.79 kPa) system regulator should be reset to deliver approximately 8 to 10 in. w.c. (14.94 to 18.68 mmHg) outlet pressure under load to allow for 3 in. w.c. (5.60 mmHg) pressure drop in the tubing. Regulators supplied by Tecvalco Ltd. are set for 7 in. w.c. (13.08 mmHg) output. Some appliances may have different inlet pressure requirements.

### Adjusting Maxitrol/O.A.R.A. Regulator

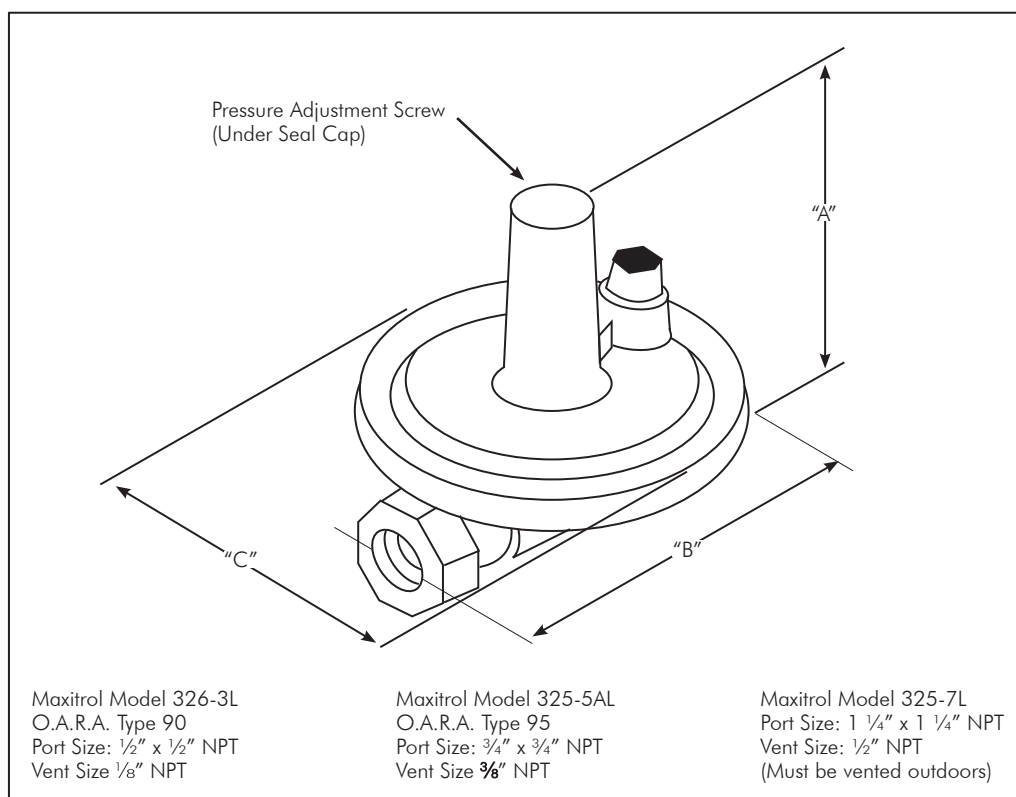


FIG. 4-26A Maxitrol 325 Pressure Regulator O.A.R.A. Type 90/95 Pressure Regulator

### Regulator Performance

#### Load Response

- A performance test should be conducted while operating all appliances at full load. This will test if adequate pressure is reaching each appliance under full-load conditions. To accomplish this, measure the line pressure at the appliance connection while operating the appliance.
- The inlet pressure for typical natural gas appliances should measure between 4 and 6 in. w.c. (7.47 and 11.21 mmHg) under full-load conditions. If this pressure cannot be obtained a slight adjustment to the pounds-to-inches regulator may be necessary to increase the line pressure. (If the service regulator needs to be adjusted, call the gas utility.) Do not set any system regulator over the system design pressure, 2 or 5 PSI (13.79 or 34.48 kPa).

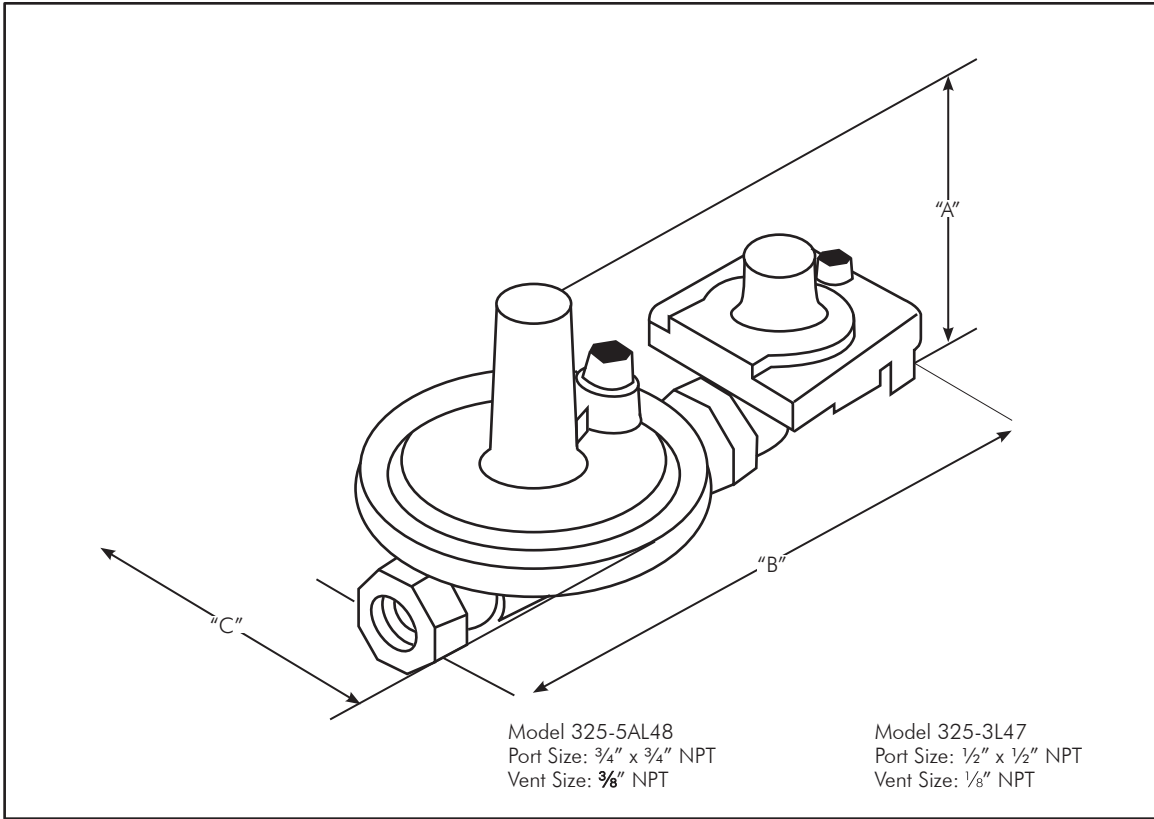


FIG. 4-36B Maxitrol 325 Pressure Regulator  
O.A.R.A. Type 90/95 Pressure Regulator

Model Number	Swing Radius	"A"	"B"	"C"
325-3L/Type 90	3" (76)	3 1/2" (89)	4 1/4" (108)	3 7/8" (98)
325-3LP	3" (76)	3 1/2" (89)	4 1/4" (108)	3 7/8" (98)
325-5AL/Type 95	4 7/8" (124)	5 1/4" (133)	5 7/8" (149)	5 7/16" (138)
325-7L	3" (76)	3 1/2" (89)	7 1/2" (191)	3 15/16" (100)
325-5AL48	4 7/16" (113)	5 3/8" (137)	9 3/4" (248)	5 7/16" (138)
325-3L47	6 1/8" (156)	7 1/4" (184)	8" (203)	7" (178)

## 4.9 UNDERGROUND INSTALLATIONS

### Acceptable Usage

DIAMONDBACK™ CSST shall not be buried directly in the ground or directly embedded in concrete. When DIAMONDBACK™ is to be buried in the ground or embedded into concrete it shall be routed inside of a nonmetallic conduit such as schedule 40 PVC. The conduit must be sealed at any end that is exposed to outdoor weather conditions to prevent water from entering. It is recommended that the CSST be one continuous piece inside the conduit from end to end CSST mechanical fittings are not allowed or permitted inside the conduit.

**FIG. 4-26** shows an acceptable installation of CSST underground or in concrete.

## 4.10 ELECTRICAL BONDING/GROUNDING

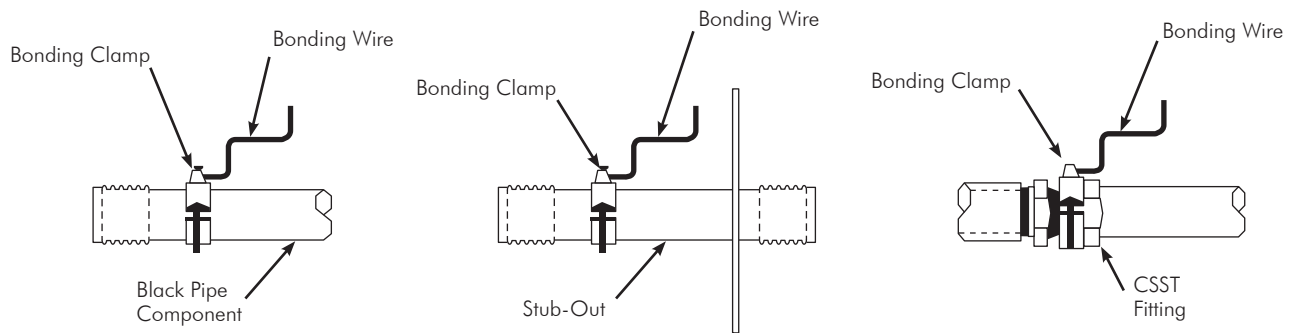
Direct bonding of DIAMONDBACK™ CSST is required for all gas piping systems incorporating DIAMONDBACK™ CSST whether or not the connected gas equipment is electrically powered. This requirement is provided as part of the manufacturer's instruction for single-family and multi-family buildings. Bonding for commercial applications should be designed by engineers knowledgeable in electrical system design and the local electrical code.

DIAMONDBACK™ CSST installed inside or attached to a building or structure shall be electrically continuous and direct bonded to an effective ground-fault current path. The gas piping system shall be considered to be direct bonding when installed in accordance with the following:

- The piping is permanently and directly connected to the electrical service equipment enclosure, the grounded conductor at the electrical service, the grounding electrode conductor (where of sufficient size) or to one or more of the grounding electrodes used.
- A single bond shall be made at or near the service entrance of the structure or the gas meter of each individual housing unit within a multi-family structure.
- The bonding conductor shall be **6 AWG** copper wire.
- Bonding jumpers shall be attached in an approved manner in accordance with NEC-2005 Article 250.70 and attachment bonding point for the bonding jumper shall be accessible.
- This bond is in addition to any other bonding requirements as specified by local codes.

DIAMONDBACK™ DBC series bonding clamps or equivalent UL 467 listed bonding clamps are recommended.

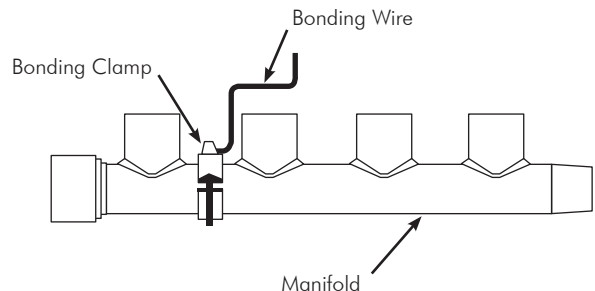
For attachment to the DIAMONDBACK™ gas piping system, a single bonding clamp must be attached to either a DIAMONDBACK™ brass fitting, a steel manifold, or to any rigid pipe component. The bonding clamp and wire are to be installed by a qualified electrician. **No location along the corrugated stainless steel tubing portion of the gas piping system shall be used as the bonding attachment point under any circumstances.**



DBC100 Bonding Clamp - Can be attached to DIAMONDBACK™ 375DMF & 500DMF CSST fittings and 500DSM & 700DSM CSST manifolds

DBC200 Bonding Clamp - Can be attached to DIAMONDBACK™ 750DMF, 1000DMF & 1250DMF CSST fittings

\*Bonding clamps for rigid pipe must be of the appropriate size and type\*



**Note: The DIAMONDBACK™ Flexible Gas Piping or other gas system components shall not be used as a grounding electrode or as the grounding path for appliances or electrical systems.**

As with all DIAMONDBACK™ guidelines, the techniques outlined within this manual are subject to all local fuel gas and building codes.

## CHAPTER 5.0: INSPECTION, REPAIR & REPLACEMENT

**Inspection:** (For Inspection Checklist See Chapter 8 Appendix C).

### REPAIR OF DAMAGED TUBING

Damaged tubing runs shall be repaired in accordance with this design guide and installation instruction manual. The repair can result in a line splice (as shown in **FIG. 5-1**) which may be located in a concealed location.

If the tubing is damaged refer to the following subsections to determine the severity of damage and, if necessary, the method of repair.

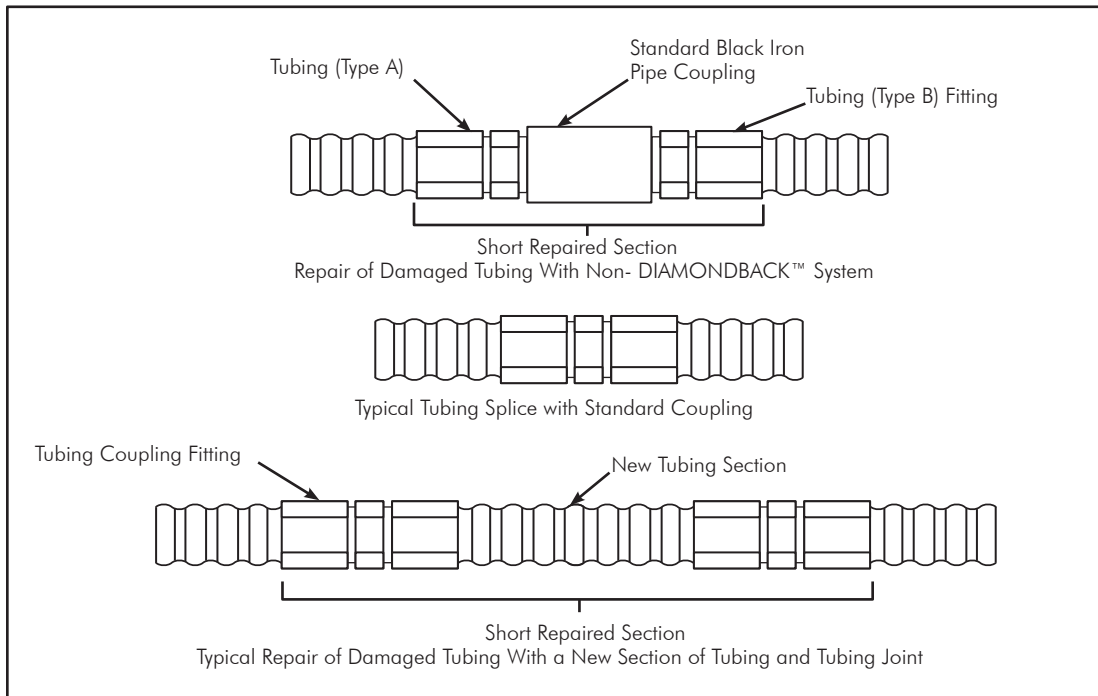


FIG. 5-1 Repair of Existing Tubing Runs

### Classification of Repairs

- No repairs or replacement of the tubing is necessary if the tubing is only slightly dented by crushing as indicated in **FIG. 5-2**.
- **DIAMONDBACK™** must be repaired or replaced under the following circumstances:
  - The tubing has been significantly damaged (**FIG. 5-3**).
  - The tubing has been punctured
  - The tubing has been bent beyond its minimum bend radius so that a crease or kink appears (**FIG. 5-4**).

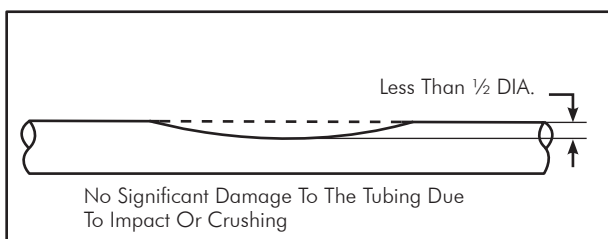


FIG. 5-2 Repair Is Not Necessary

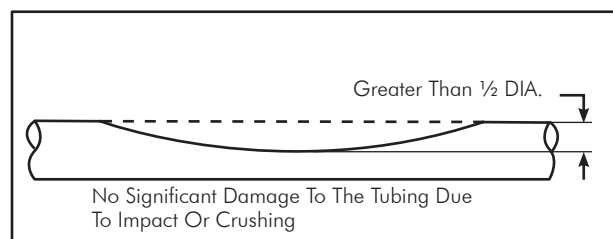


FIG. 5-3 Repair Is Necessary

## Repair of Damaged Tubing

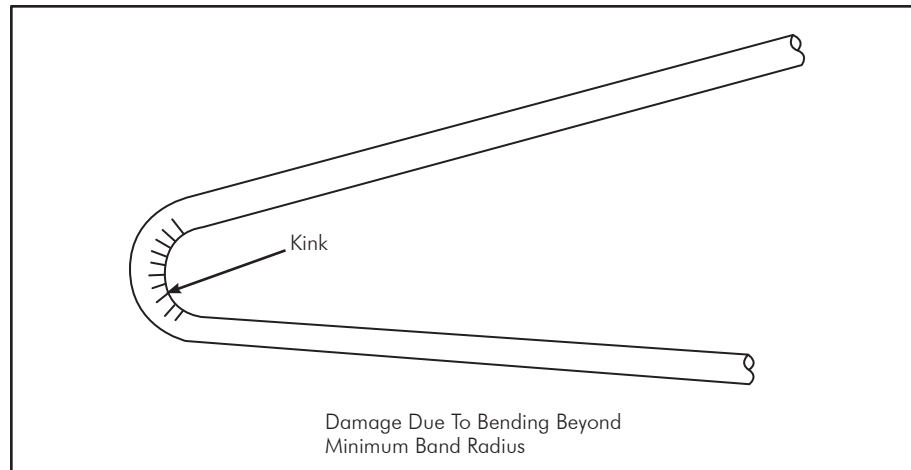


FIG. 5-4 Repair Is Necessary

### Method of Repair

Several methods of repair are discussed below depending on the nature of damage. The installer shall determine the most reliable and economical method of repair using one of the following methods:

- **Replace the entire tubing run:** In most cases, when the tubing run is short and easily accessible, it can be replaced faster and more economical than repairing the damaged section. This is the preferred method because extra fittings are not required.
- **Repair the damaged section:** The damaged tubing can be repaired by each of two methods described below:
  1. Remove the section of tubing which is damaged and reconnect the new ends with a single mechanical coupling. Use this repair method if the damaged section is small and if there is enough slack tubing in the run to make-up for the removed damaged length. (**FIG. 5-1**)
  2. Remove the section of tubing which is damaged and splice in a new section of tubing with two mechanical couplings as illustrated in **FIG. 5-5**. Use this repair method if the extent of the damage covers more than a small area, and there is not enough slack in the existing tubing run to make-up the damaged length.
  3. Also in either method, it is possible to use two mechanical joint fittings with a black iron pipe coupling instead of a single mechanical coupling.

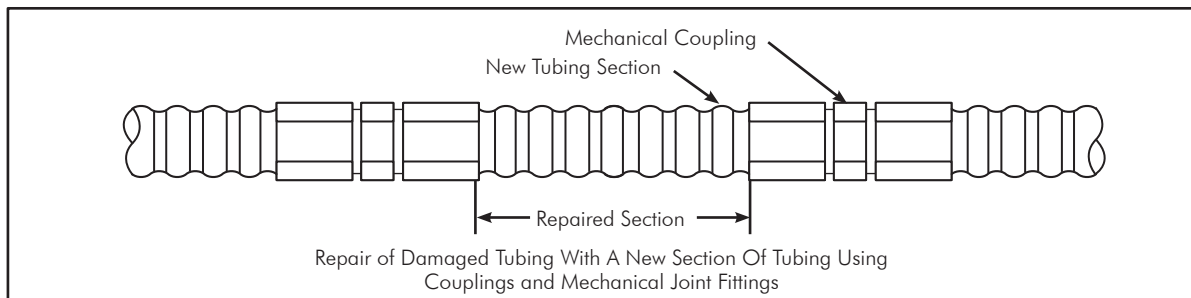


FIG. 5-5 repair of Damaged Tubing

# CHAPTER 6.0: PRESSURE/LEAKAGE TESTING

## Pressure testing and Inspection Procedure

- **The final installation must be inspected and tested for leaks in accordance with the local/state codes.** Where no local/state codes exists, the Inspection, Testing and Purging of the installation shall be performed using the procedures found in part 7 of the National Fuel Gas Code, ANSL Z223.1 and/or CAN/CGA-B149 installation codes. (1½ times the maximum working pressure, but not less than 3 PSI (20.69 kPa)). **Note: Subjecting the regulator to pressure greater than 7.5 PSI (51.71 kPa) could damage the regulator. If test pressure is greater than 7.5 PSI (51.71 kPa), replace the pounds to-inches pressure regulator with a suitable “jumper” pipe.**
- **Pressure testing must be performed during rough construction of the facility** (before interior walls finished). This will permit a more complete inspection of the piping system during the pressure testing, and save costly reworks in the event of leaks or other problems. Tecvalco Ltd. is not responsible for repairs necessary to correct defects after interior walls are finished.
- Do not connect appliances or pressurize with fuel gas until after the pressure test this been passed.
- All gas outlets for appliance connections should be capped during pressure testing.
- A2 PSI (13.79 kPa) system usually requires a pressure test of 3 PSI (20.69 kPa), depending on local code. The test may be performed as a one part test by replacing the regulator with suitable “jumper” pipe length for pressure testing the entire system. Or a two-part test may be performed as shown in **FIG. 6-1**.
  1. The first test is performed on the elevated pressure section, between the meter connection and the pounds-to-inches house line regulator.
  2. The second test is performed on the low-pressure section, between the outlet of the pounds-to-inches house line regulator and the gas appliance outlet.
- Most jurisdictions also require n additional pressure or leakage test performed after construction is completed and finished interior walls are in place. The leakage test procedure is generally performed by the gas utility at the time of setting their meter. This test is performed to assure no damage was done to the tubing during the closing-in construction process, and is required before gas service is initiated.

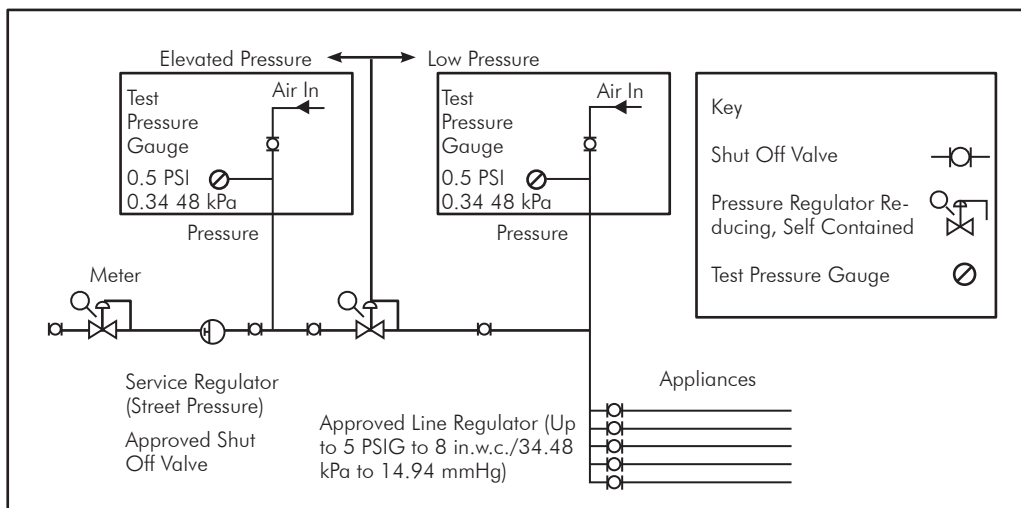


FIG. 6-1 Pressure Test Requirement for Elevated Pressure Systems

## Appliance Connection Leakage Check Procedure

After the final pressure test, inspection and final construction is complete (finished interior walls) connect the appliances to the tubing system. Use DIAMONDBACK™ CSST or black iron pipe for fixed appliances such as the furnace and water heater. Use an approved flexible appliance connector for movable appliances such as a dryer or range. 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. **Matches, candles, open flames, or other methods which could provide a source of ignition shall not be used.**
- 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 vent into a well-ventilated area.

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

# CHAPTER 7.0: SIZING TABLES

## 7.1 DIAMONDBACK™ CSST SIZING TABLES

**Table N-1**

**Low Pressure System - 0.5 in.w.c. drop (.93 mmHg)**

Maximum capacity of DIAMONDBACK™ CSST in cubic feet per hour (CFH). 1 CFH = 1000 BTU

Gas Pressure: 7 in.w.c. (13.08 mmHg)

Pressure Drop: .5 in.w.c. (.93 mmHg)

**Length In Feet (meters)**

Tubing Size	EHD**	5 (1.52)	10 (3.05)	15 (4.57)	20 (6.10)	25 (7.62)	30 (9.14)	40 (12.19)	50 (15.24)	60 (18.29)	70 (21.38)	80 (24.38)	90 (27.43)	100 (30.48)	125 (38.10)	150 (45.72)	200 (60.46)	250 (76.20)	300 (91.44)
3/8" (10)	15	75	53	45	37	33	30	26	23	21	20	18	17	16	15	13	11	10	9
1/2" (13)	19	151	108	88	77	69	63	55	49	45	41	39	37	35	31	28	25	22	20
3/4" (19)	25	335	242	200	175	158	145	126	114	104	97	91	86	82	74	68	59	53	49
1" (25)	31	635	454	374	325	292	268	233	209	192	178	167	158	150	134	123	107	96	88
1 1/4" (32)	37	1324	943	774	672	603	551	479	430	393	364	341	322	306	274	251	218	195	179

\*\*EHD (Equivalent Hydraulic Diameter): A relative measure of flow capacity. This number is used to compare individual sizes between different manufacturers. The higher the EHD value the greater flow capacity of the piping.

\* Numbers are based on 0.60 specific gravity gas.

\* Table includes losses for four (4) 90° bends and two (2) end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number in feet to the actual run length using the following formula:

\*  $L = 1.3 \times N$

L = Number of feet to be added to actual run length.

N = Number of bends and/or fittings over six (6).

**Table N-2**

**Low Pressure System - 1 in.w.c. drop (1.87 mmHg)**

Maximum capacity of DIAMONDBACK™ CSST in cubic feet per hour (CFH). 1 CFH = 1000 BTU

Gas Pressure: 7 in.w.c. (13.08 mmHg)

Pressure Drop: 1 in.w.c. (1.87 mmHg)

**Length In Feet (meters)**

Tubing Size	EHD**	5 (1.52)	10 (3.05)	15 (4.57)	20 (6.10)	25 (7.62)	30 (9.14)	40 (12.19)	50 (15.24)	60 (18.29)	70 (21.38)	80 (24.38)	90 (27.43)	100 (30.48)	125 (38.10)	150 (45.72)	200 (60.46)	250 (76.20)	300 (91.44)
3/8" (10)	15	106	75	61	53	47	43	37	33	30	26	25	23	21	19	16	15	13	13
1/2" (13)	19	212	151	124	108	97	88	77	69	63	58	55	51	49	44	40	35	31	28
3/4" (19)	25	464	335	277	242	218	200	175	158	145	135	126	120	114	102	94	82	74	68
1" (25)	31	886	635	522	454	408	374	325	292	268	248	233	220	209	188	172	150	134	123
1 1/4" (32)	37	1857	1324	1086	943	846	774	672	603	551	511	479	452	430	385	352	306	274	251

\*\*EHD (Equivalent Hydraulic Diameter): A relative measure of flow capacity. This number is used to compare individual sizes between different manufacturers. The higher the EHD value the greater flow capacity of the piping.

\* Numbers are based on 0.60 specific gravity gas.

\* Table includes losses for four (4) 90° bends and two (2) end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number in feet to the actual run length using the following formula:

\*  $L = 1.3 \times N$

L = Number of feet to be added to actual run length.

N = Number of bends and/or fittings over six (6).



**Table N-3**

**Low Pressure System - 3 in.w.c. drop (5.60 mmHg)**

Maximum capacity of DIAMONDBACK™ CSST in cubic feet per hour (CFH). 1 CFH = 1000 BTU

Gas Pressure: 10 in.w.c. (18.68 mmHg)

Pressure Drop: 3 in.w.c. (5.60 mmHg)

**Length In Feet (meters)**

Tubing Size	EHD**	5 (1.52)	10 (3.05)	15 (4.57)	20 (6.10)	25 (7.62)	30 (9.14)	40 (12.19)	50 (15.24)	60 (18.29)	70 (21.38)	80 (24.38)	90 (27.43)	100 (30.48)	125 (38.10)	150 (45.72)	200 (60.46)	250 (76.20)	300 (91.44)
3/8" (10)	15	185	131	106	92	82	75	65	58	53	49	46	43	41	36	33	29	26	23
1/2" (13)	19	362	258	212	184	165	151	131	118	108	100	94	88	84	75	69	60	53	49
3/4" (19)	25	776	561	464	405	365	335	293	264	242	225	212	200	191	172	158	138	124	114
1" (25)	31	1504	1077	886	772	693	635	553	496	454	422	396	374	355	319	292	254	228	209
1 1/4" (32)	37	3177	2264	1857	1614	1447	1324	1150	1031	943	875	820	774	735	659	603	524	470	430

\*\*EHD (Equivalent Hydraulic Diameter): A relative measure of flow capacity. This number is used to compare individual sizes between different manufacturers. The higher the EHD value the greater flow capacity of the piping.

\* Numbers are based on 0.60 specific gravity gas.

\* Table includes losses for four (4) 90° bends and two (2) end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number in feet to the actual run length using the following formula:

\*  $L = 1.3 \times N$

L = Number of feet to be added to actual run length.

N = Number of bends and/or fittings over six (6).

**Table N-4**

**Low Pressure System - 6 in.w.c. drop (11.21 mmHg)**

Maximum capacity of DIAMONDBACK™ CSST in cubic feet per hour (CFH). 1 CFH = 1000 BTU

Gas Pressure: 12 in.w.c. (22.42 mmHg)

Pressure Drop: 6 in.w.c. (11.21 mmHg)

**Length In Feet (meters)**

Tubing Size	EHD**	5 (1.52)	10 (3.05)	15 (4.57)	20 (6.10)	25 (7.62)	30 (9.14)	40 (12.19)	50 (15.24)	60 (18.29)	70 (21.38)	80 (24.38)	90 (27.43)	100 (30.48)	125 (38.10)	150 (45.72)	200 (60.46)	250 (76.20)	300 (91.44)
3/8" (10)	15	262	185	151	131	117	106	92	82	75	69	65	61	58	52	47	41	36	33
1/2" (13)	19	508	362	297	258	232	212	184	165	151	140	131	124	118	106	97	84	75	69
3/4" (19)	25	1074	776	642	561	505	464	405	365	335	312	293	277	264	238	218	191	172	158
1" (25)	31	2100	1504	1237	1077	967	886	772	693	635	589	553	522	496	446	408	355	319	292
1 1/4" (32)	37	4457	3177	2606	2264	2030	1857	1614	1447	1324	1228	1150	1086	1031	925	846	735	659	603

\*\*EHD (Equivalent Hydraulic Diameter): A relative measure of flow capacity. This number is used to compare individual sizes between different manufacturers. The higher the EHD value the greater flow capacity of the piping.

\* Numbers are based on 0.60 specific gravity gas.

\* Table includes losses for four (4) 90° bends and two (2) end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number in feet to the actual run length using the following formula:

\*  $L = 1.3 \times N$

L = Number of feet to be added to actual run length.

N = Number of bends and/or fittings over six (6).

**Table N-5**  
**Elevated Pressure System - 1 PSI drop (6.90 kPa)**

Maximum capacity of DIAMONDBACK™ CSST in cubic feet per hour (CFH). 1 CFH = 1000 BTU

Gas Pressure: 2 PSIG (13.79 kPa)

Pressure Drop: 1 PSIG (6.90 kPa)

**Length In Feet (meters)**

Tubing Size	EHD**	10 (3.05)	25 (7.62)	30 (9.14)	40 (12.19)	50 (15.24)	60 (18.29)	70 (21.34)	80 (24.38)	100 (30.48)	125 (38.10)	150 (45.72)	200 (60.46)	250 (76.20)	300 (91.44)	400 (121.92)	500 (152.40)
3/8" (10)	15	399	252	230	199	178	162	150	140	125	112	102	88	79	72	62	56
1/2" (13)	19	764	489	447	389	349	319	296	277	249	223	204	177	159	145	126	113
3/4" (19)	25	1589	1035	950	831	748	687	639	600	541	487	447	391	352	323	282	254
1" (25)	31	3142	2022	1852	1612	1448	1326	1231	1155	1037	931	853	743	667	611	532	478
1 1/4" (32)	37	6711	4289	3924	3409	3057	2797	2594	2430	2179	1954	1787	1553	1393	1274	1107	992

\*\*EHD (Equivalent Hydraulic Diameter): A relative measure of flow capacity. This number is used to compare individual sizes between different manufacturers. The higher the EHD value the greater flow capacity of the piping.

\* Numbers are based on 0.60 specific gravity gas.

\* Table includes losses for four (4) 90° bends and two (2) end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number in feet to the actual run length using the following formula:

**CAUTION:** Capacities shown in table may exceed maximum capacity for a selected regulator. The Maxitrol regulators specified meet standard ANSI Z21.80. To comply with the standard, installations exceeding 2 PSI (13.79 kPa) nominal require a tested and approved over-pressure protection device for use with the regulator.

\*  $L = 1.3 \times N$

L = Number of feet to be added to actual run length.

N = Number of bends and/or fittings over six (6).

**Table N-6**

**Elevated Pressure System - 1.5 PSI drop (10.34 kPa)**

Maximum capacity of DIAMONDBACK™ CSST in cubic feet per hour (CFH). 1 CFH = 1000 BTU

Gas Pressure: 2 PSIG (13.79 kPa)

Pressure Drop: 1.5 PSIG (10.34 kPa)

**Length In Feet (meters)**

Tubing Size	EHD**	10 (3.05)	25 (7.62)	30 (9.14)	40 (12.19)	50 (15.24)	60 (18.29)	70 (21.34)	80 (24.38)	100 (30.48)	125 (38.10)	150 (45.72)	200 (60.46)	250 (76.20)	300 (91.44)	400 (121.92)	500 (152.40)
3/8" (10)	15	490	309	282	244	218	199	184	172	154	138	125	109	97	88	76	68
1/2" (13)	19	931	596	545	474	425	389	360	338	30	272	249	216	194	177	154	138
3/4" (19)	25	1922	1251	1149	1004	905	831	773	726	654	589	541	473	426	391	342	308
1" (25)	31	3820	2457	2251	1960	1760	1612	1497	1404	1261	1132	1037	903	811	743	647	581
1 1/4" (32)	37	8180	5229	4783	4156	3727	3409	3162	2962	2656	2382	2179	1893	1698	1553	1349	1210

\*\*EHD (Equivalent Hydraulic Diameter): A relative measure of flow capacity. This number is used to compare individual sizes between different manufacturers. The higher the EHD value the greater flow capacity of the piping.

\* Numbers are based on 0.60 specific gravity gas.

\* Table includes losses for four (4) 90° bends and two (2) end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number in feet to the actual run length using the following formula:

**CAUTION:** Capacities shown in table may exceed maximum capacity for a selected regulator. The Maxitrol regulators specified meet standard ANSI Z21.80. To comply with the standard, installations exceeding 2 PSI (13.79 kPa) nominal require a tested and approved over-pressure protection device for use with the regulator.

\*  $L = 1.3 \times N$

L = Number of feet to be added to actual run length.

N = Number of bends and/or fittings over six (6).

**Table N-7**  
**Elevated Pressure System - 3.5 PSI drop (24.13 kPa)**

Maximum capacity of DIAMONDBACK™ CSST in cubic feet per hour (CFH). 1 CFH = 1000 BTU

Gas Pressure: 5 PSIG (34.48 kPa)

Pressure Drop: 3.5 PSIG (24.13 kPa)

**Length In Feet (meters)**

Tubing Size	EHD**	10 (3.05)	25 (7.62)	30 (9.14)	40 (12.19)	50 (15.24)	60 (18.29)	70 (21.34)	80 (24.38)	100 (30.48)	125 (38.10)	150 (45.72)	200 (60.46)	250 (76.20)	300 (91.44)	400 (121.92)	500 (152.40)
3/8" (10)	15	749	473	432	373	334	305	282	264	236	211	192	166	149	136	117	105
1/2" (13)	19	1406	900	823	716	642	587	545	511	458	411	376	327	293	268	233	209
3/4" (19)	25	2857	1861	1708	1493	1345	1235	1149	1079	972	876	804	703	633	581	508	458
1" (25)	31	5743	3695	3384	2947	2647	2424	2251	2111	1896	1703	1560	1358	1220	1117	973	873
1 1/4" (32)	37	12,375	7909	7235	6287	5638	5157	4783	4481	4018	3603	3296	2864	2568	2349	2041	1830

\*\*EHD (Equivalent Hydraulic Diameter): A relative measure of flow capacity. This number is used to compare individual sizes between different manufacturers. The higher the EHD value the greater flow capacity of the piping.

\* Numbers are based on 0.60 specific gravity gas.

\* Table includes losses for four (4) 90° bends and two (2) end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number in feet to the actual run length using the following formula:

**CAUTION:** Capacities shown in table may exceed maximum capacity for a selected regulator. The Maxitrol regulators specified meet standard ANSI Z21.80. To comply with the standard, installations exceeding 2 PSI (13.79 kPa) nominal require a tested and approved over-pressure protection device for use with the regulator.

\*  $L = 1.3 \times N$

L = Number of feet to be added to actual run length.

N = Number of bends and/or fittings over six (6).

**Table P-1**

**Propane Gas Low Pressure System - 0.5 in.w.c. drop (.93 mmHg)**

Maximum capacity of DIAMONDBACK™ CSST (in Thousands of BTU per hour of undiluted L.P. Gas)

Gas Pressure: 11 in. w.c. (20.55 mmHg)

Pressure Drop: 0.5 in. w.c. (.93 mmHg)

**Length In Feet (meters)**

Tubing Size	EHD**	5 (1.52)	10 (3.05)	15 (4.57)	20 (6.10)	25 (7.62)	30 (9.14)	40 (12.19)	50 (15.24)	60 (18.29)	70 (21.38)	80 (24.38)	90 (27.43)	100 (30.48)	125 (38.10)	150 (45.72)	200 (60.46)	250 (76.20)	300 (91.44)
3/8" (10)	15	119	84	68	59	53	48	42	37	34	31	29	27	26	23	21	18	16	15
1/2" (13)	19	239	170	140	121	109	100	87	78	71	66	62	58	55	49	45	39	35	32
3/4" (19)	25	530	383	317	277	249	229	200	180	165	154	145	137	130	117	108	94	85	78
1" (25)	31	1004	719	591	515	462	423	369	331	303	281	264	249	237	213	195	170	152	139
1 1/4" (32)	37	2093	1492	1224	1063	953	872	758	679	621	576	540	510	484	434	397	345	309	283

\*\*EHD (Equivalent Hydraulic Diameter): A relative measure of flow capacity. This number is used to compare individual sizes between different manufacturers. The higher the EHD value the greater flow capacity of the piping.

\* Numbers are based on 0.60 specific gravity gas.

\* Table includes losses for four (4) 90° bends and two (2) end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number in feet to the actual run length using the following formula:

\*  $L = 1.3 \times N$

L = Number of feet to be added to actual run length.

N = Number of bends and/or fittings over six (6).

**Table P-2**  
**Propane Gas Low Pressure System - 3 in.w.c. drop (5.60 mmHg)**

Maximum capacity of DIAMONDBACK™ CSST (in Thousands of BTU per hour of undiluted L.P. Gas)

Gas Pressure: 0.5 in. w.c. (3.45 kPa)

Pressure Drop: 3 in. w.c. (5.60 mmHg)

**Length In Feet (meters)**

Tubing Size	EHD**	10 (3.05)	25 (7.62)	30 (9.14)	40 (12.19)	50 (15.24)	60 (18.29)	70 (21.34)	80 (24.38)	90 (27.43)	100 (30.48)	125 (38.10)	150 (45.72)	200 (60.46)	250 (76.20)	300 (91.44)	400 (121.92)	500 (152.40)
3/8" (10)	15	207	130	119	103	92	84	78	72	68	65	58	53	46	41	37	32	29
1/2" (13)	19	409	261	239	208	186	170	158	148	140	133	119	109	95	85	78	67	60
3/4" (19)	25	887	578	530	463	417	383	357	335	317	302	272	249	218	196	180	157	142
1" (25)	31	1703	1096	1004	874	785	719	667	626	591	562	505	462	402	361	331	288	259
1 1/4" (32)	37	3580	2288	2093	1818	1631	1492	1383	1296	1224	1162	1042	953	828	743	679	590	529

\*\*EHD (Equivalent Hydraulic Diameter): A relative measure of flow capacity. This number is used to compare individual sizes between different manufacturers. The higher the EHD value the greater flow capacity of the piping.

\* Numbers are based on 0.60 specific gravity gas.

\* Table includes losses for four (4) 90° bends and two (2) end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number in feet to the actual run length using the following formula:

\*  $L = 1.3 \times N$

L = Number of feet to be added to actual run length.

N = Number of bends and/or fittings over six (6).

**Table P-3**

**Propane Gas Elevated Pressure System - 1 PSI drop (6.90 kPa)**

Maximum capacity of DIAMONDBACK™ CSST (in Thousands of BTU per hour of undiluted L.P. Gas)

Gas Pressure: 2 PSIG. (13.79 kPa)

Pressure Drop: 1 PSIG. (6.90 kPa)

**Length In Feet (meters)**

Tubing Size	EHD**	10 (3.05)	25 (7.62)	30 (9.14)	40 (12.19)	50 (15.24)	60 (18.29)	70 (21.34)	80 (24.38)	100 (30.48)	125 (38.10)	150 (45.72)	200 (60.46)	250 (76.20)	300 (91.44)	400 (121.92)	500 (152.40)
3/8" (10)	15	632	399	364	315	281	257	238	222	189	178	162	140	125	114	99	88
1/2" (13)	19	1208	773	707	615	551	504	468	438	375	353	323	280	251	230	200	179
3/4" (19)	25	2513	1636	1502	1313	1183	1086	1010	949	818	770	707	618	557	511	447	402
1" (25)	31	4968	3196	2927	2549	2289	2097	1947	1826	1566	1473	1349	1175	1055	966	841	756
1 1/4" (32)	37	10608	6780	6202	5389	4833	4421	4100	3841	3445	3089	2826	2455	2202	2014	1750	1569

\*\*EHD (Equivalent Hydraulic Diameter): A relative measure of flow capacity. This number is used to compare individual sizes between different manufacturers. The higher the EHD value the greater flow capacity of the piping.

\* Numbers are based on 0.60 specific gravity gas.

\* Table includes losses for four (4) 90° bends and two (2) end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number in feet to the actual run length using the following formula:

**CAUTION:** Capacities shown in table may exceed maximum capacity for a selected regulator. The Maxitrol regulators specified meet standard ANSI Z21.80. To comply with the standard, installations exceeding 2 PSI (13.79 kPa) nominal require a tested and approved over-pressure protection device for use with the regulator.

\*  $L = 1.3 \times N$

L = Number of feet to be added to actual run length.

N = Number of bends and/or fittings over six (6).

**Table P-4**

**Propane Gas Elevated Pressure System - 1.5 PSI drop (10.30 kPa)**

Maximum capacity of DIAMONDBACK™ CSST (in Thousands of BTU per hour of undiluted L.P. Gas)

Gas Pressure: 2 PSIG. (13.79 kPa)

Pressure Drop: 1.5 PSIG. (10.30 kPa)

**Length In Feet (meters)**

Tubing Size	EHD**	10 (3.05)	25 (7.62)	30 (9.14)	40 (12.19)	50 (15.24)	60 (18.29)	70 (21.34)	80 (24.38)	100 (30.48)	125 (38.10)	150 (45.72)	200 (60.46)	250 (76.20)	300 (91.44)	400 (121.92)	500 (152.40)
3/8" (10)	15	774	489	446	386	345	315	291	272	244	218	199	172	154	140	121	108
1/2" (13)	19	1472	942	862	749	672	615	570	534	479	430	393	342	306	280	244	219
3/4" (19)	25	3038	1978	1816	1588	1430	1313	1222	1148	1034	931	855	747	673	618	540	487
1" (25)	31	6038	3885	3558	3098	2783	2549	2367	2219	1993	1790	1640	1428	1282	1175	1023	918
1 1/4" (32)	37	12932	8265	7561	6570	5891	5389	4998	4683	4199	3765	3445	2993	2684	2455	2133	1913

\*\*EHD (Equivalent Hydraulic Diameter): A relative measure of flow capacity. This number is used to compare individual sizes between different manufacturers. The higher the EHD value the greater flow capacity of the piping.

\* Numbers are based on 0.60 specific gravity gas.

\* Table includes losses for four (4) 90° bends and two (2) end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number in feet to the actual run length using the following formula:

**CAUTION:** Capacities shown in table may exceed maximum capacity for a selected regulator. The Maxitrol regulators specified meet standard ANSI Z21.80. To comply with the standard, installations exceeding 2 PSI (13.79 kPa) nominal require a tested and approved over-pressure protection device for use with the regulator.

\*  $L = 1.3 \times N$

L = Number of feet to be added to actual run length.

N = Number of bends and/or fittings over six (6).

**Table P-5**

**Propane Gas Elevated Pressure System - 3.5 PSI drop (24.13 kPa)**

Maximum capacity of DIAMONDBACK™ CSST (in Thousands of BTU per hour of undiluted L.P. Gas)

Gas Pressure: 5 PSIG. (34.48 kPa)

Pressure Drop: 3.5 PSIG. (24.13 kPa)

**Length In Feet (meters)**

Tubing Size	EHD**	10 (3.05)	25 (7.62)	30 (9.14)	40 (12.19)	50 (15.24)	60 (18.29)	70 (21.34)	80 (24.38)	100 (30.48)	125 (38.10)	150 (45.72)	200 (60.46)	250 (76.20)	300 (91.44)	400 (121.92)	500 (152.40)
3/8" (10)	15	1186	749	684	591	529	482	446	418	374	333	304	262	236	215	185	166
1/2" (13)	19	2223	1423	1301	1132	1015	929	862	808	724	650	594	517	463	424	368	330
3/4" (19)	25	4517	2942	2700	2360	2126	1952	1816	1706	1537	1385	1217	1111	1001	919	803	724
1" (25)	31	9080	5842	5350	4659	4185	3832	3558	3337	2998	2692	2466	2147	1929	1766	1538	1380
1 1/4" (32)	37	19561	12503	11438	9938	8912	8152	7561	7084	6352	5696	5211	4528	4060	3714	3227	2894

\*\*EHD (Equivalent Hydraulic Diameter): A relative measure of flow capacity. This number is used to compare individual sizes between different manufacturers. The higher the EHD value the greater flow capacity of the piping.

\* Numbers are based on 0.60 specific gravity gas.

\* Table includes losses for four (4) 90° bends and two (2) end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number in feet to the actual run length using the following formula:

**CAUTION:** Capacities shown in table may exceed maximum capacity for a selected regulator. The Maxitrol regulators specified meet standard ANSI Z21.80. To comply with the standard, installations exceeding 2 PSI (13.79 kPa) nominal require a tested and approved over-pressure protection device for use with the regulator.

\*  $L = 1.3 \times N$

L = Number of feet to be added to actual run length.

N = Number of bends and/or fittings over six (6).

## 7.2 BLACK IRON PIPE SIZING TABLE

**Table N-8**  
**Low Pressure System**

Maximum capacity of DIAMONDBACK™ CSST in cubic feet per hour (CFH). 1 CFH = 1000 BTU

Gas Pressure: 7 in.w.c. (13.08 mmHg)

Pressure Drop: .5 in.w.c. (.93 mmHg)

**Length In Feet (meters)**

Tubing Size	I.D.	10 (3.05)	20 (6.10)	30 (9.14)	40 (12.19)	50 (15.24)	60 (18.29)	70 (21.38)	80 (24.38)	90 (27.43)	100 (30.48)	125 (38.10)	150 (45.72)	175 (53.34)	200 (60.46)
3/8" (10)	.493	95	65	52	45	40	36	33	31	29	27	24	22	20	19
1/2" (13)	.622	175	120	97	82	73	66	61	57	53	50	44	40	37	35
3/4" (19)	.824	360	250	200	170	151	138	125	118	110	103	93	84	77	72
1" (25)	1.049	680	465	375	320	285	260	240	220	205	195	175	160	145	135
1 1/4" (32)	1.380	1400	950	770	660	580	530	490	460	430	400	360	325	300	280

\* Numbers are based on 0.60 specific gravity gas.

\* Table includes losses for four (4) 90° bends and two (2) end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number in feet to the actual run length using the following formula:

\*  $L = 1.3 \times N$

L = Number of feet to be added to actual run length.

N = Number of bends and/or fittings over six (6).

## CHAPTER 8.0: DEFINITIONS

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### Appendix A

#### CONVERSION FACTORS:

INCHES OF WATER COLUMN (in.-w.c.) – Method by which pressure is measured in inches by a manometer or pressure gauge. Used in the gas industry when the pressure is less than 1 PSI.

1 PSI = 27.684 in. w.c. (approximated at 28" w.c.)

½ PSI = 13.842 in. w.c. (approximated at 14" w.c.)

¼ PSI = 6.921 in. w.c. (approximated at 7" w.c.)

#### TERMINOLOGY

**AGA** – American Gas Association

**ANSI** – American National Standards Institute

**ANSI Z223.1** – 2002 edition of the National Fuel Gas Code published by American national Standards Institute. Also known as NFPA 54 (National Fire Protection Association pamphlet 54)

**ASTM** – American Society for Testing and Materials

**Appliance (Equipment)** – Any device which utilizes gas as a fuel or raw material to produce light, heat, power, refrigeration, or air conditioning.

**Approved** – Acceptable to the authority having jurisdiction.

**ASME** – American Society of Mechanical Engineers

**Authority Having Jurisdiction** – the organization, office or individual responsible for “approving” equipment, an installation or procedure.

**BTU** – Abbreviation for British Thermal Unit, which is the quantity of heat require to raise the temperature of one pound of water one degree Fahrenheit.

**CFH** – Gas flow rate stated in cubic feet per hour. A CFH of natural gas usually contains 1000 BTU’s and LPG contains 2500. Consult your local gas utility for actual BTU content in your area.

**CAN-CGA-BI49-1** – Natural gas installation code book used in Canada, Most current edition.

**CAN-CGA-BI49.2** – Propane gas installation code book used in Canada. Most current edition.

**CSST** – Corrugated stainless steel tubing.

**Concealed Gas Piping** – Gas piping, which, when in place in a finished building, would require removal of permanent construction to gain access to the piping.

**Connector, Gas Appliance** – A factory-fabricated assembly of gas conduit and related fittings designed to convey gaseous fuel, and used for making connections between a gas supply piping outlet and the gas inlet to an appliance. It is equipped at each end for attachment to standard tapered pipe threads.

**Delivery Pressure** – Gas pressure available after the gas meter.

**Design Pressure** – The maximum permitted operating pressure.

**Drip Leg** – The container (dirt trap pocket) placed at the lowest point in a system of piping to collect foreign materials and condensate. The container must be accessible for clean-out.

**EHD (Equivalent Hydraulic Diameter)** – A measurement of the relative hydraulic efficiency between different tube sizes. The larger the value of EHD, the greater the flow capacity.

**Elevated Pressure System** – Terms for any pressure above ½ PSIG (3.45 kPa), but less than 5 PSIG (34.78 kPa).

**Exposed Gas Piping** – Gas piping which will be in view in the finished structure.

**Fuel Gas** – A commonly distributed gas used for fuel such as natural gas, manufactured gas, undiluted liquefied petroleum gas (vapor phase only), liquefied petroleum gas-air mixtures of these gases (included propane and butane).

**Gas Utilization Equipment** – Any device, which utilizes gas as a fuel or raw material or both.

**Joint** – A connection between two lengths of tubing.

**Listed** – Equipment of materials including a list published by an organization acceptable to the authority having jurisdiction and concerned with product evaluation that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

**Lockup Pressure, Regulator** – the system pressure, immediately downstream of the regulator, at which the regulator valve will completely close (leak tight) under no-flow conditions to prevent the downstream pressure from exceeding a predetermined level.

**Load** – The amount of gas required by an appliance, or group of appliances per their manufacturers rating (see CFH definition).

**Manifold** – A fitting to which a number of branch lines are connected.

**Maximum Actual Operating Pressure** – the maximum pressure existing in a piping system during a normal annual operating cycle.

**Meter** – An instrument to measure the volume of gas delivered through a piping system.

**NFPA** – National Fire Protection Agency.

**Piping System** – As used in this manual, an assembly of corrugated stainless steel tubing and tubing connection fitting, intended for field assembly and installed in residential or commercial building to distribute fuel gas to gas utilization equipment within the building. The piping system may also include a gas pressure regulator(s), shutoff valves, tub shielding devices, distribution manifold(s) and other approved devices or components.

**Pressure** – Unless stated otherwise, is expressed in pounds per square inch above atmospheric pressure, i.e. gauge pressure (PSIG).

**Pressure Drop** – The loss of static pressure of flowing fuel gas due to friction or other flow resistance in tubing, fittings, valves, regulators, or other devices in the piping system.

**Pressure Regulator** – A valve which reduces and maintains pressure. It automatically opens and closes in response to changing pressure conditions in the downstream piping.

**PSIG** – Pounds per square inch, gauge. The pressure as read from a measurement gauge or device. Gauge pressure is pressure above atmospheric pressure and is sometimes referred to as PSI.

**Purge** – To completely displace an existing, as with a new gas.

**Qualified Installer** – Any individual, firm, corporation or company which either in person or through a representative is engaged in and is responsible for the installation or replacement of building gas piping systems, who is experienced in such work, familiar with all precautions required, and has complied with all the requirements of the authority have jurisdiction.

**Quick-Disconnect Device** – A hand-operated device, which provides a means for connecting and disconnecting an appliance or an appliance connector to a gas supply, and which, is equipped with an automatic means to shut off the gas supply when the device is disconnected.

**Regulator, Gas Appliance Pressure** – A device placed in a gas line for controlling and maintaining a uniform pressure to the manifold or gas burning equipment.

**Regulator, Pressure** – A device installed in a gas line for reducing, controlling and maintaining the pressure in that portion of the piping system downstream of the device. This device is used in elevated pressure systems and is referred as a pressure regulator in this manual.

**Regulator, Service Pressure** – A device installed by the servicing gas supplier to reduce and limit the service line gas pressure to delivery pressure.

**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.



**Shielding Devices** – A component of the piping system (Floppy-Flax) used to protect the installed CSST from accidental puncture by nails, screws or similar hardware at concealed tubing support points.

**Specific gravity** – As applied to gas, is the ratio of the weight of a given volume to that of the same volume of air, both measured under the same conditions.

**Striker Plates** – A special type of shielding device used when concealed tubing is run through wall studs, floor and ceiling joists or other structural members where tubing movement is restricted.

**Tubing** – ASTM A240 Type 304 Annular Corrugated Stainless Steel Tubing which is bendable and comes in 150' & 250' rolls.

**Valve, Shutoff** – A device used in piping to control the gas supply to any section of the piping system or to an appliance.

**Vent Limiting Device** – A valve that limits the discharge of gas from a regulator in the event of a diaphragm rupture. Gas discharge is limited to an ANSI approved level. See manufacturers specifications.

**Water column, Inches** – Method of stating pressure measured in inches of water column by a manometer or pressure gauge. Refer to "CONVERSION FACTORS" listed at the beginning of Appendix A.

## Appendix B

### Specific Gravity Factor

Gas piping systems that are to be supplied with gas of specific gravity other than 0.60 shall apply a specific gravity factor.

Such applications are accomplished by multiplying the capacities given in Tables and Charts by the appropriate multiplier from **Table A-10**. In case the exact specific gravity does not appear in the table, choose the next higher value specific gravity shown.

Specific Gravity	Multiplier	Specific Gravity	Multiplier
0.35	1.31	1.00	0.78
0.40	1.23	1.10	0.74
0.45	1.16	1.20	0.71
0.50	1.10	1.30	0.68
0.55	1.04	1.40	0.66
0.60	1.00	1.50	0.63
0.65	0.96	1.60	0.61
0.70	0.93	1.70	0.59
0.75	0.90	1.80	0.58
0.80	0.87	1.90	0.56
0.85	0.84	2.00	0.55
0.90	0.82	2.10	0.54

## Appendix C: DIAMONDBACK™ CSST Installation Checklist

### Description

DIAMONDBACK™ Corrugated Stainless Steel Tubing system has been design certified by (IAS) International Approval Services for used as a fuel gas piping system. It has been tested per ANSI/IAS LC 1 – CSA 6.26. The harmonized standard for AGA and CGA. It is listed as an approved gas piping material in the National Fuel Gas Code-NFPA 54, BOCA National Mechanical Code, SBCCI Standard Gas Code, ICBO Uniform Mechanical Code, CABO 1 and 2 Family Dwelling Code and the new International Code Series. DIAMONDBACK™ is a listed product with IAPMO, and pursuant to Section 302.1 of the Uniform Plumbing Code, as an alternate material and method, may be installed with approval from the local administrative authority.

### Conditions and Requirements of an Approved Installation

DIAMONDBACK™ CSST gas piping system must be installed in accordance with all local building codes and the installations instructions. The following checklist is designed to assist the local administrative authority to perform and inspection of the CSST gas piping system.

1. DIAMONDBACK™ CSST gas piping systems must only be installed by a person who has successfully completed the manufacturer’s training program. A manufacturer’s Trained Installer Card is required to purchase and install the DIAMONDBACK™ CSST system.

Does the Installer have a manufacturer’s Trained Installer Card? **Yes**

2. Only components specified in the installation instructions as part of the DIAMONDBACK™ CSST system are approved to be used for a new installation.

Are all the components from the same manufacturer? **Yes**

3. The correct size of the CSST in cubic feet per hour (CFH) is calculated from the capacity tables in the installation instructions.

Is the CSST sized correctly? **Yes**

4. The CSST must be protected by striker plates and strip wound conduit when routed through an area of potential threat from nails and screws.

Is the CSST protected per the installation instructions? **Yes**

5. The CSST can be run directly to stationary appliances such as a furnace or water heater and must not be connected to portable appliances such as a clothes dryer or range. Portable appliances should use an approved flexible gas connector between the appliance and the CSST termination fitting.

Are termination fittings used as the gas supply for portable appliances? **Yes**

6. The CSST system must be pressure tested during the rough in phase of construction per the local codes. In the absence of local codes, test in accordance with NFPA 54, National Fuel Gas Code, 1.5 times the operating pressure and not less than 3 PSI (20.69 kPa). The regulator may need to be removed or isolated.

Was the pressure test performed correctly? **Yes**

7. A regulator with vent limiting device must be installed in a horizontal upright position. Regulators without vent limiting devices are approved for multi-poise installation.

Is a regulator with a vent-limiting device in a horizontal position? **Yes**

8. A regulator must be accessible, have a shut off ball valve on the inlet side and a union on the outlet side so it can be inspected and serviced properly.

Is the regulator accessible, and is it in-between a shut off ball valve and a union? **Yes**

9. When CSST is installed outdoors the yellow polyethylene jacket must extend into the fitting or sealed from water entry so the stainless steel tubing is not subjected to the outdoor environment.

Is any of the outdoor stainless steel tubing visible? **No**

10. CSST installed underground or in concrete must be sleeved in a nonmetallic, watertight conduit with an I.D. at least one half inch greater than the O.D. of the CSST yellow polyethylene jacket. CSST mechanical joints inside the conduit are not permitted.

Is the CSST sleeved where it is underground or in concrete? **Yes**

Contractor: \_\_\_\_\_ License #: \_\_\_\_\_

Installed By: \_\_\_\_\_

Building Address: \_\_\_\_\_

City: \_\_\_\_\_ Province/State: \_\_\_\_\_ Postal Code/Zip: \_\_\_\_\_

Authority Having Jurisdiction: \_\_\_\_\_

Approved By: \_\_\_\_\_ Date: \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

