WARDFLEX® WARDFLEX® II

2014 DESIGN & INSTALLATION GUIDE

WFDI-032014
March, 2014

WARD MANUFACTURING

MADE IN THE USA
WARDFLEX CSST
Proudly

WARDFLEX® WARDFLEX® II

DESIGN AND INSTALLATION GUIDE

CORRUGATED STAINLESS STEEL TUBING FUEL GAS* PIPING

***Includes Natural Gas and Propane**

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C US FM PHCC

CLASSIFIED UL

THROUGH-PENETRATION PRODUCTS
FOR USE IN THROUGH-PENETRATION FIRESTOP SYSTEMS
SEE UL FIRE RESISTANCE DIRECTORY 9R81

Rev. 10 January 2014

Written in accordance with ANSI-LC 1 the Standard for Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing.

IMPORTANT READ ENTIRE MANUAL

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ATTENTION!

1. The installation of WARDFLEX®/WARDFLEX®II Flexible Gas piping must be performed by a trained installer who has successfully completed the WARDFLEX® training program. The installer must also meet all qualifications required by the state and/or local administrative authority administering the provisions of the code where the gas piping is installed.
2. All piping systems using WARDFLEX®/WARDFLEX®II shall be designed and installed according to the requirements of this guide.
3. Only WARDFLEX®/WARDFLEX®II components may be used in the system. Components from other CSST systems are not interchangeable. Only components supplied or specified by WARD Manufacturing shall be used.
4. Installation shall be in accordance with local codes, or in their absence, in accordance with the National Fuel Gas Code ANSI Z223.1 in the USA, and CAN/CGA - B149.1 & B149.2 in Canada. In cases where the requirements of this guide are in conflict with the local code, the local code must take precedence, unless the local authority having jurisdiction approves a variance, or change.
5. Inspection, testing, and purging shall be performed according to the procedures in Part 4 of the National Fuel Gas Code, ANSI Z223.1, and/or - B149 installation Codes or in accordance with local codes.
6. This system and related components shall be used only in gas piping systems where the operating gas pressure does not exceed 25 psig.
7. WARDFLEX® tubing with covering may be installed in or routed through air plenums, ducts, or other areas which may be limited by building codes to materials having maximum ASTM E84 ratings of 25 Flame Spread and 50 Smoke Density. Other procedures are to be followed by the installer to meet local building codes with respect to Flame Spread and Smoke Density regulations for nonmetallic materials. Currently WARDFLEX® II does not meet ASTM E-84 requirements.
8. Tubing may be routed through concrete floors or walls, provided it is encased in previously embedded non-metallic, liquid tight conduit approved for underground use. Tubing shall not be buried directly underground.
9. The CSST is typically routed:
   - Beneath, through and alongside floor joists
   - Inside interior wall cavities
   - On top of ceiling joists in attic space.
10. Carefully unwind and route the tubing from the reel to the required location, making certain not to kink, tangle or apply excessive force.
11. Tubing end must be temporarily capped or taped closed prior to installation to prevent contamination from foreign material.
12. When installing WARDFLEX®/WARDFLEX®II avoid sharp bends, stretching, kinking, twisting, or contacting sharp objects. The tubing shall be replaced if damage occurs.

IMPORTANT - READ ENTIRE MANUAL

1.1 USER WARNINGS(see ANSI LC 1-CSA 6.26)

The use of fuel gas can be dangerous. Special attention must be given to the proper design, installation, testing and application of the gas piping system. Sound engineering practices and principles must be exercised, as well as diligent adherence to the proper installation procedures to ensure the safe operation of the piping system. All installed systems must pass customary installation inspections by the local building official having authority prior to being placed into service.

This document is intended to provide the user with general guidance when designing and installing a WARDFLEX®/WARDFLEX®II corrugated stainless steel tubing gas system. Its use with any other gas tubing system is inappropriate and may result in serious bodily injury and property damage. Where local gas or building codes impose greater requirements than this document, you should adhere to the local code requirements. Performance of accessory devices, such as pressure regulators and shut off valves, should be reconfirmed by contacting the accessory device manufacturer and receiving the latest technical data on sizing, installation, and performance.

Improper installation methods or procedures could lead to accidents such as explosions, fires, gas poisoning, asphyxiation, etc. This system shall be installed with strict adherence to this guide as well as local building codes. All installed systems must pass installation inspections by the authorized local building official prior to being placed in service. Ward Manufacturing, LLC shall have no responsibility for any misinterpretation of the information contained in this guide or any improper installation or repair work or other deviation from procedures recommended in this manual, whether pursuant to local building codes or engineering specifications or otherwise.

Only those components designed and made for or specified for use in this system shall be used in its installation. WARDFLEX®/WARDFLEX®IIcomponents and tubing shall not be used with other corrugated stainless steel tubing system components from other manufacturers.

WARDFLEX®/WARDFLEX®II shall be used only in gas piping systems where the operating gas pressure does not exceed 25 PSI. Accessories for systems shall be rated for the operating gas pressure used. Thus, for example, accessories for 25 PSI systems shall be rated for 25 PSI service. Performance of accessory devices, such as pressure regulators and shut-off valves should be reconfirmed by contacting the accessory device manufacturer and receiving the latest technical data on sizing, installation and performance.

Certain chemicals are corrosive to WARDFLEX®/WARDFLEX®II. See Section 4.1 of the current manual for more specific information on this topic.

A gas delivery system consisting of WARDFLEX®/WARDFLEX®II offers significant advantages over other gas delivery systems because of its wall dimensions and corrugated design. In contrast to rigid steel pipe, WARDFLEX®/WARDFLEX®II does not require intermediate joints in most installations because the tubing is capable of being installed in one continuous run, reducing not only the total number of joints, but also the potential for leaks at joints. WARDFLEX®/WARDFLEX®II's flexibility also affords more installation options because an installer can avoid existing obstacles, and it eliminates the repetitive measuring, cutting, threading and joint assembly that are common with installation of rigid steel piping systems. WARDFLEX®/WARDFLEX®II's flexibility offers even further safety advantages in geographic areas that are prone to seismic activity because the tubing provides greater flexibility to withstand certain movement of the ground or structural shifts.

Although WARDFLEX®/WARDFLEX®II provides significant advantages over more rigid gas delivery systems, its wall dimensions may make it more likely than steel pipe to be punctured by a nail or other sharp objects, or damaged by other extraordinary forces such as a lightning strike, depending on the circumstances. It is well known that lightning is a highly destructive force. Therefore, the user must ensure that the system is properly bonded. In order to maximize protection of the entire structure from lightning damage, the user should consider installation of a lightning protection system per NFPA 780 and other standards, particularly in areas prone to lightning. Note that lightning protection systems as set forth in NFPA 780 and/or other standards go beyond the scope of this manual. Users of WARDFLEX®/WARDFLEX®II should consider all of the limitations and benefits of WARDFLEX®/WARDFLEX®II for their particular situation. Installers shall provide building owners and electricians with the required WARDFLEX®/WARDFLEX®II Information Card discussing these limitations and benefits.

1.2 LIMITATIONS OF MANUAL

This document is intended to aid the user in the design, installation and testing of WARDFLEX®/WARDFLEX®II Corrugated Stainless Steel Tubing to distribute fuel gas in residential housing units and commercial structures. It would be impossible for this guideline to anticipate and cover every possible variation in housing configurations and construction styles, appliance loads and local restrictions. Therefore, there may be applications which are not covered in this guide. For applications beyond the scope of this guide, contact Ward Manufacturing's Engineering Department. 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. Accordingly, where local gas or building codes impose greater requirements than this manual, you should adhere to the local code requirements. This system and related components should be used only as fuel gas piping where the operating gas pressure does not exceed 25 PSI.

In CANADA the installation of CSA-CGA certified WARDFLEX®/WARDFLEX®II flexible gas tubing for natural and propane gas piping systems must be in accordance with the applicable sections of the current CAN/CGA-B 149.1 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.

1.3 LISTING OF APPLICABLE CODES & STANDARDS (See www.wardflex.com for More Information)

Standards

- ANSI LC 1, CSA 6.26 Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST)

Listings

- CSA. - Canadian Standard Association Certificate #1004880
- IAPMO - International Association of Plumbing and Mechanical Officials - File Number 3353
- UL - Classified Mark File #R18357
- ICC - International Codes Council ESR-1879 & PMG 1100
- FM - Factory Mutual 3011939

Code Compliance

- BOCA - National Mechanical Code
- ANSI/CABO 2.0 - One and Two Family Dwelling Code
- ICC - International Mechanical Code
- NFPA 54- National Fuel Gas Code
- NFPA 58- Standard for the Storage and Handling of Liquified Petroleum Gasses
- SBCCI - Southern Building Code Congress International
- UMC - Uniform Mechanical Code
- C/UPC TM - California/Uniform Plumbing Code
- Canada Natural Gas and Propane Codes B149.1 and B149.2

IMPORTANT - READ ENTIRE MANUAL

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2.0 DESCRIPTION OF SYSTEMS AND COMPONENTS

2.1 SYSTEM DESCRIPTION

2.1.1 WARDFLEX®/WARDFLEX® II SYSTEM DESCRIPTION

WARDFLEX®/WARDFLEX® IITubing:

The WARDFLEX® Corrugated Stainless Steel Tubing (CSST) Piping System has been engineered, tested and certified to meet the performance requirements of American National Standard for Fuel Gas Systems Using Corrugated Stainless Steel Tubing, ANSI LC-1. As such is acceptable for use with all recognized fuel gases, including natural gas and propane (LPG).

- Manufactured using a 304 alloy stainless steel per ASTM A240.
- Fully annealed; increasing flexibility, facilitating installation in tight locations, and reduced product memory to avoid rapid uncoiling when unbanned from spools.
- The CSST is jacketed with a non-metallic coating to ease installation when running through studs, joists, and other building components.
- Jacketing material includes UV inhibitors making it suitable for outdoor installations.
- Jacket utilizes flame retardants making it ASTM E84 compliant.
- Coating is marked at 2 foot intervals allowing for quick measurements.
- WARDFLEX® is certified for working pressures up to 5 PSI in accordance with ANSI LC-1, by CSA International.

WARDFLEX® II Tubing:

The WARDFLEX® II Corrugated Stainless Steel Tubing (CSST)Piping System has been engineered, tested and certified to meet the performance requirements of American National Standard for Fuel Gas Systems Using Corrugated Stainless Steel Tubing, ANSI LC-1. As such is acceptable for use with all recognized fuel gases, including natural gas and propane (LPG).

- Manufactured using a 304 alloy stainless steel per ASTM A240.
- Fully annealed; increasing flexibility, facilitating installation in tight locations, and reduced product memory to avoid rapid uncoiling when unbanned from spools.
- The CSST is jacketed with a non-metallic coating to ease installation when running through studs, joists, and other building components.
- Jacketing material includes UV inhibitors making it suitable for outdoor installations.
- Coating is currently NOT ASTM E-84 compliant.
- Coating is marked at 2 foot intervals allowing for quick measurements.
- WARDFLEX® is certified for working pressures up to 5 PSI in accordance with ANSI LC-1, by CSA International.

Fittings:

The 3/8" thru 1-1/4" tubing is terminated using the patented, STEPSAVER double seal fitting. The 1-1/2" and 2 utilize the WARDFLEX® traditional gasketed fitting design. Only fittings designed and listed for use with the WARDFLEX® and WARDFLEX® II CSST Piping Systems shall be used when connecting to the flexible piping.

- WARDFLEX® fittings come standard with ASME B1.20.1 male or female NPT thread connection to be used in combination with other approved fuel gas piping materials with ASME B1.20.1 threaded pipe connections.
- Fittings are manufactured from EN 12164 compliant brass, and ASTM A197 malleable iron. Depending on type of malleable iron fitting, coating will be either black e-coat or electroplated zinc (ASTM B633).
- The 3/8" thru 1-1/4" STEPSAVER fittings provide a reliable, reusable dual seal that features a primary metal to metal seal with a secondary gasket seal.
- The 1-1/2" and 2" fittings utilize a reliable gasket seal. Fitting should be examined prior to reuse for damage to gasket. If the gasket has been damaged during prior assembly it is recommended that it be replaced prior to re-assembly.

Protection Devices:

Protective devices are to be used when CSST passes through studs, joists, or other building materials that limit or restrict the movement of the flexible piping making it susceptible to physical damage from nails, screws, drill bits and other puncture threats

- Case Hardened Striker plates attach directly to studs and joists.
- Strip wound metallic conduit can be used in locations where additional protection may be required.

Pressure Regulators:

Required to be used to reduce elevated pressure, over 14 inches water column (1/2 PSI,) to standard low pressure required for most appliances.

Manifolds:

Multiport gas distribution manifolds supply multiple gas appliances in parallel arrangement from a main distribution point.

- Multiple sizes and configurations ranging in female NPT sizes ½ through 2 with 3, 4 and 6 port cross manifold configurations.
- Material is ASTM A197 Malleable Iron coated with black e-coating finish.

Shutoff Valves:

Used to control the gas flow. Ball valves shut off the gas supply at appliances, manifolds, & regulators. WARDFLEX® Valves can be utilized at manifold locations reducing the number of joints due to the integrated WARDFLEX® STEPSAVER fitting connection.

Other Components/Accessories:

CSST systems have a variety of hardware and design differences from conventional gas piping systems using rigid steel and copper tubing. To address these differences a variety of accessories are available.

- Appliance and meter stub outs, manufactured from schedule 40 steel pipe and fitted with a steel mounting plate, are used to create a fixed termination point on a wall or floor to allow the attachment of appliances or a meter.
- Manifold Brackets provide a fixed mounting location for manifolds. Material is 16 gauge steel.
- Gas outlet boxes use a WARDFLEX® 90 degree valve and a molded plastic mounting box to provide a recessed termination point for the connection of movable appliances. Fire rated outlet box also available.
- Quick connect valves and accessories provide a fixed termination point of the flexible piping system and allow for a quick-connect connection for grills and other outdoor gas powered appliances.
- Bonding clamps are provided and are to be used when performing the required bonding for the WARDFLEX® CSST piping system.

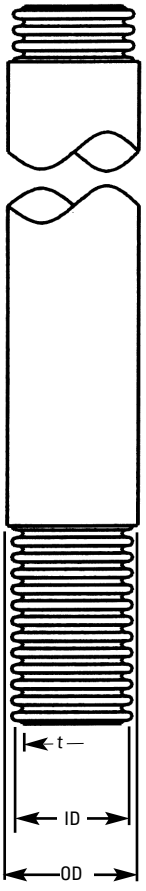
2.2 COMPONENTS

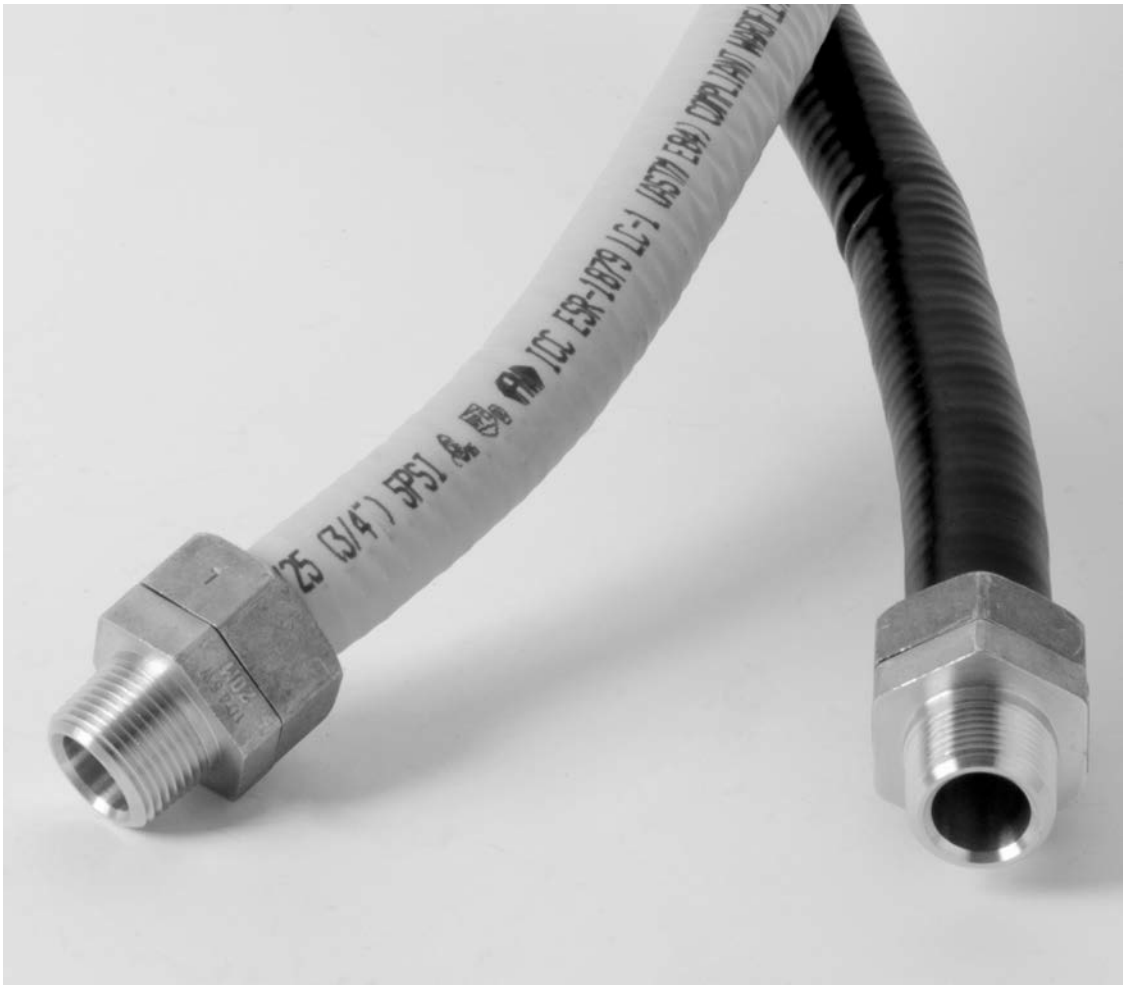
2.2.1 WARDFLEX®/WARDFLEX® II CORRUGATED STAINLESS STEEL TUBING (CSST)

COMPONENT	MATERIAL
WARDFLEX® WARDFLEX® II Corrugated Stainless Steel Tubing (CSST)	**Tubing: 304 Stainless Steel** **Jacket: Polyethylene**

DESCRIPTION								
TUBING Size	**Item**	**10A**	**15A/15C**	**20A/20C**	**25A/25C**	**32A/32C**	**38A/38C**	**50A/50C**
WARDFLEX® WARDFLEX® II	Size (in.)	3/8″	1/2"	3/4″	1″	1-1/4″	1-1/2″	2″
Equivalent Hydraulic Diameter (EHD)	EHD	15	19	25	30	37	48	62
Inner Dia. - I.D.	In.	0.452	0.591	0.787	0.984	1.26	1.59	2.12
	(mm)	(11.50)	(15.00)	(20.00)	(25.00)	(32.00)	(40.40)	(53.80)
Wall Thickness - t Note WARDFLEX® II	In.	0.008	.008/.010	0.010	0.010	0.010	0.012	0.012
	(mm)	(0.20)	(.20/.25)	(0.25)	(0.25)	(0.25)	(0.30)	(0.30)
WARDFLEX® Outside Diameter of Coating – O.D. (MAX)	In.	0.663	0.828	1.088	1.321	1.636	2.136	2.676µµ
	(mm)	(16.80)	(21.00)	(27.60)	(33.50)	(41.50)	(54.30)	(68.00)
WARDFLEX® II Outside Diameter of Coating – O.D. (MAX)	In.	N/A	0.832	1.096	1.329	1.644	2.138	2.678
	(mm)		(21.10)	(27.80)	(33.80)	(41.80)	(54.30)	(68.00)
WARDFLEX® Available Lengths	(ft)	50*, 100*, 250*, 500*, 1000	50*, 100*, 250*,500*, 1000	50*, 100*, 180*, 250, 500	50*, 100*, 180*, 250, 500	50*, 100*, 250	50, 100, 150	50, 100, 150
WARDFLEX® II Available Lengths	(ft)	N/A	50*, 100*, 250*, 500	50*, 100*, 250*, 500	50*, 100*, 250, 500	50*, 100*, 250, 400	50, 100, 150	50, 100, 150

*Custom Lengths Available Upon Request.





2.2.2 FITTINGS

COMPONENT	MATERIAL	CSST X NPS	
Mechanical Joints Male Straight	Body: Brass Retainer: Brass Nut: Brass Gasket: Composite Fiber	10M (3/8") x 3/8 15M (1/2") x 1/2 20M (3/4") x 3/4 25M (1") x 1 32M (1 1/4") x 1 1/4 38M (1 1/2") x 1 1/2 50M (2") x 2	

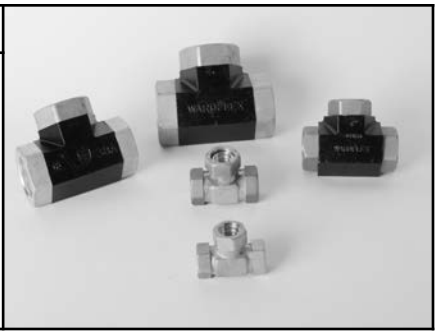
COMPONENT	MATERIAL	CSST X NPS	
Mechanical Joints Male Reducing	Body: Brass Retainer: Brass Nut: Brass Gasket: Composite Fiber	10M (3/8") x 1/2 15M (1/2") x 3/8 20M (3/4") x 1/2 25M (1") x 3/4	

COMPONENT	MATERIAL	CSST X NPS	
Mechanical Joints Female Straight	Body: Brass Retainer: Brass Nut: Brass Gasket: Composite Fiber	15M (1/2") x 1/2 20M (3/4") x 3/4 25M (1") x 1	

COMPONENT	MATERIAL	CSST X NPS	
Mechanical Joints Female Reducing	Body: Brass Retainer: Brass Nut: Brass Gasket: Composite Fiber	10M (3/8") x 1/2 15M (1/2") x 3/8 20M (3/4") x 1/2 25M (1") x 3/4	

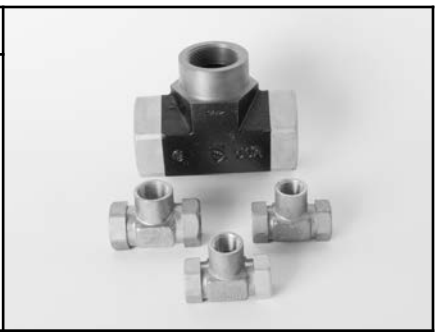
2.2.2 FITTINGS

COMPONENT	MATERIAL	CSST X CSST	
Couplings	Body: Brass Retainer: Brass Nut: Brass Gasket: Composite Fiber	10M (3/8") x 10M (3/8") 15M (1/2") x 15M (1/2") 20M (3/4") x 20M (3/4") 25M (1") x 25M (1") 32M (1 1/4") x 32M (1 1/4") 38M (1 1/2") x 38M (1 1/2") 50M (2") x 50M (2")	

COMPONENT	MATERIAL	CSST	
Mechanical Tees Straight (CSSTx CSSTxCSST)	Body: Brass/ Malleable Iron Retainer: Brass Nut: Brass Gasket: Composite Fiber	15M (1/2") 20M (3/4") 25M (1") 32M (1 1/4") 38M (1 1/2") 50M (2")	

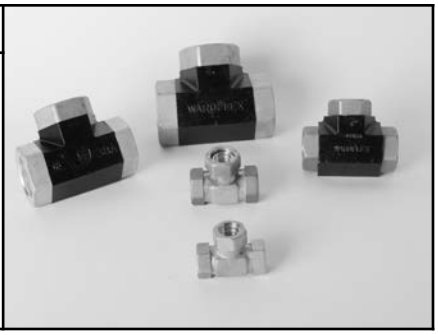
COMPONENT	MATERIAL	CSST X CSST X CSST	
Mechanical Tees Reducing (CSSTx CSSTxCSST)	Body: Brass/ Malleable Iron Retainer: Brass Nut: Brass Gasket: Composite Fiber	15M (1/2") x 15M (1/2") x 10M (3/8") 15M (1/2") x10M (3/8") x 10M (3/8") 20M (3/4") x 20M (3/4") x 15M (1/2") 25M (1") x 25M (1") x 20M (3/4") 25M (1") x 20M (3/4") x 20M (3/4") 25M (1")x 25M (1") x 15M (1/2")	

COMPONENT	MATERIAL	CSST X CSST X NPS	
Mechanical Tees Female Straight (CSSTx CSSTxNPS)	Body: Brass/ Malleable Iron Retainer: Brass Nut: Brass Gasket: Composite Fiber	15M (1/2") x 15M (1/2") x 1/2 20M (3/4") x 20M (3/4") x 3/4 25M (1") x 25M (1") x 1 32M (1 1/4") x 32M (1 1/4") x 1 1/4 38M (1 1/2") x 38M (1 1/2") x 1 1/2 50M (2") x 50M (2") x 2	

COMPONENT	MATERIAL	CSST X CSST X NPS	
Mechanical Tees Female Reducing (CSSTx CSSTxNPS)	Body: Brass/ Malleable Iron Retainer: Brass Nut: Brass Gasket: Composite Fiber	15M (1/2") x 15M (1/2") x 3/8 15M (1/2") x 15M (1/2") x 3/4 20M (3/4") x 20M (3/4") x 1/2 20M (3/4") x 20M (3/4") x 1/2 25M (1") x 25M (1") x 3/4	

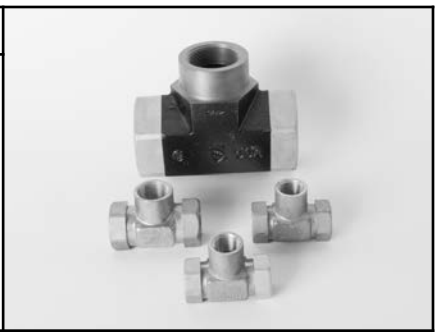
2.2.2 FITTINGS

COMPONENT	MATERIAL	CSST X CSST	
Couplings	Body: Brass Retainer: Brass Nut: Brass Gasket: Composite Fiber	10M (3/8") x 10M (3/8") 15M (1/2") x 15M (1/2") 20M (3/4") x 20M (3/4") 25M (1") x 25M (1") 32M (1 1/4") x 32M (1 1/4") 38M (1 1/2") x 38M (1 1/2") 50M (2") x 50M (2")	

COMPONENT	MATERIAL	CSST	
Mechanical Tees Straight (CSSTx CSSTxCSST)	Body: Brass/ Malleable Iron Retainer: Brass Nut: Brass Gasket: Composite Fiber	15M (1/2") 20M (3/4") 25M (1") 32M (1 1/4") 38M (1 1/2") 50M (2")	

COMPONENT	MATERIAL	CSST X CSST X CSST	
Mechanical Tees Reducing (CSSTx CSSTxCSST)	Body: Brass/ Malleable Iron Retainer: Brass Nut: Brass Gasket: Composite Fiber	15M (1/2") x 15M (1/2") x 10M (3/8") 15M (1/2") x10M (3/8") x 10M (3/8") 20M (3/4") x 20M (3/4") x 15M (1/2") 25M (1") x 25M (1") x 20M (3/4") 25M (1") x 20M (3/4") x 20M (3/4") 25M (1")x 25M (1") x 15M (1/2")	

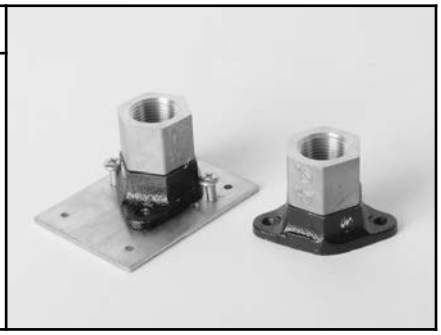
COMPONENT	MATERIAL	CSST X CSST X NPS	
Mechanical Tees Female Straight (CSSTx CSSTxNPS)	Body: Brass/ Malleable Iron Retainer: Brass Nut: Brass Gasket: Composite Fiber	15M (1/2") x 15M (1/2") x 1/2 20M (3/4") x 20M (3/4") x 3/4 25M (1") x 25M (1") x 1 32M (1 1/4") x 32M (1 1/4") x 1 1/4 38M (1 1/2") x 38M (1 1/2") x 1 1/2 50M (2") x 50M (2") x 2	

COMPONENT	MATERIAL	CSST X CSST X NPS	
Mechanical Tees Female Reducing (CSSTx CSSTxNPS)	Body: Brass/ Malleable Iron Retainer: Brass Nut: Brass Gasket: Composite Fiber	15M (1/2") x 15M (1/2") x 3/8 15M (1/2") x 15M (1/2") x 3/4 20M (3/4") x 20M (3/4") x 1/2 20M (3/4") x 20M (3/4") x 1/2 25M (1") x 25M (1") x 3/4	

2.2.2 FITTINGS

COMPONENT	MATERIAL	CSST X NPS	
Adapter Nut	Nut: Brass Locknut: Steel	10M (3/8") x 3/4 15M (1/2") x 3/4 20M (3/4") x 1	

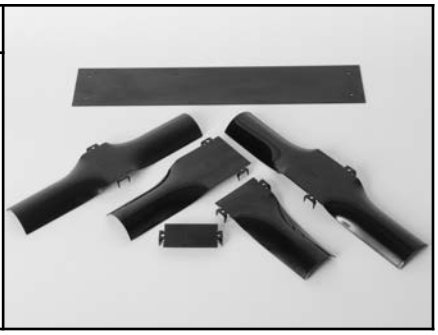
COMPONENT	MATERIAL	CSST X NPS	
Termination Fittings Male (Indoor and Outdoor*) ***Outdoor models supplied with o-rings**	Body: Brass Retainer: Brass Nut: Malleable Iron Gasket: Composite Fiber O-rings: EPDM Rubber	10M (3/8") x 1/2 15M (1/2") x 1/2 20M (3/4") x 3/4 25M (1") x 3/4 25M (1") x 1	

COMPONENT	MATERIAL	CSST X NPS	
Termination Fittings Female (Indoor and Outdoor*) *Outdoor models supplied with o-rings	Body: Brass Retainer: Brass Nut: Malleable Iron Gasket: Composite Fiber O-rings: EPDM Rubber	10M (3/8") x 1/2 15M (1/2") x 1/2 20M (3/4") x 3/4 25M (1") x 3/4	

COMPONENT	MATERIAL	CSST X NPS	
Flange Termination Fittings Male **(Indoor and Outdoor*)** ***Outdoor models supplied with o-rings**	Body: Brass Retainer: Brass Nut: Malleable Iron Gasket: Composite Fiber O-rings: EPDM Rubber	10M (3/8") x 1/2 15M (1/2") x 1/2 20M (3/4") x 3/4 25M (1") x 3/4 32M (1 1/4") x 1 1/4 38M (1 1/2") x 1 1/2 50M (2") x 2	

COMPONENT	MATERIAL	CSST X NPS	
Floor Flange Termination Assemblies Male	Body: Brass Retainer: Brass Nut: Malleable Iron Gasket: Composite Fiber	10M (3/8") x 1/2 15M (1/2") x 1/2 20M (3/4") x 3/4 25M (1") x 1	

2.2.3 PROTECTION DEVICES

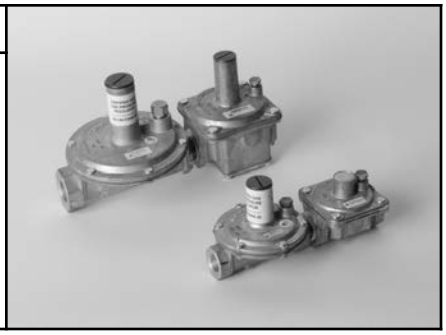
COMPONENT	MATERIAL	AVAILABLE SIZES	
Striker Plates	Case Hardened Steel	Quarter: 1 1/2" W x 3 1/2" L Half: 2 3/4" W x 6 1/2"L Full: 2 3/4" W x 11 1/2"L Extended: 2 3/4"W x 13"L Double Top: 2 3/4"W x 7 1/4"L Large: 3 1/4"W x 17 1/2"L	

COMPONENT	MATERIAL	AVAILABLE SIZES	
Stripwound Conduit	Galvanized Steel	Size (Length) 3/8" (1' and 50' L) 1/2" (1' and 50' L) 3/4" (1' and 50' L) 1" (1' and 50' L) 1 1/4" (1' and 50' L)	

2.2.4 REGULATORS

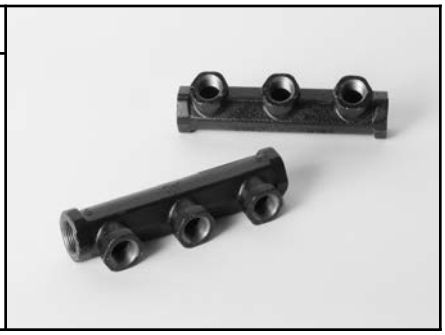
COMPONENT	MATERIAL	AVAILABLE SIZES	
2 PSI Line Pressure Regulators - Natural Gas **(Preset to 8" W.C outlet pressure)**	Body: Aluminum	**325 3D:** Port Size - 1/2 NPS x 1/2 NPS Vent Size: 1/8 NPS **325 5E:** Port Size - 3/4 NPS x 3/4 NPS Vent Size: 3/8 NPS **325 71B:** Port Size - 3/4 NPS x 3/4 NPS Vent Size: 1/2 NPS	

COMPONENT	MATERIAL	AVAILABLE SIZES	
2 PSI Line Pressure Regulators - Propane **(Preset to 11" W.C outlet pressure)**	Body: Aluminum	**325 3DLP:** Port Size - 1/2 NPS x 1/2 NPS Vent Size: 1/8 NPS **325 5ELP:** Port Size - 3/4 NPS x 3/4 NPS Vent Size: 3/8 NPS	

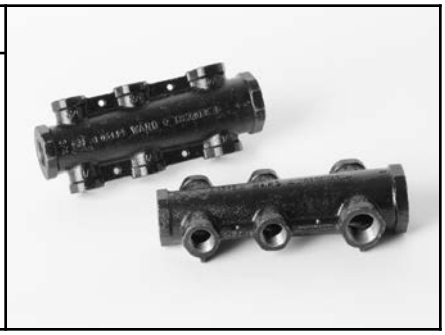
COMPONENT	MATERIAL	AVAILABLE SIZES	
5 PSI Line Pressure Regulators - Natural Gas **(preset at 8" W.C outlet pressure)**	Body: Aluminum	**325 3D OP:** Port Size - 1/2 NPS x 1/2 NPS Vent Size: 1/8 NPS **325 5E OP:** Port Size - 3/4 NPS x 3/4 NPS Vent Size: 3/8 NPS	

Equipped with approved over protection device

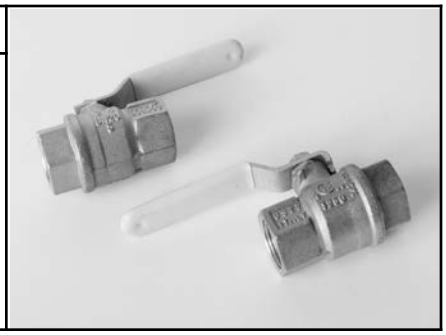
2.2.5 MANIFOLDS

COMPONENT	MATERIAL	AVAILABLE SIZES	
3 Port Manifold	Body: Malleable Iron	- 1/2 NPS x (3) 1/2 NPS Outlets - 3/4 NPS x (3) 1/2 NPS Outlets	

COMPONENT	MATERIAL	AVAILABLE SIZES	
4 Port Manifolds	Body: Malleable Iron	- 1/2 NPS x (4) 1/2 NPS Outlets - 3/4 NPSx (4) 1/2 NPS Outlets - 3/4 NPS x (1) 3/4 NPS & (3) 1/2 NPS Outlets - 1 NPS x (4) 3/4 NPS Outlets - 2 NPS x (4) 1 NPS Outlets	

COMPONENT	MATERIAL	AVAILABLE SIZES	
Cross Manifolds (6 ports)	Body: Malleable Iron	- 1/2 NPS x (6) 1/2 NPS Outlets - 3/4 NPSx (4) 1/2 NPS & (2) 3/4 NPS Outlets - 1 NPS x (4) 1/2 NPS & (2) 3/4 NPS Outlets - 1 1/4 NPS x (4) 1/2 NPS & (2) 3/4 NPS Outlets	

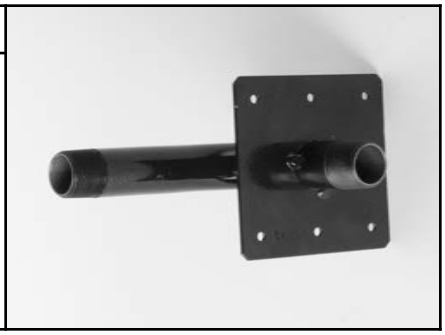
2.2.6 SHUTOFF VALVES

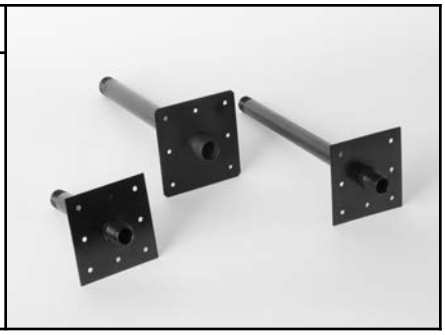
COMPONENT	MATERIAL	AVAILABLE SIZES	
AGA Approved Gas Valves	Body: Brass	- 1/2 NPS - 3/4 NPS	

COMPONENT	MATERIAL	AVAILABLE SIZES	
WARDFLEX Valve Assembly	Body: Brass Retainer: Brass Nut: Brass Gasket: Composite Fiber	CSST x NPS - 10M (3/8") x 1/2 - 15M (1/2") x 3/4 - 20M (3/4") x 3/4 - 25M (1") x 3/4	

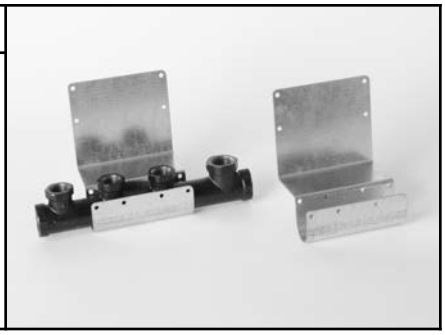
COMPONENT	MATERIAL	AVAILABLE SIZES	
WARDFLEX Right Angle Valve Assembly	Body: Brass Retainer: Brass Nut: Brass Gasket: Composite Fiber	CSST x NPS - 15M (1/2") x 1/2	

2.2.7 OTHER COMPONENTS

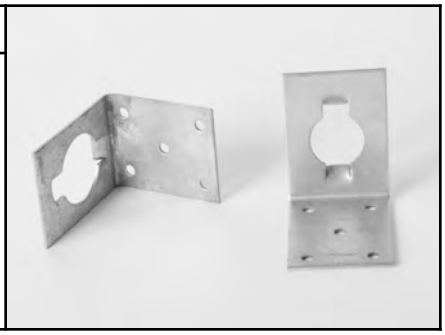
COMPONENT	MATERIAL	AVAILABLE SIZES	
Appliance Stubouts	Pipe: Schedule 40 Steel Plate: Steel	NPS x Pipe Length: - 1/2 NPS - 3/4 NPS	

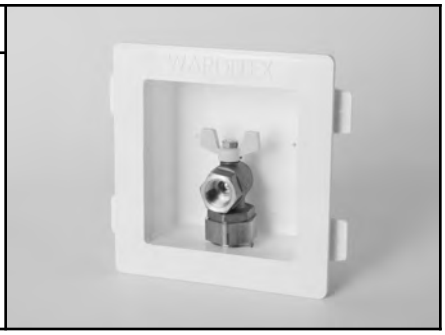
COMPONENT	MATERIAL	AVAILABLE SIZES	
Meter Stubouts	Pipe: Schedule 40 Steel Plate: Steel	NPS x Pipe Length: - 1/2 x 6" - 1/2 x 12" - 3/4 x 6" - 3/4 x 12" - 1 x 6" - 1 x 12" - 1 1/4 x 6" - 1 1/4 x 12"	

COMPONENT	MATERIAL	AVAILABLE SIZES	
Fireplace Stubout	Pipe: Schedule 40 Steel Plate: Steel	NPS x Pipe Length: - 1/2 x 7"	

COMPONENT	MATERIAL	AVAILABLE SIZES	
Manifold Bracket	Bracket: 16 Gauge Steel		

2.2.7 OTHER COMPONENTS

COMPONENT	MATERIAL	AVAILABLE SIZES	
Right Angle Mounting Bracket	Bracket: Steel	Fits CSST Adapter Nuts Sizes: - 3/8" and 1/2" - 3/4"	

COMPONENT	MATERIAL	AVAILABLE SIZES	
Gas Outlet Box	Box: Plastic Valve: Brass	15M (1/2") 20M (3/4")	

COMPONENT	MATERIAL	AVAILABLE SIZES	
Quick Connects	Box: Plastic Valve: Brass	Surface Mount Kit: - 1/2 NPS Valve Only: - 1/2 NPS	

COMPONENT	MATERIAL	AVAILABLE SIZES	
Bonding Clamp	Clamp: Bronze	1.WFBC: - Fits 3/8 through 1 ridged pipe sizes 2.WFBC: - Fits 1 1/4 through 2 Ridged pipe sizes. UL 467 Approved	

3.1 SYSTEM OVERVIEW

3.1.1 INTRODUCTION

The following section will be used to assist you while you design and size your WARDFLEX®/WARDFLEX®II fuel gas piping system. At any point in which you require further assistance with this process you can visit our webpage (WWW.WARDFLEX.COM) or contact Ward Manufacturing's Engineering Department.
WARDFLEX® and WARDFLEX® II are required to be tested, listed, and installed in accordance with the Standard For Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing, ANSI LC1. It is required by this standard to provide installation instructions which include proper sizing tables and methods of sizing.

3.1.2 SYSTEM DESIGN

In order to properly design a fuel gas piping system you must first recognize all the important criteria.
Requirements for a proper system design include:

- Verify your system meets all local codes. When local codes are in conflict with the manufactures guidelines the local codes must always take precedence.
- Determine the supply pressure coming from the meter by means of a gauge or a rating supplied by the gas company.
- Determine your total system demand for all appliances as well as the largest single load.
- Prepare a floor plan sketch with the load and length combinations for all appliances.
- Determine your allowable pressure drop.

IMPORTANT NOTE:
When choosing a pressure drop to size a WARDFLEX®/WARDFLEX®II system the minimum operating pressure of the appliance must be considered. Choosing a pressure drop that will reduce the supply pressure below the minimum operating pressure of the appliance will cause the appliance to perform poorly or not at all.

Example:
System Supply Pressure: 7 inches W.C.
Appliance minimum operating pressure: 5 inches W.C.

The use of a 3 inch W.C. pressure drop would result in a minimum inlet pressure at the appliance of 4 inches W.C. In this case an alternate pressure drop of 2 inches or less should be selected to meet the minimum operating pressure of the appliance.

3.2 SYSTEM CONFIGURATIONS

3.2.1 INTRODUCTION

There are multiple configurations in which you can install gas piping systems. The following sections will explain these different types of configurations. To the right is a key to accompany the figures used throughout the section:

KEY:

———	BLACK PIPE
- - - - -	WARDFLEX PIPE
Ⓜ	METER
	APPLIANCE SHUT OFF VALVE
	MANIFOLD
	REGULATOR
	TEE
	SERVICE SHUT OFF VALVE

3.2.2 SERIES SYSTEMS

A series system is the most commonly used system for rigid pipe systems utilizing low pressure. A typical series system contains a main run (header) which branches off with tees to the individual appliances. An example of a series system can be seen in figure 3.1

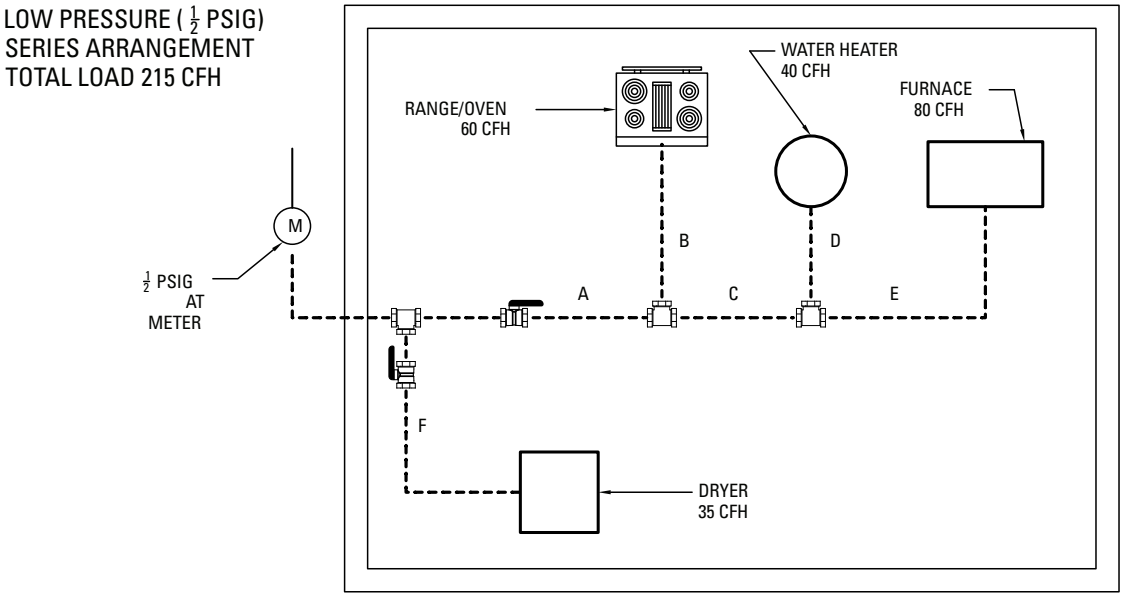


FIGURE 3.1

3.2.3 PARALLEL SYSTEMS

In a parallel system a main run from the meter supplies a central distribution manifold. Individual runs from the manifold supply the appliances. Typically it is best to position the manifold closest to the appliance requiring the greatest load. An example of a parallel system can be seen below in figure 3.2.

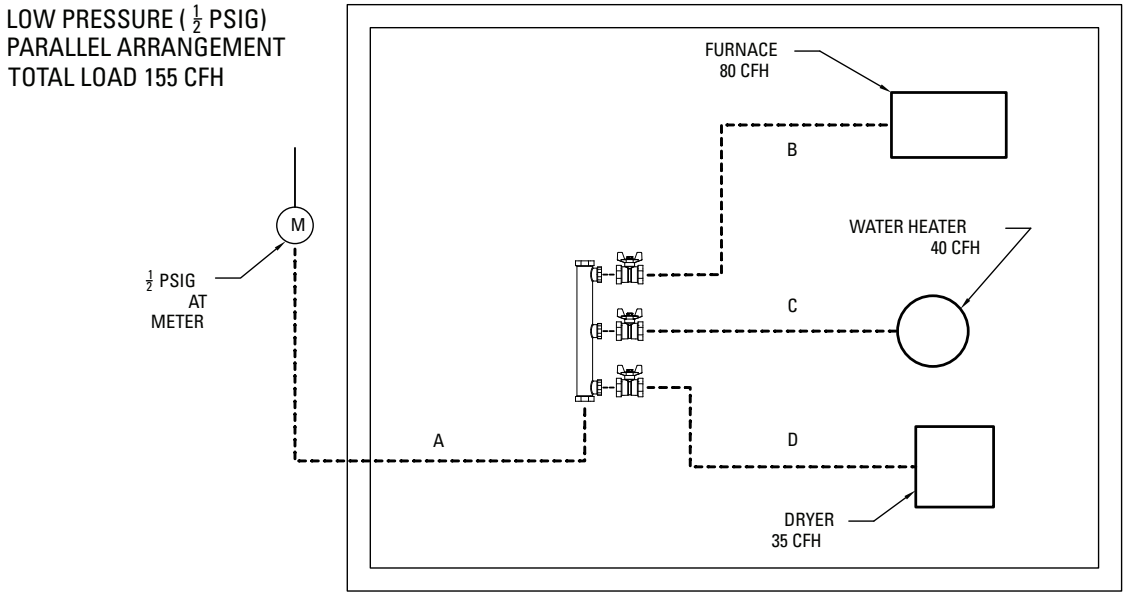


FIGURE 3.2

3.2.4 DUAL PRESSURE SYSTEMS

A dual pressure system utilizes two operating pressures downstream of the meter. The first pressure is set by the service regulator and is usually 2 PSI but can be higher or lower depending on local code. This is the high pressure side of the system. The second operating pressure also known as the low pressure side of the system is set with a pound-to-inches regulator. This pressure can be between 8 to 14 inches W.C. depending on local code, system design, and type of fuel gas. A dual pressure system is shown below in figure 3.3.

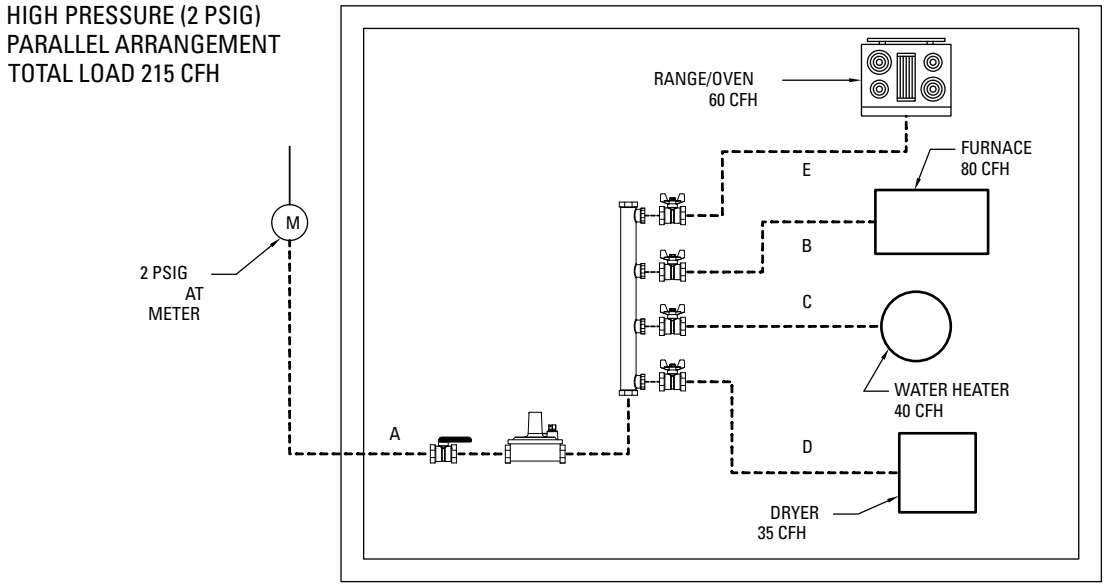


FIGURE 3.3

3.2.5 HYBRID SYSTEMS

Hybrid systems incorporate the use of Corrugated Stainless Steel Tubing with rigid black pipe or copper tubing. In low pressure systems it is often advantageous to use CSST and rigid pipe in the same system. This will help reduce pressure drops in systems which contain long runs and/or high loads. WARDFLEX® and WARDFLEX® II are approved for use with any fuel gas piping system when approved pipe threads are used at the interface. A hybrid system is shown below in Figure 3.4.

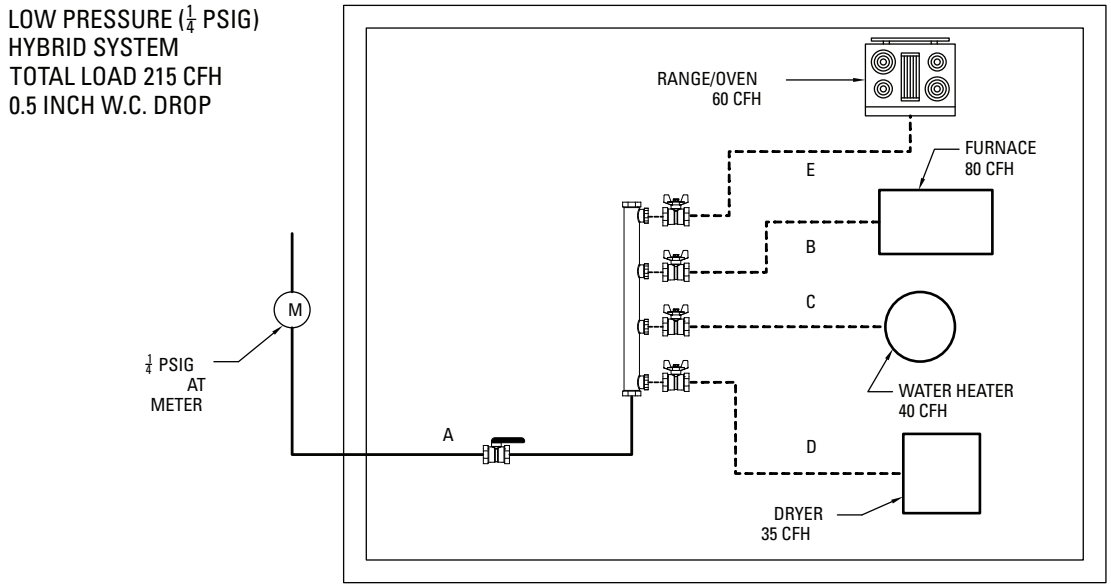


FIGURE 3.4

3.2.6 ELEVATED PRESSURE SYSTEM

In an elevated pressure system a pounds-to-inches regulator is positioned directly in front of each appliance. This is typical in systems where there are long runs and/or high loads because it allows for the use of smaller tubing sizes while being able to supply the minimum inlet requirements of all appliances. An elevated Pressure system can be seen below in Figure 3.5.

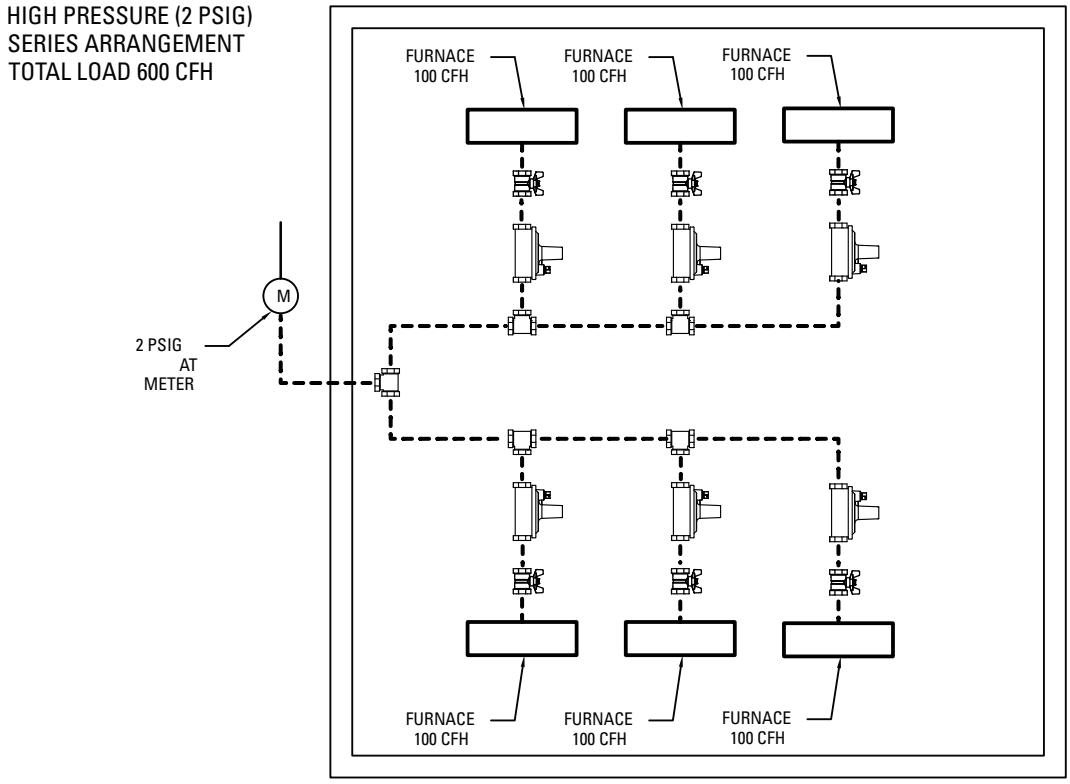


FIGURE 3.5

3.3 SYSTEM SIZING

3.3.1 INTRODUCTION

This section will provide you with sizing methods and examples. The following procedures should be closely followed when sizing the WARDFLEX®/WARDFLEX®II system to ensure it will operate properly. Section 7 of this Design and Installation Guide contains tables that will help you properly select tubing sizes. Care should be taken to ensure you are using the correct tables for your system requirements. For additional assistance with sizing contact Ward Manufacturing's Engineering Department.

3.3.2 LONGEST LENGTH METHOD

When using the longest length method to size a system you must use a table that fits your design criteria. For sizing each run of tubing you need to determine the total gas load for all appliances serviced by that section as well as the longest length that particular section delivers gas. The longest length must include the run from the meter to the furthest appliance. The longest length method can also be used for hybrid and dual pressure systems.
In the case of a dual pressure system you would size the run from the meter to the regulator separately from the rest of the system. The following examples demonstrate the use of the longest length method.

EXAMPLE 1: LOW PRESSURE PARALLEL SYSTEM

The following example demonstrates a typical single family house with 4 appliances with a centrally located manifold. The pressure at the meter is 14 inches W.C. (.5 PSI) and the allowable pressure drop is 6.0 inches W.C. Table A-9 will be used for this example.

LOW PRESSURE LOAD ($\frac{1}{2}$ PSIG)
PARALLEL ARRANGEMENT
TOTAL LOAD 215 CFH

LENGTH OF RUN	LOAD	TUBE SIZE
A=5 feet	215 CFH	15A (1/2")
B=10 feet	80 CFH	10A (3/8")
C=10 feet	40 CFH	10A (1/2")
D=15 feet	35 CFH	10A (3/8")
E=15 feet	60 CFH	10A (3/8")

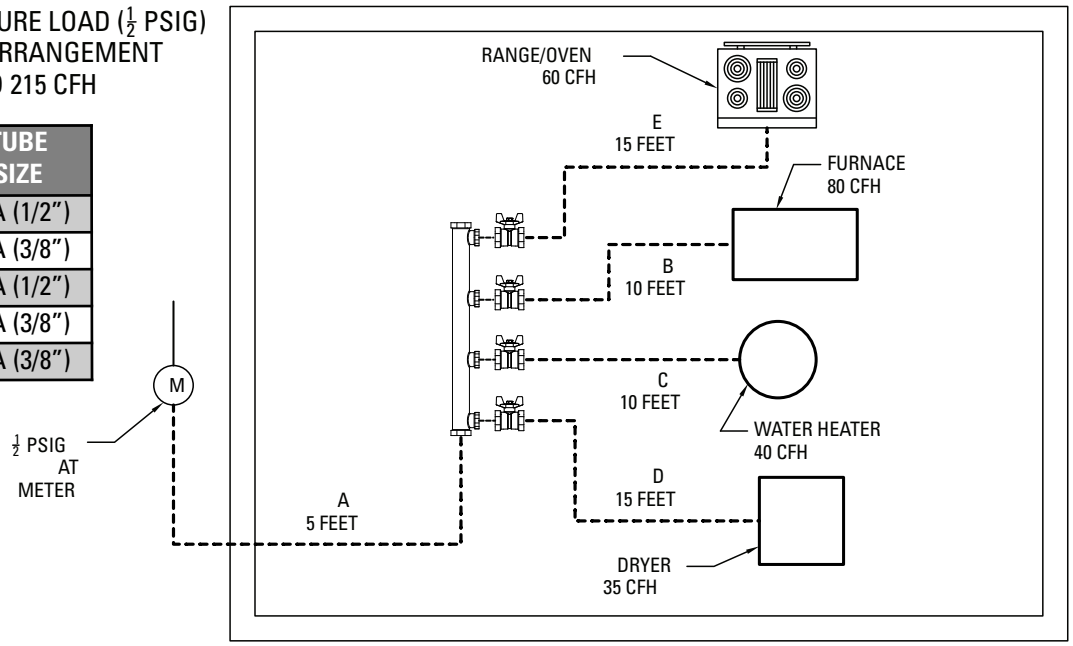


FIGURE 3.6

SIZING PROCEDURE:

1. Size Section "A"

- Determine distance from meter to furthest appliance (range/oven 20 ft.).
- Determine total load supplied by "A" (215 CFH).
- Refer to Table A-9 for a length of 20 ft. and a load of 215 CFH.
- Section "A" will be size 15A tubing.

2. Size Section "B"

- Distance from meter to furnace is 15 ft.
- Load is 80 CFH.
- Table A-9 indicates size 10A tubing.

3. Size Section "C"

- Distance from meter to water heater is 15 ft.
- Load is 40 CFH.
- Table A-9 indicates size 10A tubing is required.

4. Size Section "D"

- Distance from the meter to the dryer is 20 ft.
- Load is 35 CFH.
- Table A-9 indicates size 10A tubing is required.

5. Size Section "E"

- Distance. From the meter to range/oven is 20 ft.
- Load is 60 CFH.
- Table A-9 indicates size 10A tubing is required.

EXAMPLE 2: LOW PRESSURE SERIES SYSTEM

This example demonstrates a low pressure series arrangement. The main run (header) uses Tees to branch off to the appliances. The dryer has a separate service line to prevent the use of large tubing sizes. The pressure at the meter is 14 inches W.C. (.5PSI) and the allowable pressure drop is 6 inches W.C. Table A-9 will be used.

LOW PRESSURE ($\frac{1}{2}$ PSIG)
SERIES ARRANGEMENT
TOTAL LOAD 215 CFH

LENGTH OF RUN	LOAD	TUBE SIZE
A=10 feet	180 CFH	15A (1/2")
B=15 feet	60 CFH	10A (3/8")
C=10 feet	120 CFH	15A (1/2")
D=5 feet	40 CFH	10A (3/8")
E=10 feet	80 CFH	10A (3/8")
F=10 feet	35 CFH	10A (3/8")

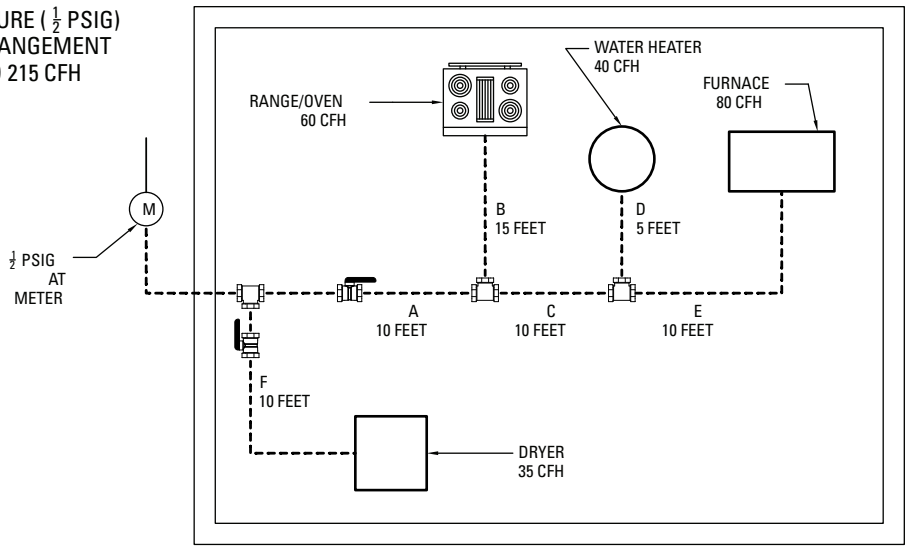


FIGURE 3.7

SIZING PROCEDURE:

1. Size Section "A"
- Distance from meter to furthest appliance (furnace) is 30 ft.
- The load that "A" delivers is 180 CFH.
- Table A-9 at 30 ft. indicates a flow of 189 CFH with size 15A tubing.

2. Size Section "B"
- Distance from meter to range/oven is 25 ft.
- Load is 60 CFH.
- Table A-9 indicates size 10A tubing.

3. Size Section "C"
- The longest run from the meter that includes section "C" is 30 ft. (meter to furnace).
- The total load that "C" delivers is 120 CFH.
- Table A-9 indicates size 15A tubing.

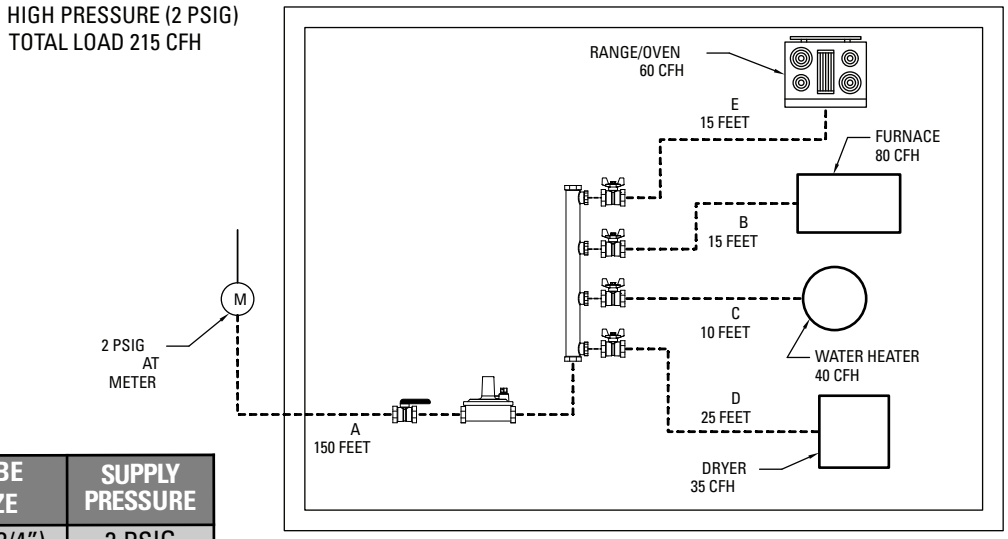
4. Size Section "D"
- Meter to water heater is 25 ft.
- Load is 40 CFH.
- Table A-9 indicates size 10A tubing.

5. Size Section "E"
- The longest run that includes section "E" from the meter to the furnace is 30 ft.
- Load is 80 CFH.
- Table A-9 indicates size 10A tubing is required.

6. Size Section "F"
- The longest run that includes section "F" from the meter to the dryer is 10 ft.
- Load is 35 CFH.
- Table A-9 indicates size 10A tubing is required.

EXAMPLE 3: DUAL PRESSURE PARALLEL SYSTEM

This example shows the proper way to size a dual pressure system. The use of two operating pressures downstream of the meter require two sizing tables be used and each side of the system should be sized separately. Tables A-6 and A-11 will be used.



LENGTH OF RUN	LOAD	TUBE SIZE	SUPPLY PRESSURE
A=150 feet	215 CFH	20A (3/4")	2 PSIG
B=15 feet	80 CFH	10A (3/8")	8" WC
C=10 feet	40 CFH	10A (3/8")	8" WC
D=25 feet	35 CFH	10A (3/8")	8" WC
E=15 feet	60 CFH	10A (3/8")	8" WC

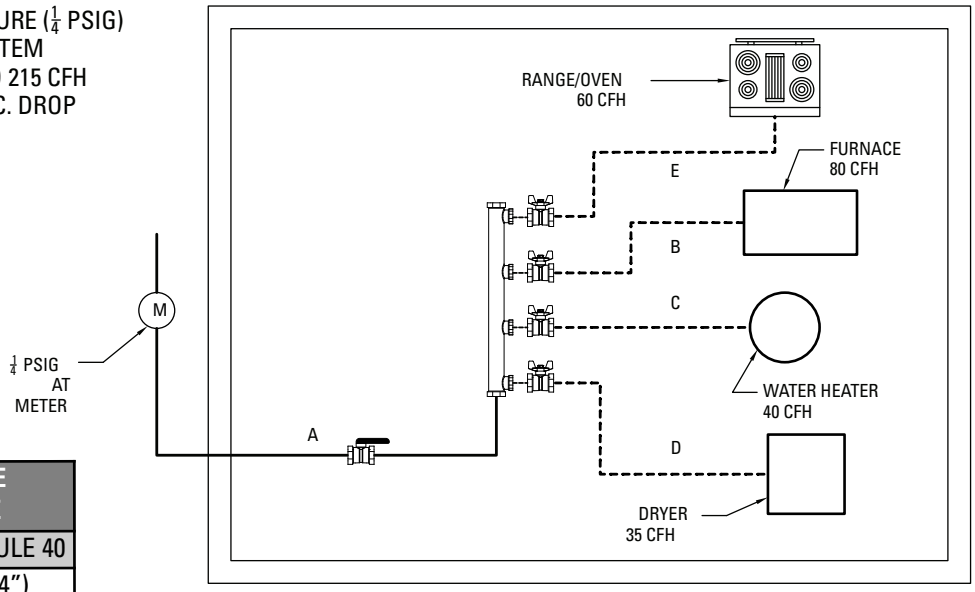
SIZING PROCEDURE:

1. Size Section "A"
   - Determine distance from meter to regulator (150 ft.).
   - Determine the load supply by "A" (215 CFH).
   - Refer to Table A-11 to determine the tubing size needed to deliver the maximum system capacity at 2 PSIG use 20A per table A-11.
2. Size Section "B"
   - Regulator to furnace is 15 ft.
   - Load is 80 CFH.
   - Table A-6 indicates size 10A tubing.
3. Size Section "C"
   - Regulator to water heater is 10 ft.
   - Load is 40 CFH.
   - Table A-6 indicates size 10A tubing.
4. Size Section "D"
   - Regulator to dryer is 25 ft.
   - Load is 35 CFH.
   - Table A-6 indicates size 10A tubing.
5. Size Section "E"
   - Regulator to range/oven is 15 ft.
   - Load is 60 CFH.
   - Table A-6 indicates size 10A tubing.

EXAMPLE 4: HYBRID SYSTEM

This example demonstrates a hybrid system which uses black pipe to the manifold and WARDFLEX® CSST to the individual appliances. The supply pressure is 7 inches W.C. (.25 PSI) and the allowable pressure drop is .5 inches W.C. Table A-1 will be used for the CSST section and Table A-21 will be used for the black pipe section.

LOW PRESSURE ($\frac{1}{4}$ PSIG)
HYBRID SYSTEM
TOTAL LOAD 215 CFH
0.5 INCH W.C. DROP



LENGTH OF RUN	LOAD	TUBE SIZE
A=25 feet	215 CFH	1" SCHEDULE 40
B=15 feet	80 CFH	20A (3/4")
C=10 feet	40 CFH	15A (3/4")
D=15 feet	35 CFH	15A (1/2")
E=15 feet	60 CFH	20A (3/4")

SIZING PROCEDURE:

1. Size Section "A"

- Distance from the meter to furthest appliance is 40 feet (dryer).
- Total load supplied by the section is 215 CFH.
- Using Table A-21 locate length of pipe at least 40 feet and a capacity of at least 215 CFH.
- You will find a capacity of 320 CFH which would indicate 1" Schedule 40 pipe.

2. Size Section "B"

- 40 ft. from the meter to the furnace and a load of 80 CFH.
- Refer to Table A-1 and locate a 40 ft. length at the left and follow across to capacity greater than or equal to 80 CFH.
- A capacity of 97 CFH is indicated with size 20A tubing.

3. Size Section "C"

- 35 ft. from the meter to the water heater and a load of 40 CFH.
- Table A-1 indicates size 15A tubing will be required.
- Capacity of 47 CFH is indicated with size 15A tubing.

4. Size Section "D"

- 40 ft. from the meter to the dryer and a load of 35 CFH.
- For a length of 40 ft., find a value greater than 40 CFH in Table A-1.
- A capacity of 47 CFH is indicated with size 15A tubing.

5. Size Section "E"

- 40 ft. from meter to the range and a load of 60 CFH.
- For a length of 40 ft. find a greater value than 60 CFH in Table A-1.
- The table indicates size 20A tubing.

3.3.3 SUMMATION SIZING METHOD

An alternate solution to the longest length method is the summation sizing method which adds the pressure drops through a particular section of tubing or black pipe. This can be an useful method when the supply pressure and/or pressure drop is not indicated in one of the sizing charts. This method for sizing is more accurate than the longest length method because you're doing actual calculations for load and length combinations rather than taking from a range of values in a chart. Table A-23 through Table A-27 contain the pressure drop per foot values of WARDFLEX®/WARDFLEX®II as well as polyethylene and steel pipe.

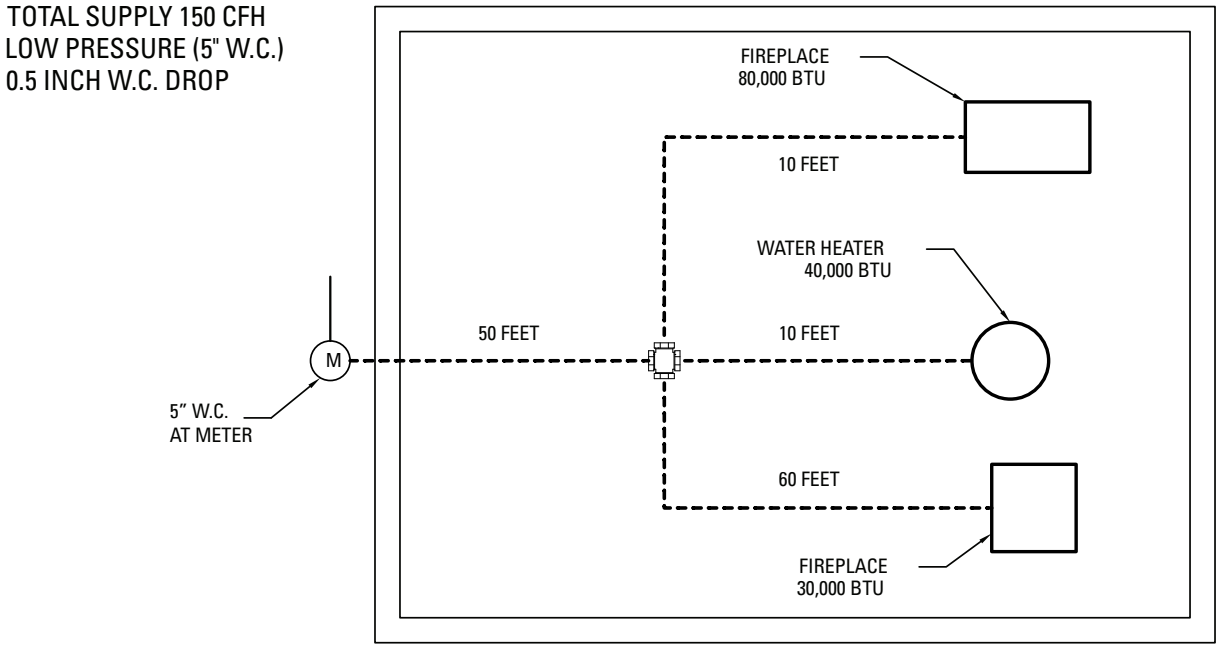
The procedure for the summation sizing method is as follows:

1. Make a sketch containing the load and lengths for your system.
2. Find the desired flow in the left hand column of Table A-23.
3. Now locate the desired tubing size in the top row of the table.
   The point at which these two intersect is your pressure drop per foot of the selected tubing size.
4. Multiply this value by the length of this portion of the system and you have pressure drop for this section of tubing.
5. Repeat this procedure for any additional legs in the system.
6. Now add up the pressure drops to find the total system pressure drop.
7. If this value is greater than the allowable pressure drop for the system you must increase your tubing or pipe size.

The following example demonstrates the summation sizing method:

EXAMPLE 5: LOW PRESSURE EXAMPLE

This example demonstrates a single household with 3 appliances.
The supply pressure is 5 inches W.C. with a .5 inch W.C. allowable pressure drop.



LINE	LENGTH (FEET)	LOAD (CFH)	TUBE SIZE
Main	50	150 CFH	32A (1 1/4")
Furnace	10	80 CFH	15A (1/2")
Water Heater	10	40 CFH	15A (1/2")
Fireplace	60	30 CFH	15A (1/2")

SIZING PROCEDURE:

1. Size the Main Line
   - Pressure drop per foot for 32A @150 CFH is .002
   - Multiply that by the length of the section
   - Pressure drop for this section is .100 (50' x .002)
2. Size the Furnace Line
   - Pressure drop per foot for 15A @ 80 CFH is .0353
   - Multiply that by the length of the section
   - Pressure drop for this section is .353 (10' x .0353)
3. Size the Water Heater Line
   - Pressure drop per foot for 15A @ 40 CFH is .0087
   - Multiply that by the length of the section
   - Pressure drop for this section is .087 (10' x .0087)
4. Size the Fireplace Line
   - Pressure drop per foot for 15A @30 CFH is .0049
   - Multiply that by the length of the section
   - Pressure drop for this section is .294 (60' x .0049)
5. Add the Main line pressure drop to the pressure drop of the individual appliance lines
   - Pressure drop at Furnace = .453 (.100+.353)
   - Pressure drop at Water Heater = .187 (.100+.087)
   - Pressure drop at Fireplace = .394 (.100+.294)
6. Check all the pressure drops to be sure they are at or below the allowable pressure drop.

All pressure drops in this example were below the allowable .5 inch W.C. pressure drop therefore the current tubing sizes will work for this application. If a particular appliance run had a pressure drop larger than .5 inches of W.C. you would need to repeat the process with a larger tubing size. Also, if you would like to maintain smaller tubing sizes you can repeat the calculations for smaller tubing until you exceed the allowable pressure drop.

3.3.4 WARDFLEX SIZING SOFTWARE

Ward Manufacturing the makers of WARDFLEX® CSST have provided free sizing software that is available as a free download on the WARDFLEX® webpage at www.WARDFLEX.com. The software can be downloaded onto a personal computer and used to size WARDFLEX® and WARDFLEX® II fuel gas systems as well as hybrid systems. The sizing utilizes the summation sizing method to help you achieve smaller tubing sizes.
Some features of the software include:

- Ability to size low pressure, dual pressure, and hybrid systems.
- Choose between Natural gas and propane.
- Size add-ons to systems by drawing out the existing arrangement.
- Choose between English or metric units.
- Select 1 of 3 methods for supply parameters.

4.1 GENERAL INSTALLATION PRACTICES

ATTENTION:

WARDFLEX® AND WARDFLEX® II ARE ENGINEERED FUEL GAS PIPING SYSTEMS AND AS SUCH, THE TUBING AND FITTINGS ARE NOT INTERCHANGEABLE WITH OTHER CSST MANUFACTURES PRODUCT. THE USE OF OTHER CSST PRODUCTS WITH BOTH WARDFLEX® AND WARDFLEX® II IS PROHIBITED. CONNECTION BETWEEN TWO DIFFERENT MANUFACTURERS CSST PRODUCTS MAY BE ACCOMPLISHED USING MALLEABLE IRON PIPE FITTINGS WITH ASME B1.20.1 COMPLIANT THREADS.

A. All System hardware should be stored in its original package in a clean dry location prior to installation. Care must be taken to ensure WARDFLEX® AND WARDFLEX® II CSST is not damaged prior to installation.

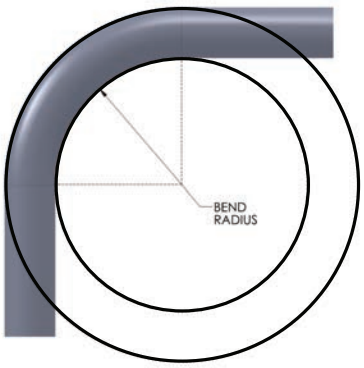
B. Tubing ends must be temporarily capped, plugged or taped proir to installation to prevent dirt or other foreign debris from entering the tubing.

C. Tubing exposed to extreme low temperatures should be allowed to come up to room temperature prior to installation.

D. Care must be taken to not kink, tangle, twist, stretch or apply excessive force to the tubing or fittings. WARDFLEX® AND WARDFLEX® II are flexible piping system and can be bent during installation around obstructions. Avoid stressing the tubing with tight bends and repetitive bending. Refer to Table 4.1 for recommended bend radius for both WARDFLEX® AND WARDFLEX® II.

TUBING SIZE	ABSOLUTE MINIMUM BEND RADIUS	RECOMMENDED INSTALLED BEND RADIUS INCHES
10A (3/8")	3/4"	3"
15A/15C (1/2")	3/4"	3"
20A/20C (3/4")	1"	3"
25A/25C (1")	1-1/4"	3"
32A/32C (1-1/4")	1-5/8"	4"
38A/38C (1-1/2")	4"	5"
50A/50C (2")	4-1/2"	6"

Table 4.1



E. When installing in, through or around sharp metal structures (i.e. metal studs, sheet metal, i-beams), rubber grommets or protective tubing should be used to prevent any direct contact which could subject the tubing to damage.

F. Tubing should be supported in a workman like manner with metallic pipe straps, bands, brackets, hangers or building structural components suitable for the size of piping support intervals are not to exceed those shown in Table 4.3. A proper support is one which is designed to be used as a pipe hanger, does not damage the tubing during installation, and provides full support of the tubing once installed. Plastic zip ties and/or cable ties are not to be used as the primary support for the CSST tubing.

ATTENTION:

WHEN SUPPORTING WARDFLEX® YELLOW JACKETED CSST AVOID USING CONDUCTIVE METALLIC SYSTEMS SUCH AS, DUCTING, PIPING, VENTING, AND ELECTRICAL CABLES TO SUPPORT THE PIPING.

G. WARDFLEX®/WARDFLEX® II system components shall not be exposed to any acids, bases, salts or other caustic materials. Some chemical compounds have been identified that may aggressively corrode 304 stainless steel. Contact with these chemicals should be absolutely avoided. Any contact should immediately and thoroughly be washed off. The plastic covering is not affected by these compounds and will protect the tubing as long as it is undamaged. Should the plastic covering become damaged, wrapping 2 layers of WARDFLEX® self fusing tape around the exposed area will help prevent from exposure to the caustic materials. See the list below of some chemicals to avoid.

CHEMICALS TO AVOID INCLUDE: BUT NOT LIMITED TO:

- Hydrochloric Acid (common name: muriatic or brick wash)
- Zinc Chloride and Ammonium Chloride (soldering flux, pool algaecide)
- Calcium or Sodium Hypochlorite (bleach or pool chemicals)
- Copper Chloride (may be found in fungicides or wood preservatives)
- Ferric Chloride (swimming pool flocculent)
- Phosphoric Acid (scale removers)
- Sodium Chloride (salt water)
- Sulfuric Acid (battery acid)
- Leak detection with chloride-containing compounds found in some common soap (e.g., dishwashing soap) can corrode WARDFLEX®. Avoid use of these compounds in connection with WARDFLEX®.

ANY LEAK DETECTION SOLUTION COMING IN CONTACT WITH THE WARDFLEX® SYSTEM SHOULD HAVE A SULFUR AND HALOGEN CONTENT OF LESS THAN 10 PPM OF EACH (ASTM E515-05 section 7.4).

4.2 FITTING ASSEMBLY

4.2.1 WARDFLEX® AND WARDFLEX® II STEPSAVER FITTING

Step 1 - Cut the Tubing
Using a tubing cutter, cut the WARDFLEX® or WARDFLEX® II tubing to the desired length. Then using a utility knife remove the coating to expose a minimum of four corrugations. NOTE: The coating on the WARDFLEX® II tubing shall be stripped back no more than 5 corrugations. Be sure not to score the tubing while removing the plastic coating.

Step 2 - Install the Nut and Retainer
Slide the nut over the tubing and place the retainer ring. Leave one corrugation exposed from the end of the retainer to the end of tubing. The small end of the retainer must point towards the cut end of the tubing.

Step 3 - Install the Body
Slide the nut over the retainer and thread it onto the body rotating only the nut.

Step 4 - Wrench Tighten
Using appropriate wrenches tighten the nut until it fully contacts the body. Tightening torque should not exceed the maximum torque listed in Table 4.2 **Do not use any thread sealant on the CSST Connection.** Thread sealant should be used only for NPT threaded connections.

NOTE:

DURING TIGHTENING, ROTATE THE NUT ONLY; THE BODY MUST NOT BE ROTATED WITH RESPECT TO THE TUBING.

TUBING SIZE	WARDFLEX MAXIMUM TIGHTENING TORQUE
10A (3/8")	50 ft-lb
15A (1/2")	50 ft-lb
20A (3/4")	120 ft-lb
25A (1")	160 ft-lb
32A (1-1/4")	200 ft-lb
38A (1-1/2")	200 ft-lb
50A (2")	200 ft-lb

Table 4.2

4.2.2 WARDFLEX®/ WARDFLEX® II FITTING REASSEMBLY

A. The STEPSAVER fitting, with its patented dual seal technology which when installed correctly, will give you a quick reliable seal the first time every time. Should the need arise to disassemble a WARDFLEX® STEPSAVER fitting,it may be reused if:
   - The metal to metal and gasket seals show no signs of extensive physical damage.
   - The threads on both the nut and body of fitting assembly show no signs of extensive physical damage.
   - Both halves of the retainer are intact.

B. The WARDFLEX®/WARDFLEX® II 38M (1 1/2") and 50M (2") fittings are also allowed for reuse if:
   - The gasket seals show no signs of extensive physical damage.
   - If the gasket is damaged, replacements are available.
   - The threads on both the nut and body of fitting assembly show no signs of extensive physical damage.
   - Both halves of the retainer are intact.

C. As with any installation, a pressure test should always be performed before placing the piping system into service. See section 6.1 for Pressure Testing and Inspection Procedure

4.3 TUBING ROUTING

4.3.1 VERTICAL RUNS

Vertical runs inside hollow wall cavities are the preferred location for installation of vertical sections. To avoid damage, tubing should be free to move within the wall cavity without immediate supports between floors but must be supported at the point of penetration between floors. Vertical run support spacing is not to exceed 10 feet, requiring hangers only where the height of each floor is greater than 10 feet. The run must conform to Section 4.4 Protection, if it is installed in a location that it will be concealed.

4.3.2 HORIZONTAL RUNS

Areas beneath, alongside, or through floor and ceiling joists or other structural members are typical installation locations for both residential and commercial applications. Structural members may be considered supports for horizontal tubing if they meet the requirements as specified in Table 4.3. The run must conform to Section 4.4 Protection, if it is installed in a location that it will be concealed.

ATTENTION:

CARE SHOULD BE TAKEN WHEN INSTALLING WARDFLEX® YELLOW JACKETED CSST, TO MAINTAIN AS MUCH SEPARATION AS REASONABLY POSSIBLE FROM OTHER ELECTRICALLY CONDUCTIVE SYSTEMS IN THE BUILDING.

TUBING SIZE	MINIMUM SUPPORT INTERVAL
10A (3/8″)	4 feet.
15A/15C (1/2″)	6 feet.
20A/20C (3/4″)	8 feet USA 6 Feet Canada
25A/25C (1″)	8 feet USA 6 Feet Canada
32A/32C (1-1/4″)	8 feet USA 6 Feet Canada
38A/38C (1-1/2″)	8 feet USA 6 Feet Canada
50A/50C (2″)	8 feet USA 6 Feet Canada

Table 4.3

4.3.3 CLEARANCE HOLES AND NOTCHING

Clearance holes for routing WARDFLEX®/ WARDFLEX® II CSST shall have a diameter at least ½" greater than the outside diameter of the tubing. The minimum hole diameters for each tubing size are listed in Table 4.4. Table 4.5 identifies some basic guidelines if drilling and/or notching is required of any structural member. However you should always check local code requirements before proceeding.

A. Holes drilled in vertical members of the wall framing should not exceed 1/4 the width of the member.

B. Holes drilled in plates and other horizontal frame members should not exceed 1/2 the width of the member.

C. Where a hole is to be drilled in a joist, the outside edge of the hole should be located not less than 3 in. away from the floor or ceiling.

D. Notching is not preferred practice, however, when notching, the notched depth must be a minimum of one tubing diameter with the maximum notch being determined by local code.

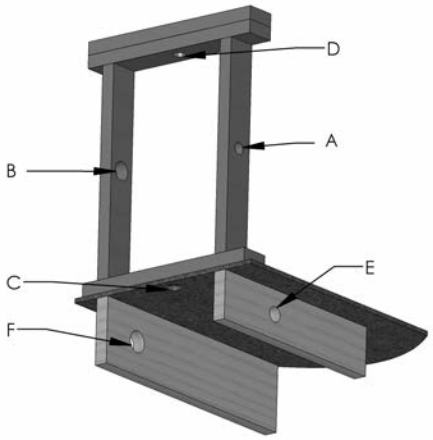
E. See Table 4.5 for typical maximum hole sizes in structural members.

TUBING SIZE	10A (3/8″)	15A/15C (1/2″)	20A/20C (3/4″)	25A/25C (1″)	32A/32C (1-1/4″)	38A/38C (1-1/2″)	50A/50C (2″)
MINIMUM CLEARANCE HOLE DIAMETER	1-1/8"	1-1/4"	1-1/2"	1-3/4"	2-1/4"	2-5/8"	3-1/4"

Table 4.4

	A	B	C	D	E	F
DESCRIPTION	2"x4" Stud Load Bearing Wall	2"x4" Stud Non-Load Bearing Wall	2"x4" Sole Plate	2"x4" Top Plate	2"x6" Floor Joist	2"x8" Floor Joist
MAX. HOLE SIZE	1.375"	2.125"	2"	1.75"	1.75"	2.420"
Maximum WARDFLEX Tubing Size	20A/20C (3/4")	25A/25C (1")	25A/25C (1")	25A/25C (1")	25A/25C (1")	32A/32C (1-1/4")

Table 4.5



4.3.4 CONCEALED LOCATIONS FOR FITTINGS

WARDFLEX®/WARDFLEX® II mechanical fittings have been tested and listed per the requirements of ANSI LC-1 /CSA 6.26. This specification provides test requirements which certify fittings for concealed locations and connections where accessibility is not possible. When the use of a concealed fitting is required always reference the National Fuel Gas Code NFPA 54 or CSA B149 or other relevant local code. These guidelines address some of the known situations which may require the use of concealed fittings. This guide cannot address all applications of concealed fittings but provides instead typical instructions to demonstrate the principles which apply to fittings listed for installation in concealed locations.

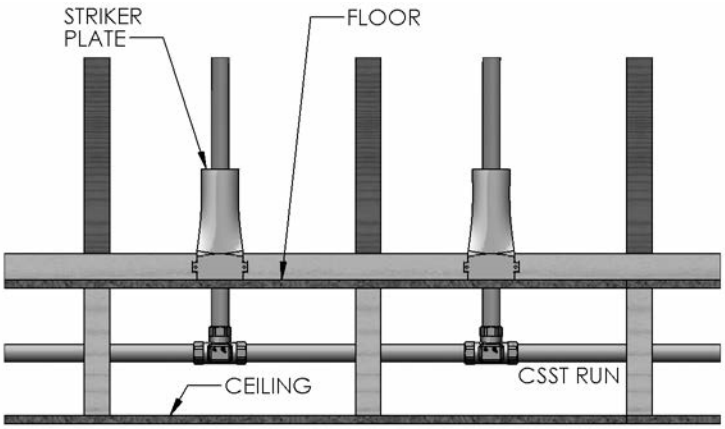


Figure 4.3

Figure 4.3 Multiple gas outlets connected to the same run of WARDFLEX®/ WARDFLEX® II. In this situation a tee-type fitting can be used and installed in a concealed location.

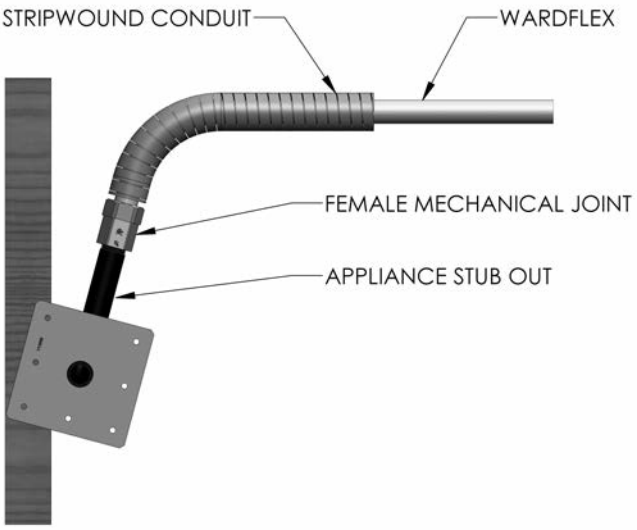


Figure 4.4

Figure 4.4 Appliance stub out with a WARDFLEX®/ WARDFLEX® II female mechanical fitting which can be installed in a concealed location. For this type of arrangement refer to section 4.4 on for protection details.

Installation in or through chimneys, clothes chutes, gas vents, dumbwaiters, and elevator shafts are all prohibited locations for

A. WARDFLEX®/WARDFLEX® II fittings and tubing.

B. Manifold stations for dual pressure systems, which include the multiport manifold, shutoff valves, and/or pressure regulators, shall not be installed in concealed locations regardless of the qualifications of the tubing fittings.

C. Fittings installed inside accessible enclosure boxes, for such items as quick connect gas outlets or fire place shut off valves, are exempted from these guidelines.

4.3.5 MODIFICATION TO EXISITNG SYSTEM

A. New Ceilings in Unfinished Rooms/Basements - CSST fittings originally installed in accessible ceiling locations can be concealed in the event a ceiling is installed at a later date.

B. Extension to Existing Tubing Run - Concealed CSST can be modified to permit an extension to another appliance location provided there is sufficient capacity to supply both applications at the same time. If an accessible location for the modification is not available, the existing tubing run can be modified with a tee fitting, resulting in a concealed fitting.

C. When any modification to an existing CSST installation leads to concealed tubing, protection devices may be required. Refer to Section 4.4 for details on protection.

4.3.6 OUTDOOR INSTALLATIONS

Per ANSI LC-1/CSA 6.26 WARDFLEX®/WARDFLEX® II CSST products are approved for installation where exposure to outdoor environments can occur. The following guidelines shall be followed when installing WARDFLEX®/WARDFLEX® II outdoors to protect tubing and fittings from the effects of weather.

A. The covering shall remain intact as much as practical for the given installation.
Any portion of exposed stainless steel shall be wrapped with tape (e.g. PVC, Self Fusing Silicone) or sleeved (e.g. PVC, Polyolefin) to prevent corrosive attack by acid wash or other caustic compounds that may be present. If contact with caustic compounds should occur ensure that all traces are immediately removed to prevent premature corrosion failure.

B. WARDFLEX®/WARDFLEX® II mechanical joint fittings shall be protected from the effects of weather when used outdoors. After the connection is made to outdoor equipment the fitting assembly shall be wrapped with tape (e.g. PVC, Self Fusing Silicone) or by applying shrink sleeves (e.g. PVC, Polyolefin) around the entire assembly.

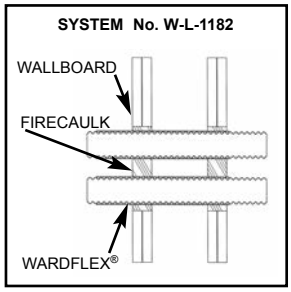
C. When installed outdoors between grade and six feet above WARDFLEX®/WARDFLEX® II must be protected inside non-metallic conduit or installed in a location where it will not be subjected to mechanical damage.

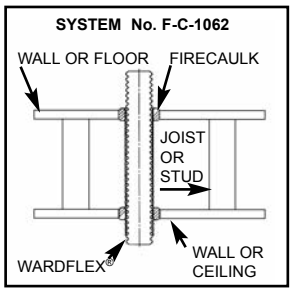
D. When installed in crawl spaces or underneath mobile homes, WARDFLEX®/WARDFLEX® II shall be installed in accordance with these installation instructions.

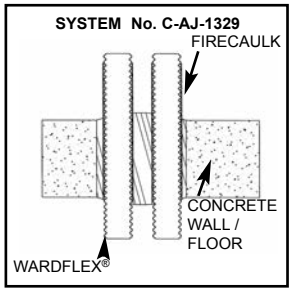
4.3.7 FIRE RATED CONSTRUCTION

A. WARDFLEX®/WARDFLEX® II have been reviewed for installation through UL Classified fire rated construction and is listed for use in a number of UL Through Penetration Firestop System Listings. See table 4.6 for a complete listing. System numbers are subject to change and deletion be sure to verify systems in the latest revision of UL Fire Resistance. In the event there is a conflict between this guide and UL, UL takes precedence.

TYPICAL INSTALLATIONS







R18357 WARDFLEX® UL Through Penetrating Firestop Listings

System No.	Rating hr		Firecaulk Product	Remove Covering	Max Size	Max Quantity
	F	T				
C-AJ-1217	3 & 4	0	5		2	1
C-AJ-1225	2	0	1	R	2	1
C-AJ-1240	2 & 3	0	6		3	1
C-AJ-1327	3	2 & 3	2		1-1/4	1
C-AJ-1328	3	2 & 3	3		1-1/4	1
C-AJ-1329	3	2	2		1-1/4	3
C-AJ-1330	3	2	3		1-1/4	3
C-AJ-1346	2	0	9		1	1
C-AJ-1353	3	0	4		2	1
C-AJ-1354	2	0	4		2	>1
C-AJ-1427	2	0	7		1	1
C-AJ-1428	2	0	7		1	1
C-AJ-1429	2	0	7		1	>1
C-AJ-1513	2	0	9		2	1 OR MORE
C-AJ-1551	2	0	1, 7, 10,		1	1
C-AJ-1553	1 & 2	0	12		1	3
C-AJ-1556	2	0	1, 10, 13,16		1	1 OR MORE
C-AJ-1584	3	1	19		1 1/4	1 OR MORE
C-AJ-1600	3 & 4	0	15		2	1
F-C-1029	1 & 2	1	1	R	2	1
F-C-1061	1/4 & 1	1/4 & 1	2		1-1/2	1
F-C-1062	1/4 & 1	1/4 & 1	3		1-1/2	1
F-C-1074	1 & 2	1/4, 1/2 & 1	4		2	1
F-C-1075	1 & 2	1/4, 1/2 & 1	4		1	>1
F-C-1094	1	1/4	7		1	1
F-C-1095	1	3/4	7		1	1
F-E-1002	1	1	4		2	1
F-E-1003	1	1	4		1	>1
F-E-1009	1	1/4	7		1	1
F-E-1010	1	3/4	7		1	1
W-J-1079	2	2	2		1-1/4	1
W-J-1080	2	2	3		1-1/4	1
W-J-1081	2	2	2		1-1/4	3
W-J-1082	2	2	3		1-1/4	3
W-J-1098	2	1	4		1-1/4	1
W-J-1099	2	1	4		2	1
W-J-1101	2	1	4		2	>1
W-J-1122	2	1/4	7		1	>1
W-J-1127	2	1/4	7		1	1
W-J-1206	1 & 2	3/4 & 1 1/2	19	1 1/4	1 OR MORE	
W-L-1001	VARIES	VARIES	1		1	1
W-L-1096	2	0	1	R	2	1
W-L-1179	1 & 2	1 & 2	2		1-1/4	1
W-L-1180	1 & 2	1 & 2	3		1-1/4	1
W-L-1181	1 & 2	1 & 2	2		1-1/4	3
W-L-1182	1 & 2	1 & 2	3		1-1/4	3
W-L-1199	1 & 2	1 & 2	2		1-1/4	1
W-L-1200	1 & 2	1 & 2	3		1-1/4	1
W-L-1222	1	1/4, 3/4 &1	4		1-1/4	1
W-L-1223	1	1	4		2	1
W-L-1224	1	2	4		2	>1
W-L-1243	1 & 2	0	9		1	1
W-L-1287	1 & 2	0 & 1/4	7		1	>1
W-L-1296	1 & 2	0 & 1/4	7		1	1
W-L-1407	2 & 2	0	12		1	3
W-L-1427	1 & 2	3/4 & 1 1/2	19		1 1/4	1 OR MORE
W-L-1429	1 & 2	3/4 & 1 1/2	8		1 1/4	1
W-L-8071	1 & 2	0	9		2	1 OR MORE

System No. explanations: First alpha: F=floor is being penetrated, W=wall, C=walls or floors, E=Floor-ceiling assemblies consisting of concrete with membrane protection Second alpha: A=concrete floors with a minimum thickness less than or equal to 5 inches, C= framed floors,J=concrete or masonry walls with a minimum thickness less than or equal to 5 inches, L= framed walls. Rating hours: F= flame passage criteria, T= temperature rise of 325°F. Firecaulk Products: 1 3M COMPANY: CP-25-WB+, 2 Rectorseal: Metacaulk 1000, 3 Rectorseal: Biostop 500+ caulk, 4 Specified Technology: SpecSeal LCI sealant, 5 Specified Technology: SpecSeal 100, 101, 102, 105, 120 or 129, 6 Specified Technology: SpecSeal 100, 101, 105, 120 or 129 Sealant, SpecSeal LC 150, 151, 152or 155 Sealant may be used for 2 hr F Rating only. 7 3M COMPANY: IC 15WB, 8 EGS NELSON FIRESTOP: LBS+, 9 HILTI INC: FS-ONE Sealant 11 Rectorseal: Biostop 350i 12 NUCO INC: Self Seal GG 266 13 3M COMPANY: FB 1000 NS 14 3M COMPANY: FB 1003SL IC 15WB+ 15 Hercules Chemical: Hercules Plumbers Firestop Sealant 16 Rectorseal: Metacaulk 350i 17 HILTI INC: CP 606 18 NUCO CO Self Seal GG 200 19 Rectorseal FlameSafe FS900+ or FS1900 Consult UL Fire Resistance Directory-Volume 2 for specific construction details or contact WARD MANUFACTURING These can be downloaded directly from UL's web site:http://database.ul.com/cgibin/XYV/cgifind.new/LISEXT/1FRAME/srchres.html

4.4 PROTECTION

4.4.1 INTRODUCTION

WARDFLEX®/WARDFLEX® II tubing shall be protected from physical damage caused by screws, nails, drill bits, etc. The tubing is most susceptible to puncture at all points of support. The best practice is to install the tubing in those areas where the likelihood of physical damage is minimized and no protection is needed; for example:

A. Where tubing is supported at least 3 inches from any outside edge of a stud, joist, etc. or wall surface.

B. Where any unsupported tubing can be displaced in the direction of potential penetration at least 3 inches.

C. Where tubing is supported under the joist in basements or crawl spaces and is not concealed by wall board or ceilings.

When WARDFLEX®/WARDFLEX® II is installed in locations where the potential of physical damage exists, the use of hardened steel striker plates, listed for use with CSST, must be used. Striker plates other than those provided for use with WARDFLEX®/WARDFLEX® II are prohibited. The tubing may also be routed inside strip wound conduit or schedule 40 pipe when protection is required.

In areas where penetration through studs, joists, plates and other similar structural members occur striker protection is required when all of the following criteria apply:

1. When the piping system is installed in a concealed location and is not viewable.
2. When the piping system is installed in a location that does not allow free movement to avoid puncture threats.
3. When the piping system is installed within 3 inches of possible points of penetration.

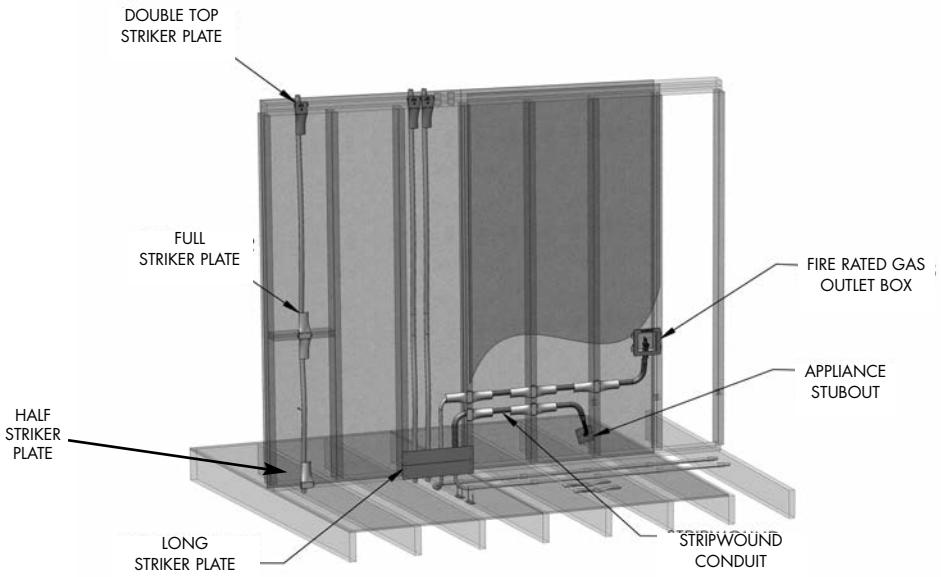


Figure 4.5

4.4.2 STRIKER PLATES

Striker plates are used to prevent tubing damage in areas where potential penetration threats exist through studs, joists, plates, and other similar structural members. Only striker plates supplied by Ward Manufacturing are permitted for use with WARDFLEX®/WARDFLEX® II. For installations where all three above criteria apply the following striker plate protection must be applied.

A. At concealed support points and points of penetration less than 2 inches from any edge of a stud, joist, plate, etc. shielding is required at the area of support and extending 5 inches in one or both directions (if appropriate).

B. At concealed support points and points of penetration within 2 to 3 inches from any stud, joist, plate, etc., listed quarter striker plates are required at the area of support. Figure 4.7 and Figure 4.8 show proper means of protection for this type of installation.

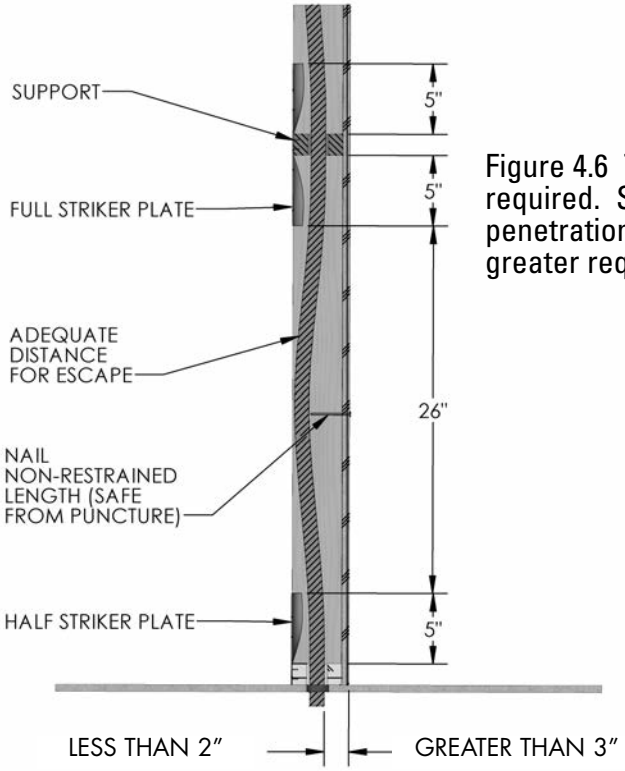


Figure 4.6 Typical locations where striker plates are required. Striker plates are installed at both horizontal penetrations unrestrained vertical runs of 26 inches or greater require no additional protection.

Figure 4.6

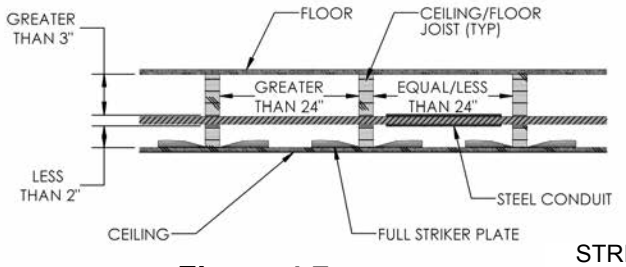
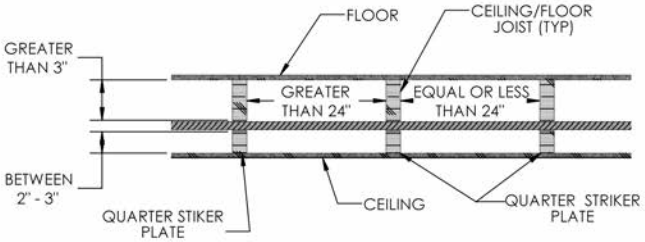


Figure 4.7



STRIPWOUND METAL CONDUIT

Figure 4.8

C. Tubing routed horizontally through structural members shall be protected from puncture threats with the appropriate shielding material. At penetration joints, listed striker plates of the appropriate size shall be utilized. Tubing between constraints that are less than 24 inches apart and meeting the criteria requiring full striker plates, shall be additionally protected by stripwound metal-conduit, or schedule 40 pipe.

D. CSST greater than 1" nominal diameter installed within a concealed hollow wall cavity of 2" x 4" construction shall be protected along the entire concealed run length with stripwound metal conduit, or schedule 40 pipe.

E. Should an unfinished ceiling (I.e. basement) be covered at a later date, the quarter striker plates, shown in figure 4.9 and 4.10, should be replaced with appropriate protection devices that provide adequate protection for potential penetration threats.

F. Although figures 4.9 and 4.10 are acceptable, installation method 4.11 is preferred.

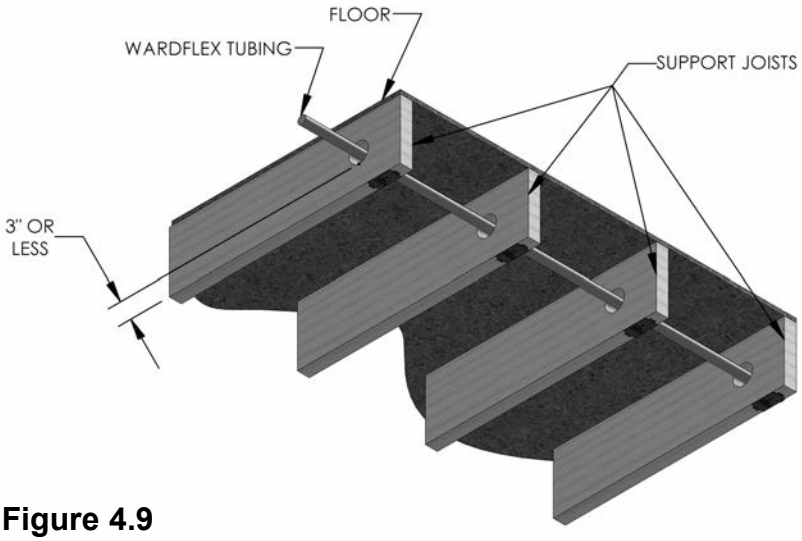


Figure 4.9

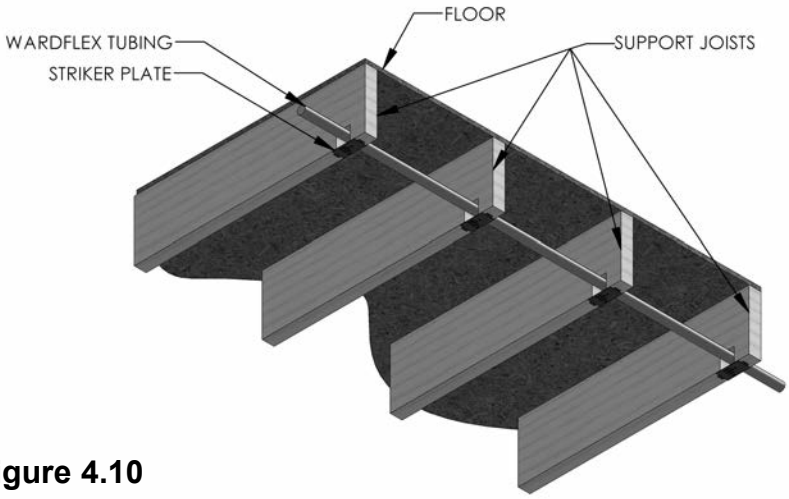


Figure 4.10

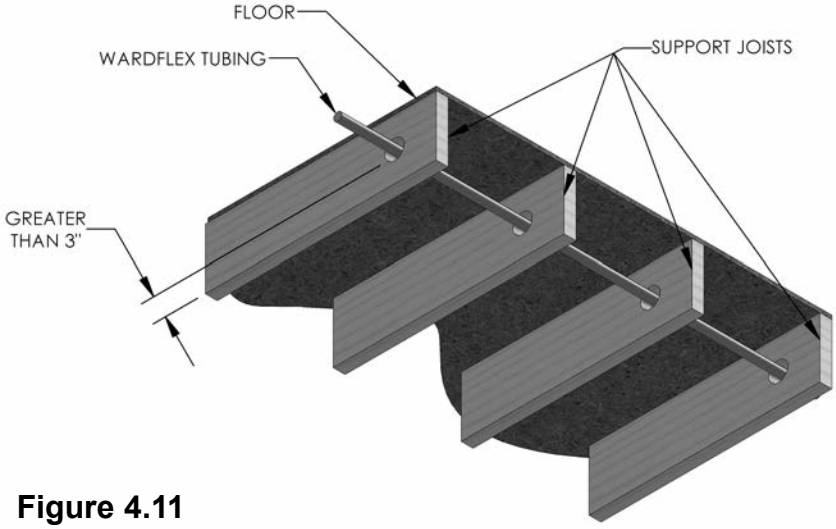


Figure 4.11

4.4.3 STRIPWOUND METAL CONDUIT

A. At termination points not covered by ANSI specifications, standard stripwound metal conduit shall be installed as additional protection. Stripwound conduit shall not be used as a substitute for striker plates where tubing passes through structural members.

B. Stripwound conduit shall also be used to shield tubing from puncture threats when WARDFLEX®/WARDFLEX® II is installed in a concealed location where it cannot be displaced a minimum 3”from a potential puncture threat or the distance between supports is less than 24 inches. See Figure 4.12.

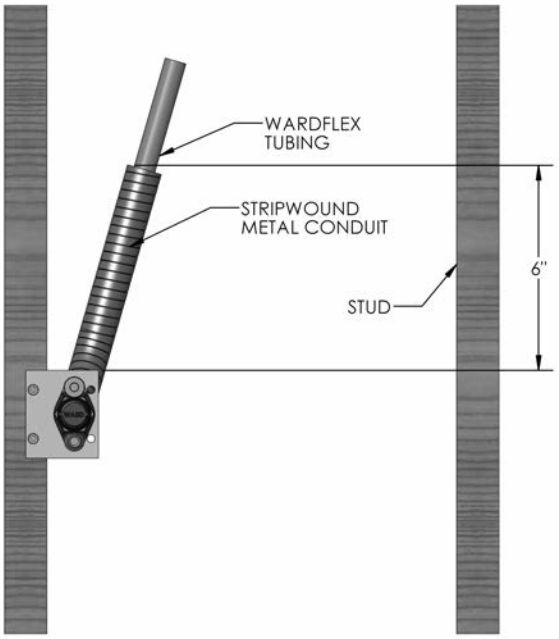


Figure 4.12

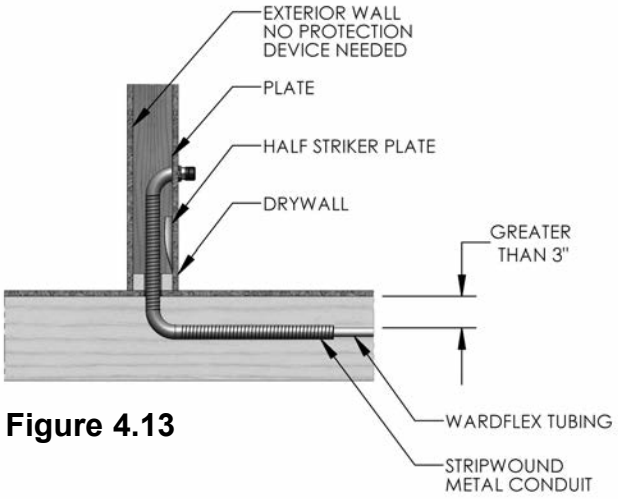


Figure 4.13

Figure 4.13 Termination fitting for an appliance connection with stripwound conduit providing extra protection inside the wall and floor cavities.

4.4.4 INSTALLATION IN INSULATED WALLS

Rigid installations present significant puncture threats for WARDFLEX®/ WARDFLEX® II installations in concealed spaces. In concealed spaces, e.g. wall cavities, rigid insulation will prevent CSST from being displaced. WARDFLEX®/WARDFLEX® II shall not be installed in a wall cavity with foam insulation without additional protection as described below.

A. Tubing shall be routed through an approved conduit in walls where "foamed in" insulation is to be used i.e. rigid steel pipe or conduit. Approved conduit shall be secured according to local building practice.
B. Protection methods such as pipe, conduit and strip wound hose, supply protection and give the tubing space in which to move. On exterior walls the tubing may be fastened to the sheathing with cable clamps or secured with sticks/wires sprung between studs to center tubing between interior and exterior surfaces.
C. When tubing is installed inside walls with batt insulation the tubing shall be routed between the face (craft paper/vapor barrier) and the wall surface. If installed in a concealed location where it cannot be displaced a minimum 3"from a potential puncture threat the run shall be protected with stripwound conduit.
D. CSST tubing does not need additional protection where it is more than three inches from any puncture threats although consideration must be given to the chance that it may migrate toward penetration threats as the insulation is applied and during curing.

4.5 METER-CONNECTIONS

4.5.1 UNSUPPORTED METERS

A. Meters which depend on the service and house piping for support shall not be directly connected to the flexible gas piping.

B. The use of an outdoor termination fitting mounted to the exterior of the structure, meter stubout or other rigidly mounted termination fitting are acceptable transitional methods.

METER CONNECTION -PIPE SUPPORTED METER

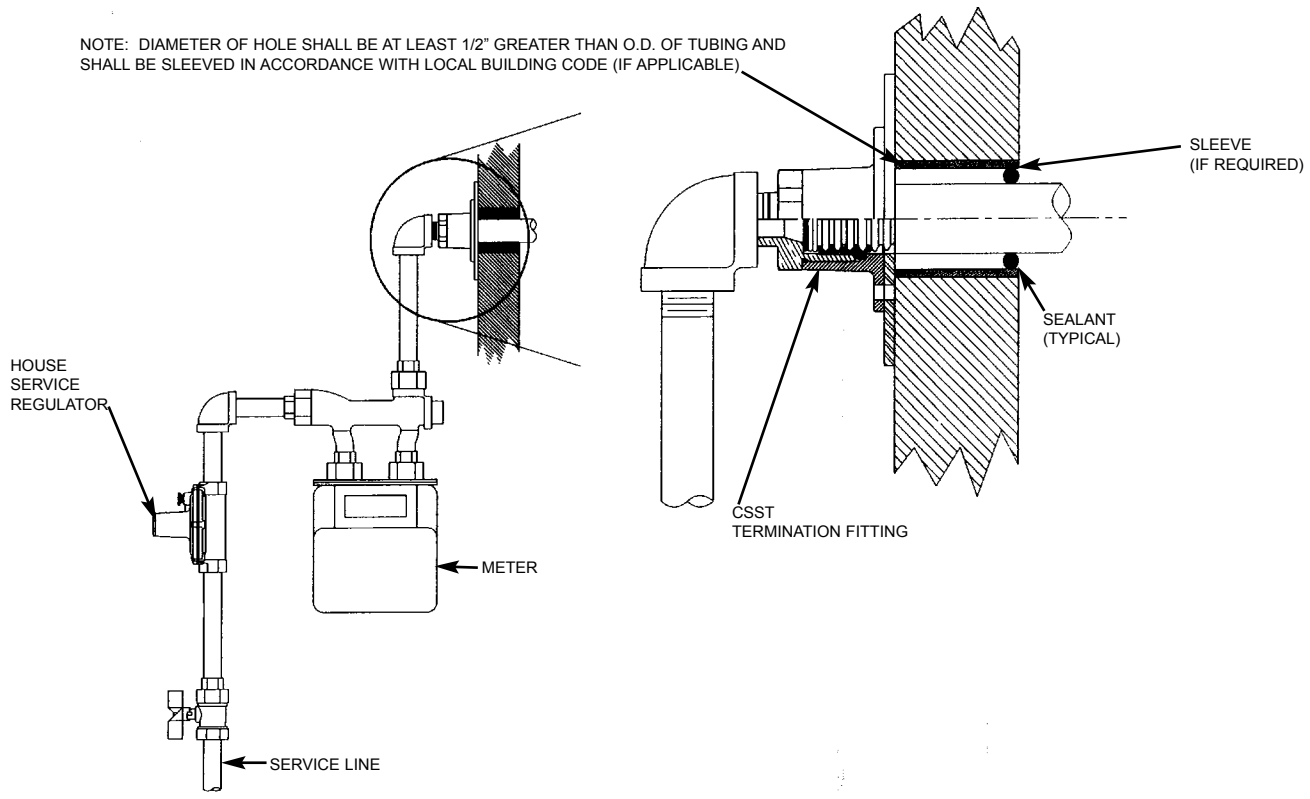


Figure 4.15

**METER CONNECTION -
PIPE SUPPORTED METER**

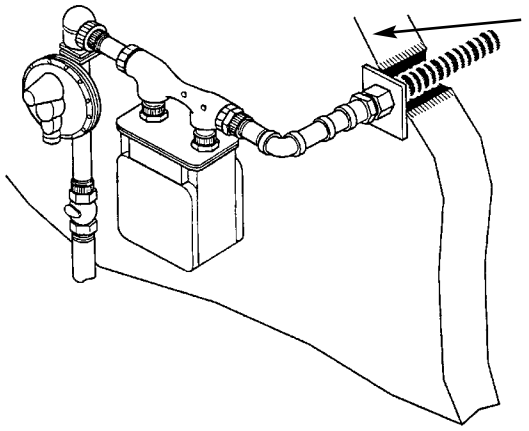
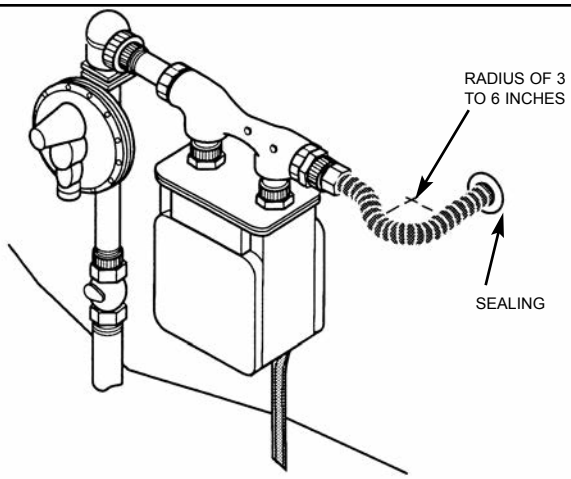


Figure 4.16

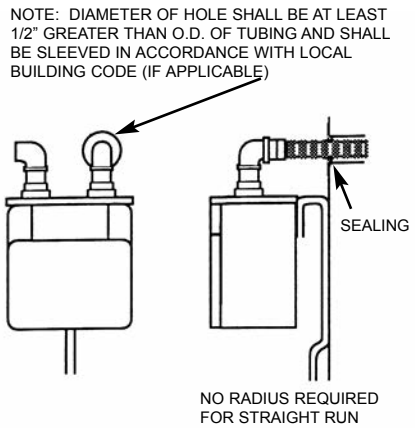
4.5.2 SELF SUPPORTED METER

A. Meters which are independently supported by a bracket may be directly connected to WARDFLEX®/ WARDFLEX® II.
B. If practical a 3 to 6 in. loop of tubing should be included to compensate for meter movement and differential setting.

NOTE: WARD MANUFACTURING DOES NOT REQUIRE MECHANICAL PROTECTION FOR OUTDOOR METER CONNECTION MORE THAN 6 FT. ABOVE GRADE HOWEVER, LOCAL CODES MUST BE CONSIDERED. CHECK WITH YOUR LOCAL CODE AUTHORITY.



NOTE: WHEN DIRECT CONNECTION OF WARDFLEX® TO A METER IS BETWEEN 0 AND 6 FEET ABOVE GRADE THE TUBING MUST BE PROTECTED BY NON METALLIC PIPE (E.G. PVC).



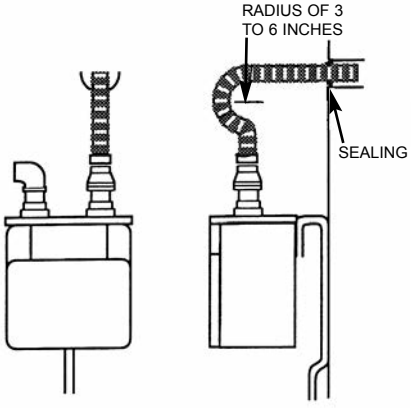


Figure 4.17

4.6 APPLIANCE CONNECTIONS

4.6.1 MOVEABLE APPLIANCES

IMPORTANT
WARDFLEX®/WARDFLEX® II ARE NOT RATED AS FLEXIBLE APPLIANCE CONNECTORS AND MUST NOT BE DIRECTLY CONNECTED TO MOVABLE APPLIANCES.

A. When using WARDFLEX® or WARDFLEX® II with moveable appliances such as a ranges or dryers, the tubing must be rigidly terminated before the appliance. Appliance stub outs, termination fittings or transitioning to rigid black pipe are acceptable means to terminate CSST prior to the appliance.

B. Final connection from CSST termination point to a movable appliance shall be made with a flexible appliance connector or another approved connection device.

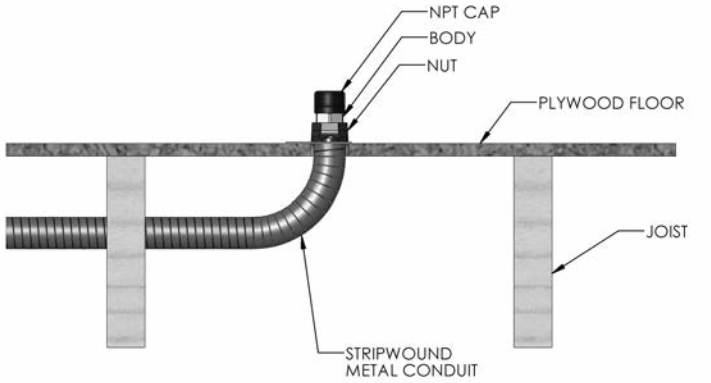


Figure 4.18

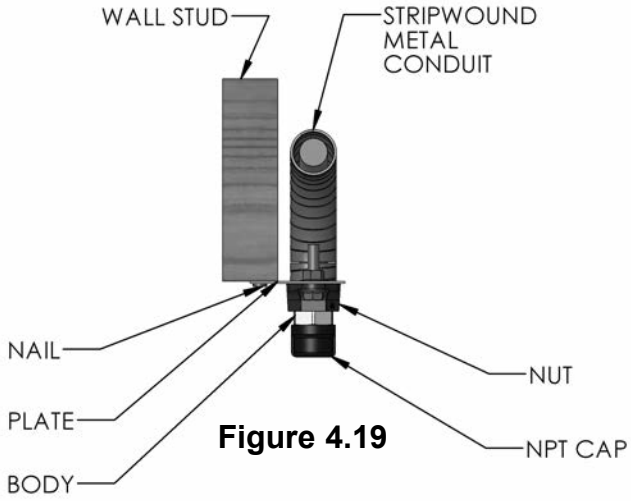


Figure 4.19

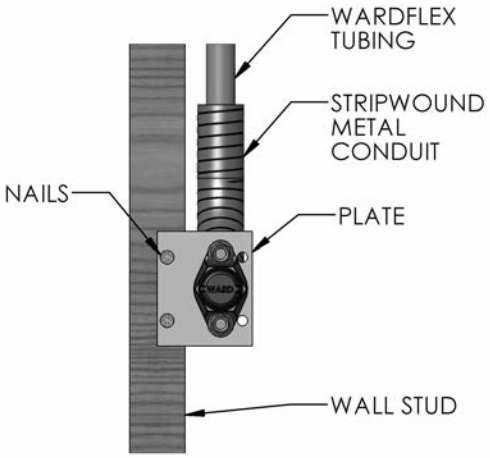


Figure 4.20

4.6.2 NON-MOVEABLE APPLIANCE

A. WARDFLEX®/WARDFLEX® II can be directly connected to a non-moveable appliance such as a furnace or water heater (Figure 4.21) (be sure to check with local code if this is acceptable prior to installation).

B. In this type of application, no termination fitting is required and the CSST should be terminated at the appliance shut off valve.

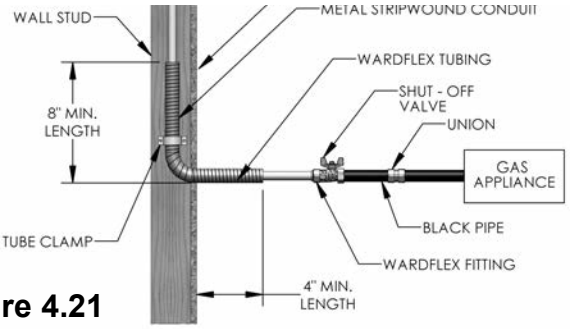


Figure 4.21

ATTENTION:

WHEN NON-MOVABLE APPLIANCES UTILIZE METALLIC VENTS WHICH EXTEND BEYOND OR PROTRUDE THROUGH THE ROOF, CONTACT BETWEEN WARDFLEX® YELLOW COATED CSST AND THE APPLIANCE CABINET OR VENT IS PROHIBITED.

4.6.3 OUTDOOR APPLICANCES-BARBEQUE GRILL AND GAS LIGHT CONNECTION

A. Movable grills shall be connected using an approved outdoor appliance connector which shall be attached to the CSST system at either a termination fitting, quick disconnect or other rigidly mounted transition fitting (Figure 4.22). An approved outdoor appliance connector shall be used to connect the appliance to the gas piping system.

B. Permanently mounted grills located on decks shall be connected to the CSST system as shown in figure 4.23 and in accordance with the manufacturer's instructions. The outdoor portion of the CSST system shall be supported against the side of any inside deck joist.

C. Permanently mounted outdoor lights located on decks shall be connected to the CSST system in the manner as permanently mounted grills as shown in figure 4.23 and in accordance with manufacturer's instructions.

D. Yard mounted lights shall be connected to the CSST system as shown in figure 4.24.
All WARDFLEX®/WARDFLEX® II installed below grade shall be routed through nonmetallic watertight conduit and fittings protected in accordance with the requirements of section 4.3.6 Outdoor Installation.

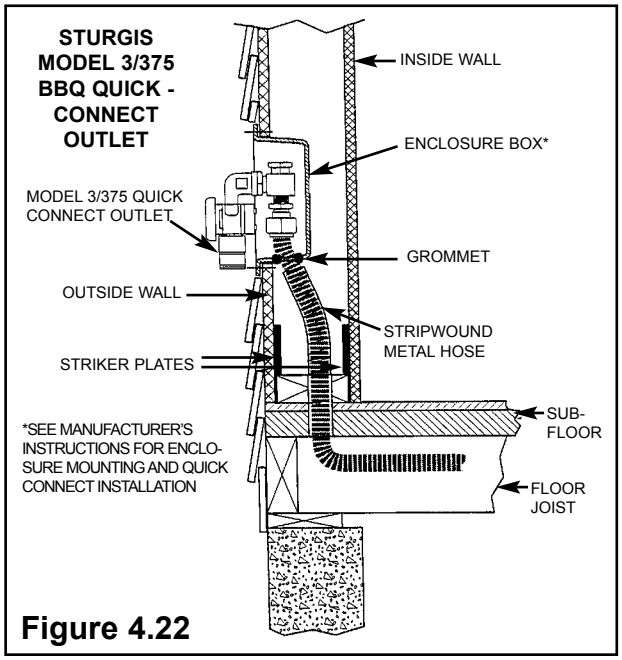


Figure 4.22

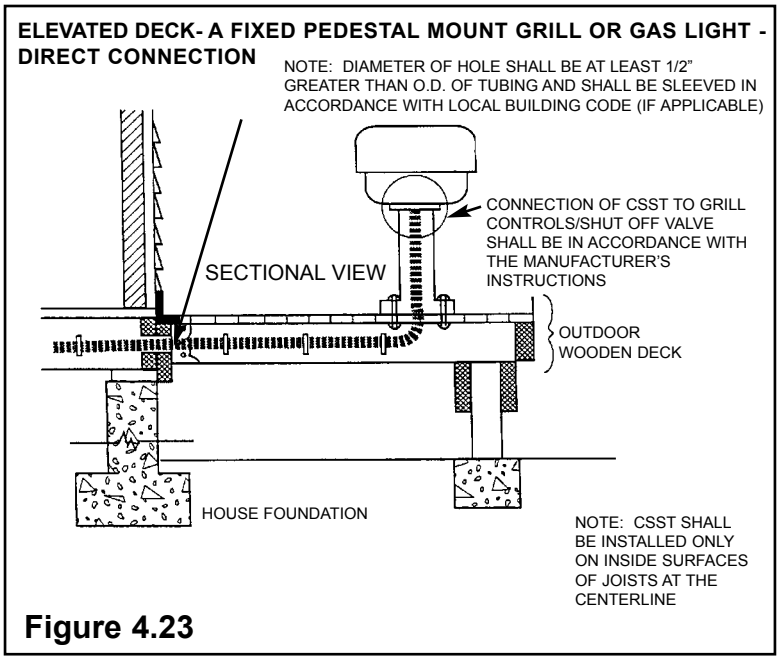


Figure 4.23

GROUND LEVEL GAS LIGHT/PEDESTAL BBQ GRILL - BURIED CONNECTION

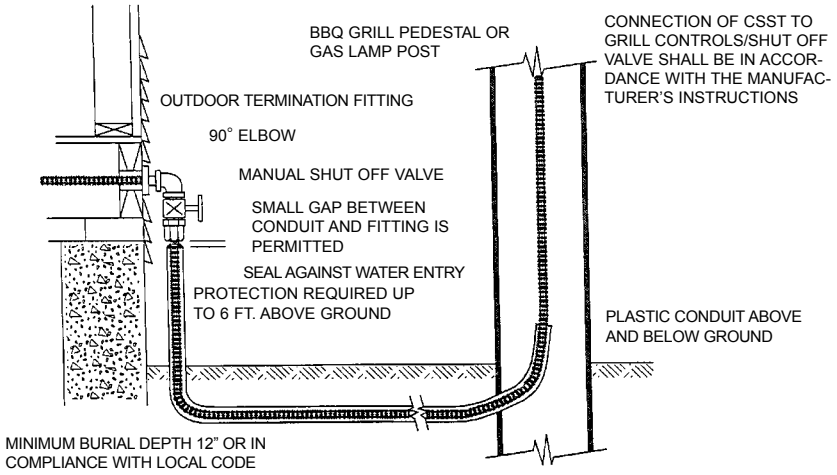


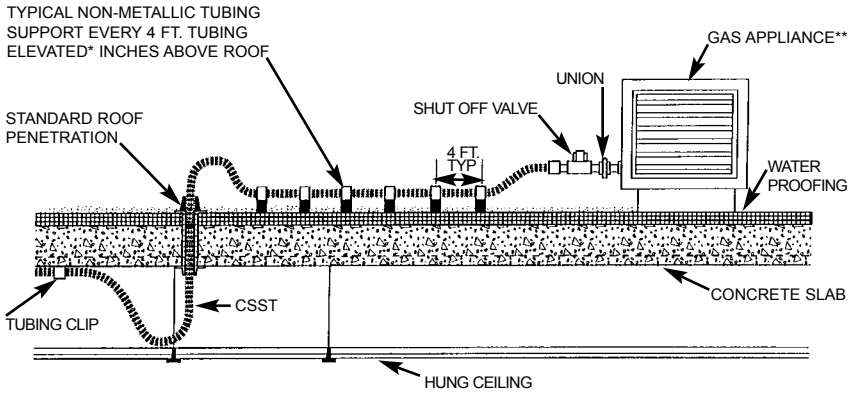
Figure 4.24

4.6.4 SPECIAL APPLICATIONS

A. Roof Top Installations

For a roof top appliance no additional mechanical protection of the tubing is required. Whenever possible, roof penetrations shall include an outdoor termination fitting and shall be located within 6 feet of the equipment to be connected as shown in figure 4.25. All long runs of tubing shall be supported in accordance with minimum support intervals in Table 4.3 and raised above the roof distance determined by local code/practice. WARDFLEX®/WARDFLEX® II routed vertically up the side of a building, to the roof, shall be protected in accordance with section 4.3.6 Outdoor Installation.

LONG OUTDOOR CONNECTION TO ROOF MOUNTED EQUIPMENT

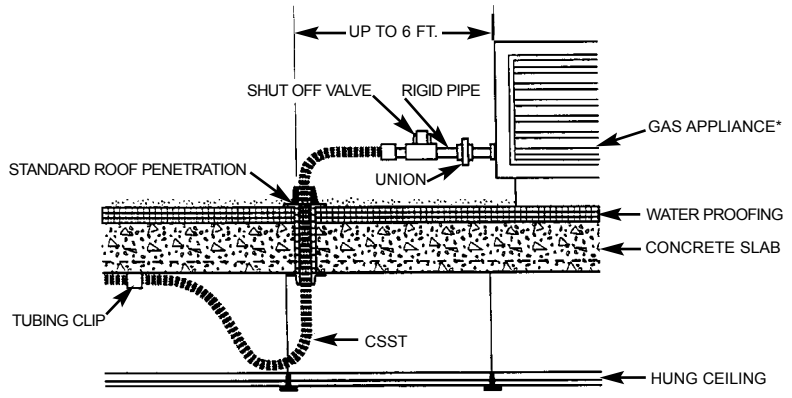


* HEIGHT OF ELEVATION BASED ON LOCAL PLUMBING/BUILDING CODE REQUIREMENTS AND/OR WINTER ICE BUILDUP.

** WHEN THE EQUIPMENT MANUFACTURER REQUIRES THE USE OF A FLEXIBLE CONNECTOR.

Figure 4.25

SHORT (1 TO 6 FT.) OUTDOOR CONNECTION TO ROOF MOUNTED EQUIPMENT



*WHEN THE EQUIPMENT MANUFACTURER REQUIRES THE USE OF A FLEXIBLE CONNECTOR

Figure 4.26

B. Infrared Heaters

Infrared heaters mounted from ceilings and walls of structures shall be connected to WARDFLEX®/WARDFLEX® II system as shown in figure 4.27 and installed in accordance with manufacturer's instructions and ANSI 383.6 "Standard for gas fired infrared heaters".

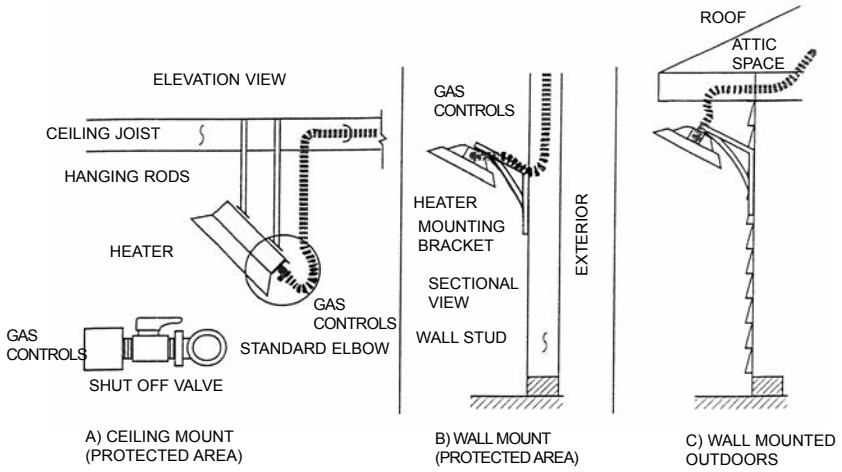


Figure 4.27

C. Pad Mounted Gas Appliances

Gas appliances mounted on concrete pads or blocks, such as heat pumps, air conditioners, pool heaters and NGV refueling systems, shall be connected to the WARDFLEX®/WARDFLEX® II system at a termination fitting using either rigid pipe or an approved outdoor appliance connector as shown in Figure 4.28. Pad mounted equipment (in most cases) is considered "fixed" if not moved for cleaning, maintenance, etc. (i.e. A/C units).

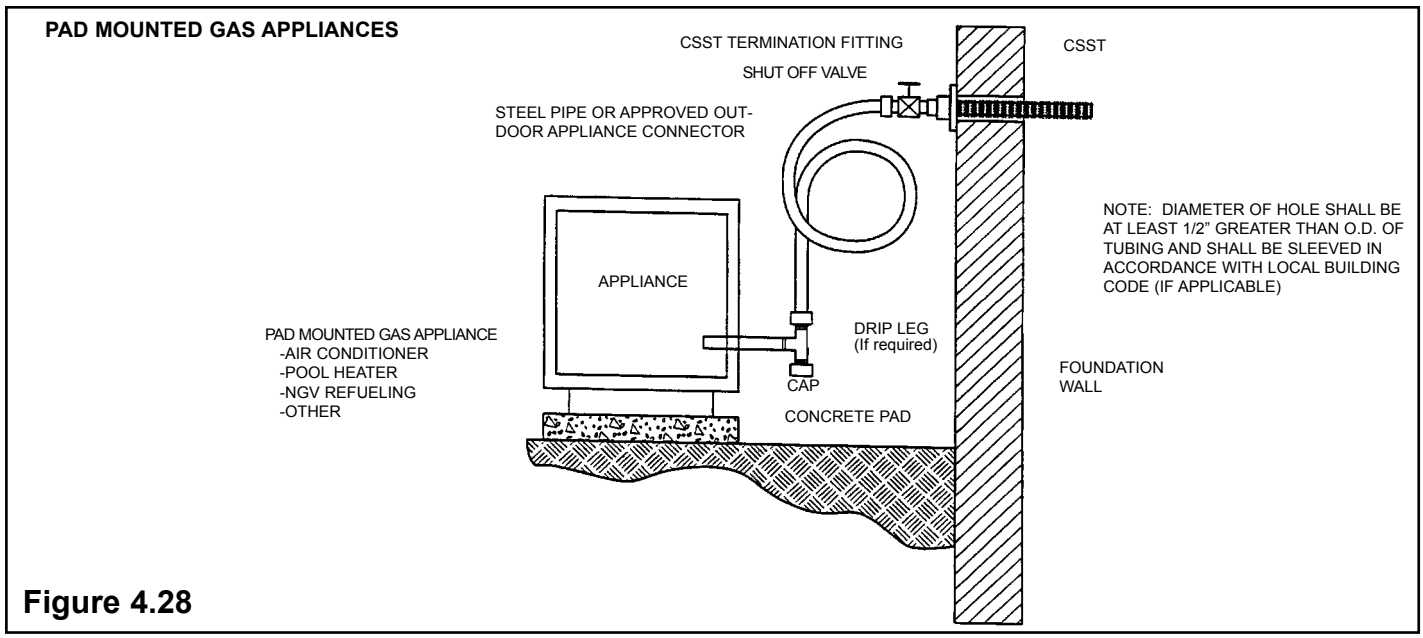


Figure 4.28

4.6.5 GAS FIREPLACES

WARDFLEX®/WARDFLEX® II CSST shall not be routed directly into a metallic fireplace enclosure.
The CSST connection shall be made outside of the enclosure to a section of rigid metallic pipe.

A. When routing WARDFLEX® and WARDFLEX® II through masonry construction, for connection to gas fireplaces and gas logs CSST is required to be sleeved in a non metallic conduit through the masonry structure. The plastic coating should be left intact, through the sleeved portion of the installation, and the annular space between the jacket and sleeve should be caulked at both the interior and exterior locations.

B. For any fireplace application where installation of CSST is desired, the WARDFLEX® Fireplace Stubout shall be used to terminate the CSST outside the enclosure. While other listed installation practices are acceptable this method is preferred to prevent inadvertent damage, that can be caused by the fireplace enclosure, to the CSST.

C. Adherence to local codes and manufacturer's instructions are required, be sure to know and understand all requirements prior to installation.

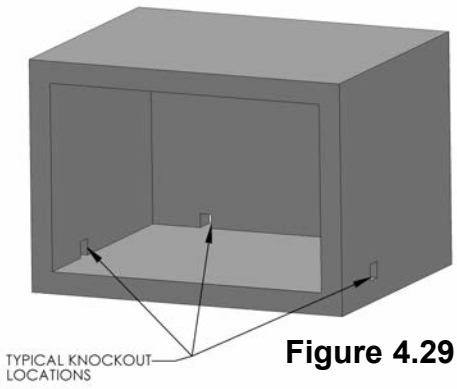


Figure 4.29

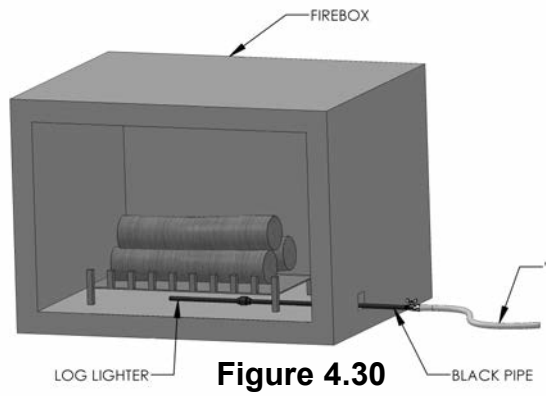


Figure 4.30

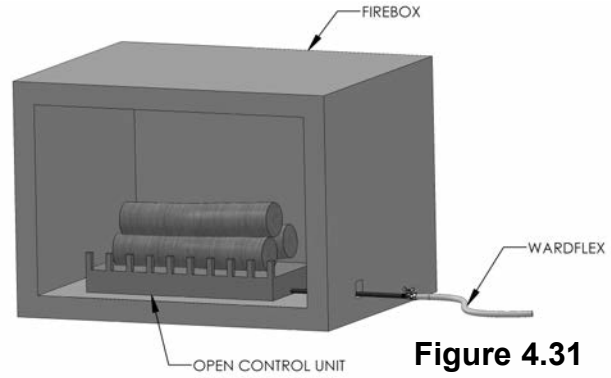


Figure 4.31

4.7 MANIFOLD STATION

A. Manifolds are used where multiple tubing runs are made from a common location forming a parallel system configuration. Manifolds may be a one piece unit manufactured from malleable iron or brass. They may also be constructed as a welded fabrication of steel and subcomponents and brass or malleable iron tee's connected with pipe nipples. See figures 4.33 and 4.34 below for examples of manifolds.

B. Manifolds shall be rigidly installed and may be mounted in any orientaion. Mounting can be done with mounting brackets (figure 4.34), supplied mounting holes on manifolds (if equipped) or rigid piping into a non-movable gas appliance.

C. Manifolds installed in low pressure applications or in locations removed from the regulator, without shutoff valves, may be concealed.

D. A Manifold Station utilizing a pounds to inch regulator (figure 4.35) shall be installed in an accessible location to allow access to the regulator for inspection, service and replacement if required.

E. Installation of manifold stations in an enclosure box or gas load center is permitted. Refer to local code requirements for proper installation techniques and venting requirements.

SINGLE 3 - PORT MANIFOLD WITH ADDED TEE ALLOWING FOUR PORTS

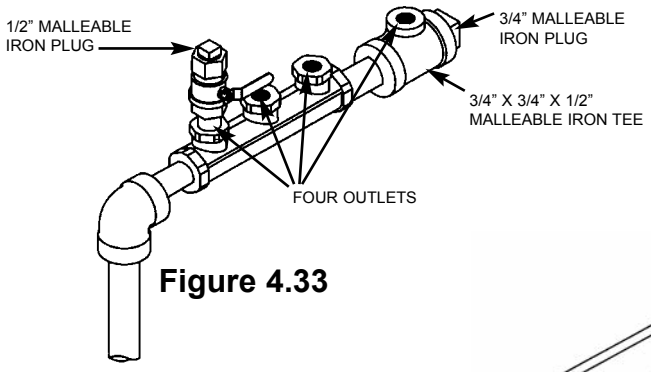


Figure 4.33

SINGLE 3 - PORT MANIFOLD WITH MANIFOLD BRACKET AND WARDFLEX GAS VALVES INSTALLED

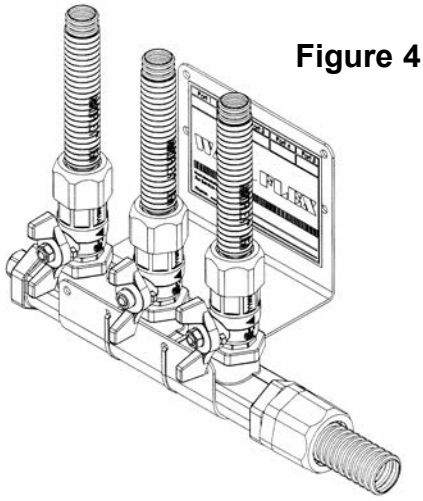


Figure 4.34

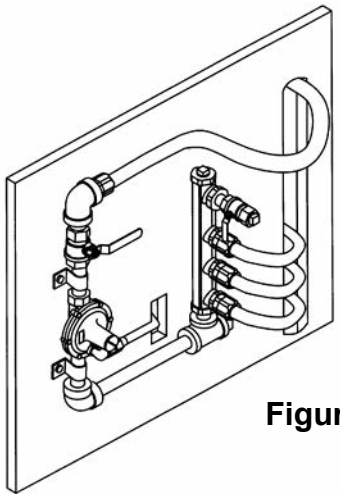


Figure 4.35

4.8 PRESSURE REGULATORS

4.8.1 INSTALLATION REQUIREMENTS

A WARDFLEX®/WARDFLEX® II CSST system utilizing gas line pressures above ½ PSI are required to use a line pressure regulator upstream of the appliances to reduce the line pressure to less than ½ PSI.
The regulator shall incorporate construction which will "lock up" under no-flow conditions to limit the downstream pressure to not more than 1/2 PSIG. The regulator shall comply with a nationally recognized standard for pressure regulators.

TYPICAL REGULATOR/MANIFOLD CONFIGURATION WHEN USING A VENT LIMITER

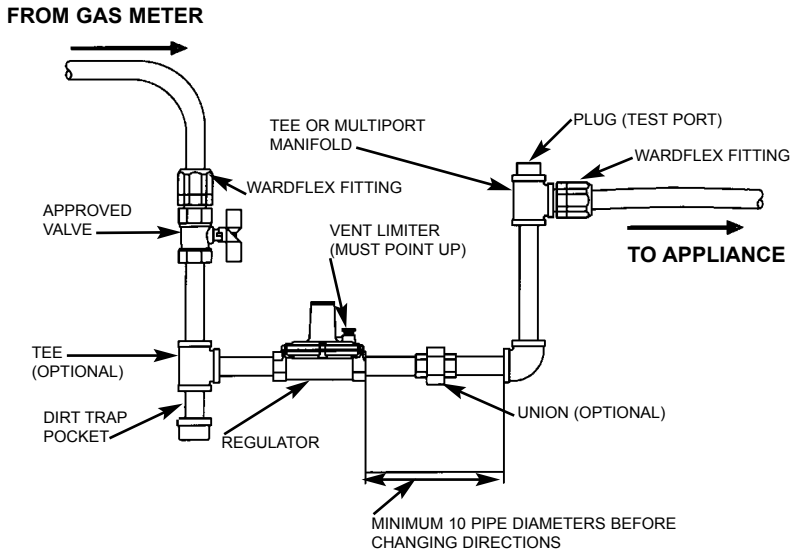


Figure 4.38

Regulators used to reduce elevated system pressure for appliance use must also conform to the following:

- Sized to supply the required appliance load.
- Equipped with an acceptable vent limiting device, supplied by the manufacturer, or be capable of being vented to the outside atmosphere.
- Installed in accordance with manufacturer's printed instructions.
- Installed in an accessible location.
- A CSA Design Certified shut-off valve must be installed upstream of the pressure regulator.

Regulator capacities are listed in table below.

REGULATOR CAPACITIES

Model	Maximum Individual Load	Maximum Total Load
325-3L	140,000 BTU/HR	250,000 BTU/HR
325-5L	425,000 BTU/HR	600,000 BTU/HR
325-7L	900,000 BTU/HR	1,000,000 BTU/HR
325-3L48(OPD)	200,000 BTU/HR	200,000 BTU/HR
325-5AL600 (OPD)	425,000 BTU/HR	425,000 BTU/HR

4.8.2 REGULATOR VENTING REQUIREMENTS

VENT LINES

Venting is required for all regulators to avoid a gas buildup in an enclosed area in the event that the regulator diaphragm ruptures. Vent lines should be properly sized per the manufacturers instructions and installed to ensure proper operation.

VENT LINE INSTALLATION GUIDELINES:

- The vent line shall not be smaller than the vent connected to the pressure regulator.
- The recommended minimum size vent line for the regulator is 1/4 in. nominal ID copper tubing or other approved material. The maximum length installed for this size vent line should be less than 30 feet. Larger diameter vent lines can be used if necessary. In determining the proper size vent line for a particular installation, a test may be necessary with the vent line and regulator under normal use to ensure proper regulator operation. Consult with the regulator manufacturer for limitations of length and size of the vent line.
- The vent shall be designed and installed to prevent the entry of water, insects or other foreign materials that could cause blockage.
- Under no circumstances shall a regulator be vented to the appliance flue or building exhaust system.

VENT LIMITER OPTION:

Vent limiters are an alternate venting option available for Maxitrol 325-3L, 325-5L and 325-7L regulators. When a vent limiter is desired all installation guidelines for the vent limiter and regulator must be followed to ensure proper operation of the unit.

VENT LIMITER INSTALLATION GUIDELINES:

- Regulators must be installed in the horizontal upright position and in a well ventilated area when using a vent limiter. Consult with local code before installation.
- Only a vent limiter supplied by the regulator manufacturer may be used, no piping shall be installed between the regulator and vent limiting device.
- Leak detection fluids may not be used on vent limiters as they can cause corrosion and operational failure.
- Remove the vent limiter and check the vent opening if a leaking diaphragm is suspected. Remember, regulators will “breathe” when regulating, creating a bubble - A leak will blow bubbles constantly. Do not leak test the vent limiter with liquid leak test solution. This action will contaminate the internal ball check mechanism or plug the breathing hole, resulting in erratic regulator operation.
- Vent limiters shall not be used outside or anyplace where they are subject to damage from the

ACCESSORIES FOR GAS PRESSURE REGULATORS

Vent Limiting Means

1,2

3

Figure 4.39

Automatic vent limiting device-ball check permits free inhalation for fast regulator-diaphragm response on opening cycle, but limits gas escapement should a diaphragm rupture. May be used in multi-poise mounting but to achieve quick regulator response it must be mounted in an upright position.

1-IAS certified for 14”W.C. Color-brass 1/8” NPT.

2-IAS certified for 2PSI (LP) and 5 PSI (natural) with 325-3. Color-green 1/8”NPT

3-IAS certified for 2PSI (LP) and 5 PSI (natural) with 325-5A. Color-brass 3/8”NPT
Satisfies ANSI Standards for both natural and LP gas.

4.8.3 REGULATOR ADJUSTMENT

- Adjustments can be accomplished by first removing the regulator seal cap to expose the adjusting screw. Turning the screw clockwise will increase outlet pressure, turning it counter-clockwise will decrease pressure.
- If spring adjustment will not produce the desired outlet pressure, check to make sure the main supply pressure is adequate. If the main supply pressure is adequate, contact the manufacturer or WARDFLEX® for other line-regulator options. Do not continue to turn regulator adjusting screw clockwise if the 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.
- The 2 PSI system pounds-to-inches regulator can be adjusted to an outlet pressure ranging between 7 to 11 inches water column pressure for natural gas and 11 to 13 inches water column for propane. The regulator must be adjusted according to the manufactures recommended procedure. A pressure gauge mounted just downstream of the regulator can monitor the set pressure under various loads.
- The regulator outlet is pre-set and labeled at the factory for either 7" natural gas or 11" propane.
- The "average" natural gas appliance is designed to operate at 3 to 6 inches water column pressure, and a pressure difference of 1 to 2 inches of water column across the appliance regulator which will prevent slow regulator response.

  Thus, the appliance regulator will operate best at 4 to 7 inches W.C. inlet pressure. The pounds to-inches system regulators for natural gas are set to deliver 7 inches of W.C. outlet pressure under load to allow for 1-2 inches of W.C. pressure drop in the tubing.
- The average propane gas appliance is designed to operate at 10 to 10 1/2 inches water column pressure. Thus, the pounds to inches regulators for propane gas are set to deliver 11 inches water column outlet pressure under load to allow for 0.5 inches water column pressure drop in the tubing.

4.8.4 OVER PRESSURIZATION PROTECTION

Gas systems using pressures above 2 PSI up to 5 PSI must use OPD (Over Pressure Protection Devices).

4.9 UNDERGROUND INSTALLATIONS

4.9.1 GENERAL INFORMATION

WARDFLEX®/WARDFLEX® II may not be directly buried or directly embedded in or under concrete slabs.

WARDFLEX®/WARDFLEX® II may be installed underground in/under a concrete slab when routed through previously embedded, non-metallic, watertight conduit such as PVC pipe. Conduit used to protect WARDFLEX®/WARDFLEX® II CSST, when installed underground, must have an I.D. ½" larger than the O.D of the CSST.

For outdoor underground installations, the annular space between the CSST and the conduit must be sealed to prevent entrance of moisture, dirt, debris, and insects. The use of a mechanical joint, coupling, or tee is prohibited inside the conduit.

For indoor buried installations, Ward Manufacturing does not require the conduit to be vented to the outside. Due to its continuous construction and availability in long run lengths, no fittings are permitted inside the conduit. This eliminates the possibility of gas build up caused by leaking fittings after the system has been placed in service. In the event that local code requires the conduit to be vented, the use of a tee designed for use with non-metallic conduit may be placed at the termination end of the conduit. One end of the tee should be sealed while the other outlet can be used to connect a vent line that is routed outside (figure 4.40). Vent lines routed to the outside of a structure must be installed in such a manner to prevent entrance of moisture, dirt, debris, and insects.

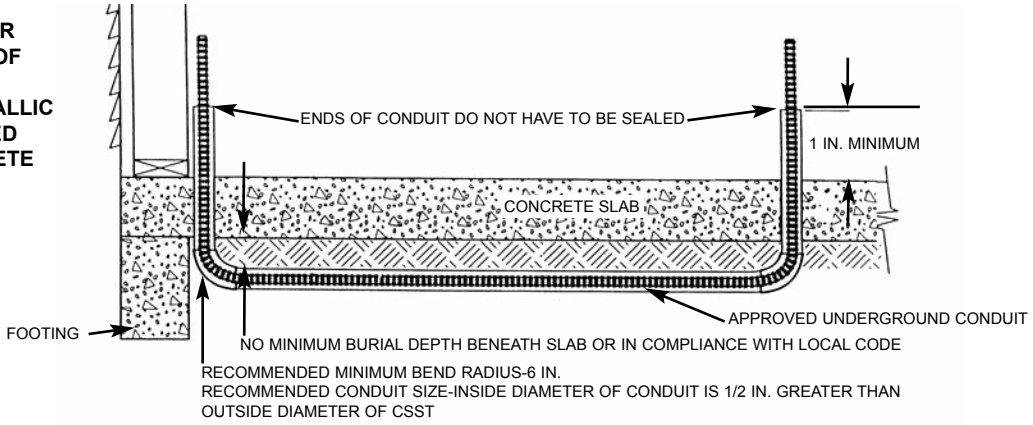
BURIAL DEPTHS:

- Outdoors – minimum of 12"
- In slab – 1-1/2" minimum concrete coverage.
- Under slab – no minimum burial depth below slab or in compliance with local codes.

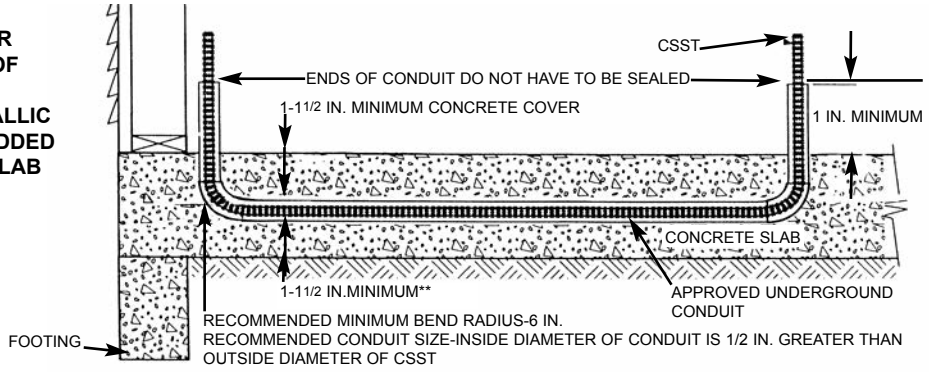
CONDUIT TERMINATION HEIGHT:

- Indoors – Conduit to extend a minimum of 1" above finished floor height.
- Outdoors – Conduit to extend a minimum of 4" above finished grade.

TYPICAL INDOOR INSTALLATION OF CSST WITH NON-METALLIC CONDUIT BURIED UNDER CONCRETE SLAB



TYPICAL INDOOR INSTALLATION OF CSST WITH NON-METALLIC CONDUIT EMBEDDED IN CONCRETE SLAB



** CONDUIT MUST BE SURROUNDED WITH A MINIMUM OF1-11/2 IN. OF CONCRETE
FITTINGS USED TO CONNECT CONDUIT MUST BE SEALED WATERTIGHT

INDOOR INSTALLATION OF CSST WITH NON-METALLIC CONDUIT EMBEDDED IN OR UNDER CONCRETE SLAB WITH VENTING

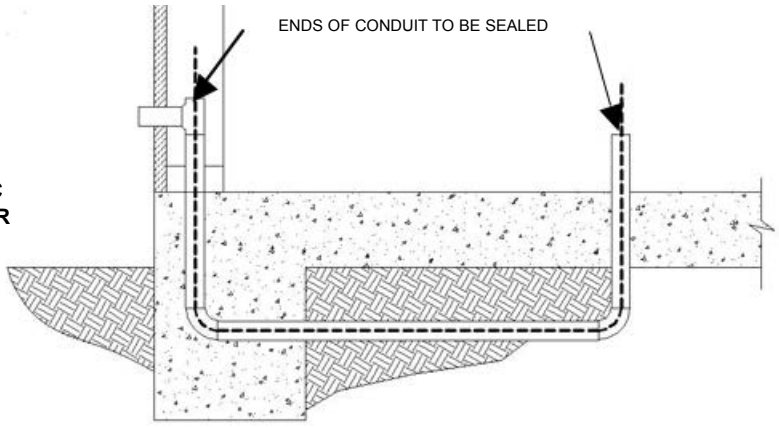


Figure 4.40

4.10 WARDFLEX® CSST ELECTRICAL BONDING

Direct bonding is required for all natural and LP gas piping systems incorporating WARDFLEX® CSST whether or not the piping system is connected to an electrically powered gas appliance. Direct bonding is included as part of the manufacture's requirements for both single family and multi-family buildings. A person knowledgeable about electrical system design, local electrical code, and these requirements should specify the bonding for commercial applications. WARDFLEX® CSST installed inside or attached to the exterior of a building or structure shall be electrically continuous and directly bonded, by a qualified person, to the ground system of the building. The gas piping is considered to be directly bonded when installed in accordance with the following instructions:

- A bonding conductor is permanently and directly connected to the electrical service grounding system. This can be achieved through a connection to the electrical service equipment enclosure, the grounded conductor at the electrical service, the grounding electrode conductor (where of sufficient size) or to the one or more grounding electrodes used.
- A single bond connection is made to the building gas piping downstream of the utility meter or second stage regulator (LP systems), but near the gas service entrance (either indoors or outdoors) of the structure, or down stream of the gas meter of each individual housing unit within a multi-family structure. A "daisy chain" configuration of the bonding conductor is permitted for multi-meter installations. A bonding connection shall not be made to the underground, natural gas utility service line or the unde ground supply line from a LP storage tank.
- The bonding conductor is not smaller than a #6 AWG copper wire or equivalent. The bonding conductor is installed and protected in accordance with the NEC.
- The bonding conductor is attached in an approved manner in accordance with NEC and the point of attachment for the bonding conductor is accessible.
- Bonding/grounding clamp used is listed to UL 467 or other acceptable national standards.
- The bonding clamp is attached at one point within the piping system to a segment of rigid pipe, a pipe component such as a nipple, fitting, manifold, or CSST fitting provided it is manufactured with an appropriate and Code listed material. The bonding clamp must be attached such that metal to metal contact is achieved with the steel pipe component. Remove any paint or applied coating on the pipe surface beneath the clamp. See Figure 4.41 for guidance. The corrugated stainless steel tubing portion of the gas piping system shall not be used as the point of attachment of the bonding clamp at any location along its length.

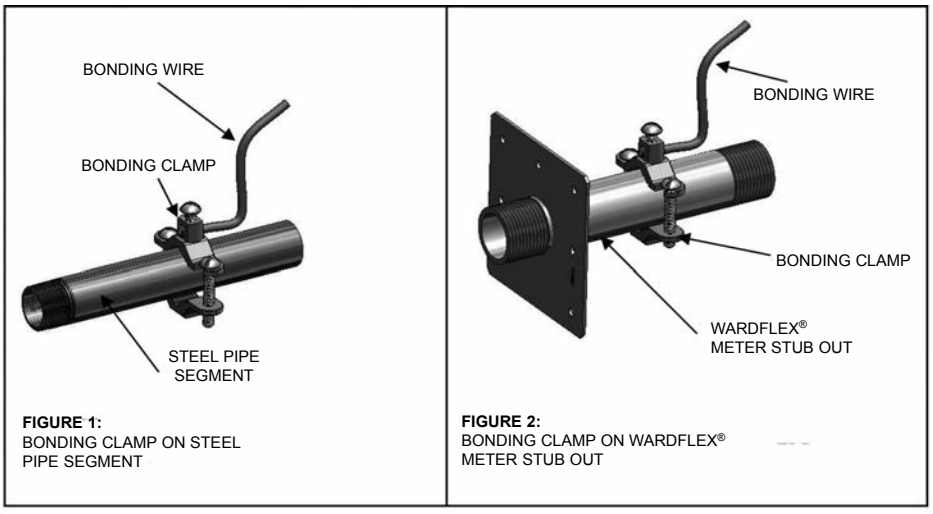


FIGURE 1:
BONDING CLAMP ON STEEL PIPE SEGMENT

FIGURE 2:
BONDING CLAMP ON WARDFLEX® METER STUB OUT

Figure 4.41

Proper grounding and bonding may reduce the risk of damage and fire from a lightning strike. Lightning is a highly destructive force. Even a nearby lightning strike that does not strike a structure directly can cause metallic systems in the structure to become energized. If these types of systems are not properly bonded, the difference in potential between the systems may cause the charge to arc from one system to another system. Arcing can cause damage to CSST. Bonding and grounding as set forth above should reduce the risk of arcing and related damage.

Depending upon conditions specific to the location of the structure in which the WARDFLEX® system is being installed, including but not limited to whether or not the area is prone to lightning, the owner of the structure should consider whether or not a lightning protection system is necessary or appropriate. Lightning protection systems are beyond the scope of this bulletin, but are covered by NFPA 780, which is the Standard for the Installation of Lightning Protection Systems, and other standards.

WARDFLEX® II CSST Piping Systems have no additional bonding requirements imposed by the manufacturer. WARDFLEX® II shall be bonded in accordance with the National Electrical Code NFPA 70 Article 250.104 in the same manner as rigid metallic piping systems. In the event that local code requirements conflict with the WARDFLEX® II bonding requirements, local code must take precedence. It is the responsibility of the trained installer to verify all local code compliance.

5.1 MINIMUM INSPECTION REQUIREMENTS

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

Classification of Repairs

- No repairs or replacement of the tubing is necessary if the tubing is only slightly dented by crushing as indicated in Figure 5.1.

REPAIR UNNECESSARY - NO SIGNIFICANT DAMAGE TO THE TUBING DUE TO IMPACT OR CRUSHING

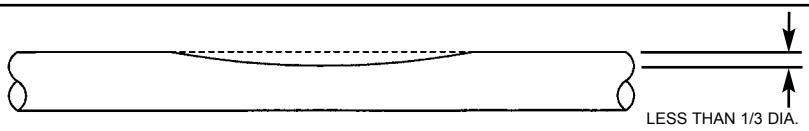


Figure 5.1

- The tubing must be repaired or replaced under the following circumstances:
- The tubing has been significantly damaged (Figure 5.2).
- The tubing has been punctured.
- The tubing has been bent beyond its minimum bend radius so that a crease or kink appears (Figure 5.3).

REPAIR NECESSARY - SIGNIFICANT DAMAGE TO THE TUBING DUE TO IMPACT OR CRUSHING

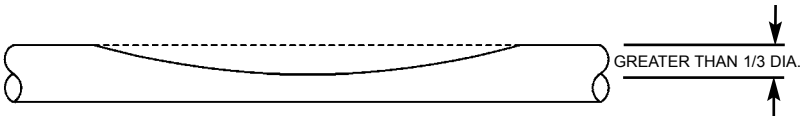


Figure 5.2

5.2 REPAIR/REPLACEMENT OF DAMAGED TUBING

Several methods of repair are discussed below depending on the nature of damage.

REPAIR NECESSARY

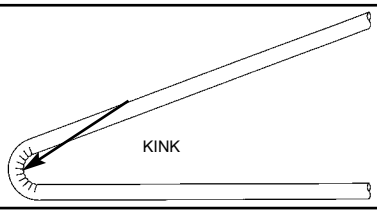


Figure 5.3

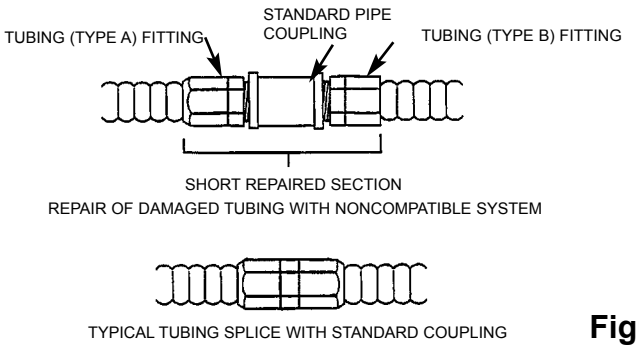
WARDFLEX® AND OTHER DESIGNS ARE NOT INTERCHANGEABLE. DO NOT MIX COMPONENTS

In the case of the Outdoor Termination Fitting, install new O-Rings. 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 economically 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 following two methods.

Method 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.

Method 2: Remove the section of tubing which is damaged and repair/replace as illustrated in figure 5.4.



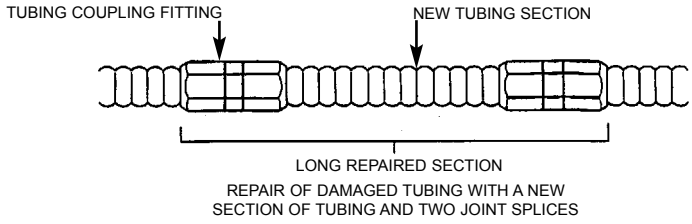


Figure 5.4 **REPAIR METHODS**

Appliance Connection and Leakage Check Procedure

- After the pressure test, inspection and final construction is complete (finished interior walls), connect the appliances to the tubing system.
- Turn the gas on at the meter and inspect for leaks before operating the appliance. Regulator adjustment may be necessary on 2 PSIG systems (refer to manufacturer's instruction) to obtain proper appliance line pressure.
- Connections made at each appliance must be checked for leaks with a non-corrosive commercial leak-testing fluid due to lack of sensitivity in solutions using soap buds or household detergents as stated in ASTM E515-05 section 9.3. Any leak detection solution coming in contact with the WARDFLEX System should have a sulfur and halogen content of less than 10 ppm of each (ASTM E515-05 section 7.4).
- Before placing appliances in operation, the piping system should be purged. This displaces the air in the system with fuel gas. Purge into a well ventilated area.

6.1 PRESSURE TESTING AND INSPECTION PROCEDURE

- The final installation is to be inspected and tested for leaks at 1 1/2 times the maximum working pressure, but not less than 3 PSIG, using procedures specified in Chapter 7 "Inspection, Testing and Purging" of the National Fuel Gas Code, NFPA 54/ANSI Z223.1 In Canada, refer to the applicable sections of the CAN/CGA - B149 Installation codes.
- Maximum test pressures recommended -10A-50A-40 PSI MAX. Excess pressure will permanently distort tubing.
- Do not connect appliances until after pressure test is completed.
- Inspect the installed system to ensure:
  - Presence of listed striker plates and other protective devices at all required locations.
  - Acceptable physical condition of the tubing.
  - Presence of fittings (with nut bottomed out to the body).
  - Correct regulator and manifold arrangement with proper venting requirements.
  - All gas outlets for appliance connections should be capped during pressure testing.
  - Pressure testing should be performed during rough construction of the facility (before interior walls are finished). This will permit a more complete inspection of the piping system during the pressure testing.
  - The elevated pressure system requires a two-part pressure test. (See Figure 6.1)
    - The first part is performed on the elevated pressure section, between the meter connection and the pressure regulator.
    - The second part is performed on the low pressure section, between the pressure regulator and the individual gas appliance outlets.

PRESSURE TEST REQUIREMENTS FOR ELEVATED PRESSURE SYSTEMS

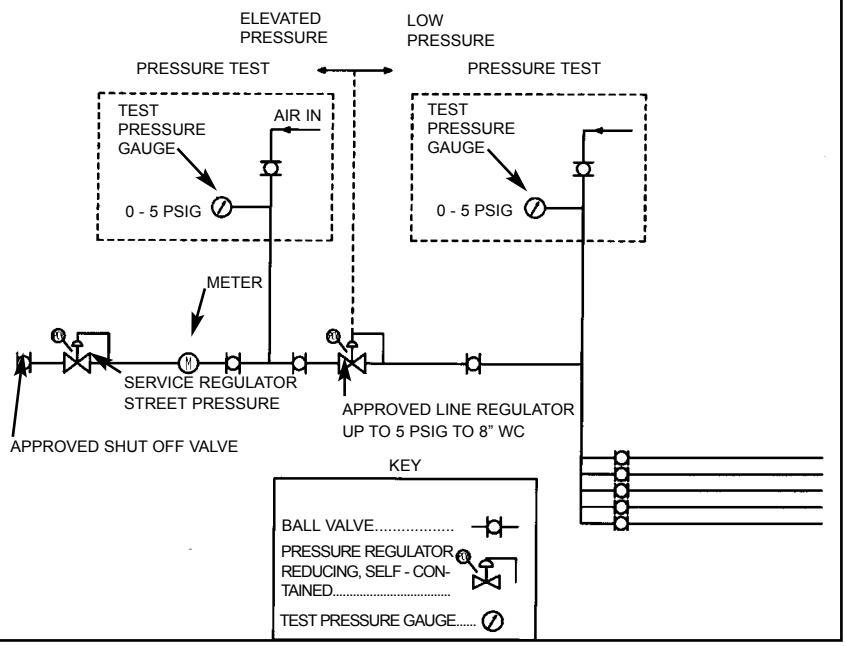


Figure 6.1

7.0 SIZING TABLES (NATURAL AND LP)

Table **Page**

Important Note:

When choosing a pressure drop to size the WARDFLEX® system the minimum operating pressure of the unit must be considered. Choosing a pressure drop that will reduce the supply pressure below the minimum operating pressure of the unit will cause the unit to perform poorly or not at all.

Example:

System Supply Pressure: 7 inches W.C. *Unit minimum operating pressure: 5" W.C.*

The use of a 3 inch W.C. pressure drop would result in a minimum inlet pressure at the unit of 4 inches W.C. In this case an alternate pressure drop of 2 inches or less should be selected to meet the minimum operating pressure of the unit.

7.1 NATURAL GAS - LOW PRESSURE

Maximum Capacitiy of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) of Natural Gas (Approximately 1000 BTU per cubic foot)

Table A-1

Gas Pressure of: 0.5 psi or Less
Pressure Drop of: 0.5 inches W.C.
(based on a 0.60 specific gravity gas)

Tubing Length (Ft.)	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
	5	63	134	270	471	873	2073	3993
	10	44	95	192	330	625	1473	2880
	15	36	77	157	268	514	1206	2379
	20	31	67	137	231	447	1046	2077
	25	27	60	122	206	402	937	1870
	30	25	55	112	188	368	857	1716
	40	21	47	97	162	320	743	1498
	50	19	42	87	144	288	666	1348
	60	17	39	80	131	263	609	1237
	70	16	36	74	121	245	564	1151
	80	15	33	69	113	230	528	1080
	90	14	31	65	107	217	498	1022
	100	13	30	62	101	206	473	972
	125	12	27	55	90	185	424	875
	150	10	24	51	82	170	387	803
	200	9	21	44	71	147	336	701
	250	8	19	39	63	132	301	631
	300	7	17	36	57	121	275	579
	400	6	15	31	49	106	239	506
	500	5	13	28	44	94	214	455
	600	5	12	25	40	86	195	418
	700	4	11	24	37	81	181	388
	800	4	10	22	34	75	169	365
	900	4	10	21	32	71	160	345
	1000	4	9	20	31	68	152	328
	1100	3	9	19	29	65	145	314
	1200	3	8	18	28	62	139	301
	1300	3	8	17	27	59	133	290
	1400	3	8	17	26	58	128	280
	1500	3	7	16	25	55	124	271

Table A-2

Gas Pressure of: 0.5 psi or Less
Pressure Drop of: 1.0 inches W.C.
(based on a 0.60 specific gravity gas)

Tubing Length (Ft.)	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
	5	90	189	379	673	1219	2917	5536
	10	63	134	270	471	873	2073	3993
	15	51	109	221	383	718	1697	3298
	20	44	95	192	330	625	1473	2880
	25	39	85	172	294	561	1319	2592
	30	36	77	157	268	514	1206	2379
	40	31	67	137	231	447	1046	2077
	50	27	60	122	206	402	937	1870
	60	25	55	112	188	368	857	1716
	70	23	51	104	173	342	794	1595
	80	21	47	97	162	320	743	1498
	90	20	45	92	152	303	701	1417
	100	19	42	87	144	288	666	1348
	125	17	38	78	129	259	596	1214
	150	15	34	71	117	237	545	1114
	200	13	30	62	101	206	473	972
	250	12	27	55	90	185	424	875
	300	10	24	51	82	170	387	803
	400	9	21	44	71	147	336	701
	500	8	19	39	63	132	301	631
	600	7	17	36	57	121	275	579
	700	7	16	33	53	113	255	539
	800	6	15	31	49	106	239	506
	900	6	14	29	46	99	225	478
	1000	5	13	28	44	94	214	455
	1100	5	12	27	42	90	204	435
	1200	5	12	25	40	86	195	418
	1300	5	11	24	38	83	188	402
	1400	4	11	24	37	81	181	388
	1500	4	11	23	36	78	175	376

Table includes losses for four 90 degree bends and 2 end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number of feet to the actual run length using the following formula:
L = 1.3 (n) L = Numbers of feet to be added to actual run length. n = Number of bends and/or fittings over six.

Maximum Capacitiy of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) of Natural Gas (Approximately 1000 BTU per cubic foot)

Table A-3

Gas Pressure of: 0.5 psi or Less
Pressure Drop of: 1.5 inches W.C.
(based on a 0.60 specific gravity gas)

Tubing Length (Ft.)	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
	5	112	231	462	828	1481	3563	6703
	10	78	164	329	580	1061	2531	4834
	15	63	134	270	471	873	2073	3993
	20	54	116	234	407	759	1799	3487
	25	48	104	210	363	683	1611	3139
	30	44	95	192	330	625	1473	2880
	40	38	82	167	285	544	1278	2515
	50	34	73	149	254	489	1145	2264
	60	31	67	137	231	447	1046	2077
	70	28	62	127	214	415	970	1932
	80	26	58	119	199	390	908	1814
	90	25	55	112	188	368	857	1716
	100	23	52	106	178	350	813	1633
	125	21	46	95	159	315	729	1470
	150	19	42	87	144	288	666	1348
	200	16	37	76	124	250	578	1177
	250	14	33	68	111	225	518	1060
	300	13	30	62	101	206	473	972
	400	11	26	54	87	179	410	849
	500	10	23	48	78	161	368	764
	600	9	21	44	71	147	336	701
	700	8	19	41	65	137	311	652
	800	8	18	38	61	128	291	612
	900	7	17	36	57	121	275	579
	1000	7	16	34	54	115	261	551
	1100	6	15	33	52	110	249	527
	1200	6	15	31	49	106	239	506
	1300	6	14	30	47	102	229	487
	1400	6	14	29	46	98	221	470
	1500	5	13	28	44	94	214	455

Table A-4

Gas Pressure of: 0.5 psi or Less
Pressure Drop of: 2.0 inches W.C.
(based on a 0.60 specific gravity gas)

Tubing Length (Ft.)	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
	5	130	267	532	960	1702	4106	7676
	10	90	189	379	673	1219	2917	5536
	15	73	154	311	546	1003	2389	4573
	20	63	134	270	471	873	2073	3993
	25	56	120	242	420	784	1857	3594
	30	51	109	221	383	718	1697	3298
	40	44	95	192	330	625	1473	2880
	50	39	85	172	294	561	1319	2592
	60	36	77	157	268	514	1206	2379
	70	33	72	146	248	477	1118	2212
	80	31	67	137	231	447	1046	2077
	90	29	63	129	218	423	987	1965
	100	27	60	122	206	402	937	1870
	125	24	53	110	184	361	840	1683
	150	22	49	100	167	331	767	1544
	200	19	42	87	144	288	666	1348
	250	17	38	78	129	259	596	1214
	300	15	34	71	117	237	545	1114
	400	13	30	62	101	206	473	972
	500	12	27	55	90	185	424	875
	600	10	24	51	82	170	387	803
	700	10	22	47	76	157	359	747
	800	9	21	44	71	147	336	701
	900	8	20	41	66	139	317	663
	1000	8	19	39	63	132	301	631
	1100	8	18	38	60	126	287	603
	1200	7	17	36	57	121	275	579
	1300	7	16	35	55	117	264	558
	1400	7	16	33	53	113	255	539
	1500	6	15	32	51	109	246	521

Table includes losses for four 90 degree bends and 2 end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number of feet to the actual run length using the following formula:
L = 1.3 (n) L = Numbers of feet to be added to actual run length. n = Number of bends and/or fittings over six.

Maximum Capacitiy of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) of Natural Gas (Approximately 1000 BTU per cubic foot)

Table A-5

Gas Pressure of: 0.5 psi or Less
Pressure Drop of: 2.5 inches W.C.
(based on a 0.60 specific gravity gas)

Tubing Length (Ft.)	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
	5	145	298	593	1076	1895	4583	8527
	10	102	211	423	754	1357	3256	6151
	15	82	173	346	613	1116	2666	5080
	20	71	150	301	528	972	2314	4436
	25	63	134	270	471	873	2073	3993
	30	57	122	247	429	800	1895	3664
	40	49	106	214	370	696	1644	3200
	50	44	95	192	330	625	1473	2880
	60	40	86	176	301	572	1346	2643
	70	37	80	163	278	531	1248	2458
	80	34	75	152	259	499	1168	2308
	90	32	71	144	244	471	1102	2183
	100	31	67	137	231	447	1046	2077
	125	27	60	122	206	402	937	1870
	150	25	55	112	188	368	857	1716
	200	21	47	97	162	320	743	1498
	250	19	42	87	144	288	666	1348
	300	17	39	80	131	263	609	1237
	400	15	33	69	113	230	528	1080
	500	13	30	62	101	206	473	972
	600	12	27	57	92	189	432	892
	700	11	25	52	85	175	401	830
	800	10	23	49	79	164	375	779
	900	9	22	46	75	155	354	737
	1000	9	21	44	71	147	336	701
	1100	9	20	42	67	141	321	670
	1200	8	19	40	64	135	307	643
	1300	8	18	39	62	130	295	620
	1400	7	18	37	59	126	285	598
	1500	7	17	36	57	121	275	579

Table A-6

Gas Pressure of: 0.5 psi or Less
Pressure Drop of: 3.0 inches W.C.
(based on a 0.60 specific gravity gas)

Tubing Length (Ft.)	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
	5	160	327	649	1182	2069	5014	9293
	10	112	231	462	828	1481	3563	6703
	15	90	189	379	673	1219	2917	5536
	20	78	164	329	580	1061	2531	4834
	25	69	147	295	518	953	2268	4352
	30	63	134	270	471	873	2073	3993
	40	54	116	234	407	759	1799	3487
	50	48	104	210	363	683	1611	3139
	60	44	95	192	330	625	1473	2880
	70	41	88	178	305	580	1365	2678
	80	38	82	167	285	544	1278	2515
	90	36	77	157	268	514	1206	2379
	100	34	73	149	254	489	1145	2264
	125	30	66	134	226	439	1025	2038
	150	27	60	122	206	402	937	1870
	200	23	52	106	178	350	813	1633
	250	21	46	95	159	315	729	1470
	300	19	42	87	144	288	666	1348
	400	16	37	76	124	250	578	1177
	500	14	33	68	111	225	518	1060
	600	13	30	62	101	206	473	972
	700	12	28	57	93	191	438	904
	800	11	26	54	87	179	410	849
	900	10	24	51	82	170	387	803
	1000	10	23	48	78	161	368	764
	1100	9	22	46	74	154	351	731
	1200	9	21	44	71	147	336	701
	1300	9	20	42	68	142	323	675
	1400	8	19	41	65	137	311	652
	1500	8	19	39	63	132	301	631

Table includes losses for four 90 degree bends and 2 end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number of feet to the actual run length using the following formula:
L = 1.3 (n) L = Numbers of feet to be added to actual run length. n = Number of bends and/or fittings over six.

Maximum Capacitiy of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) of Natural Gas (Approximately 1000 BTU per cubic foot)

Table A-7

Gas Pressure of: 0.5 psi or Less
Pressure Drop of: 4.0 inches W.C.
(based on a 0.60 specific gravity gas)

	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
Tubing Length (Ft.)	5	186	377	747	1370	2377	5778	10642
	10	130	267	532	960	1702	4106	7676
	15	105	218	436	780	1400	3362	6341
	20	90	189	379	673	1219	2917	5536
	25	81	169	340	600	1095	2613	4984
	30	73	154	311	546	1003	2389	4573
	40	63	134	270	471	873	2073	3993
	50	56	120	242	420	784	1857	3594
	60	51	109	221	383	718	1697	3298
	70	47	101	205	354	667	1573	3067
	80	44	95	192	330	625	1473	2880
	90	41	89	181	311	591	1390	2724
	100	39	85	172	294	561	1319	2592
	125	35	76	154	263	504	1182	2334
	150	32	69	141	239	462	1080	2141
	200	27	60	122	206	402	937	1870
	250	24	53	110	184	361	840	1683
	300	22	49	100	167	331	767	1544
	400	19	42	87	144	288	666	1348
	500	17	38	78	129	259	596	1214
	600	15	34	71	117	237	545	1114
	700	14	32	66	108	219	505	1036
	800	13	30	62	101	206	473	972
	900	12	28	58	95	194	446	920
	1000	12	27	55	90	185	424	875
	1100	11	25	53	86	177	404	837
	1200	10	24	51	82	170	387	803
	1300	10	23	49	79	163	372	773
	1400	10	22	47	76	157	359	747
	1500	9	22	45	73	152	347	723

Table A-8

Gas Pressure of: 0.5 psi or Less
Pressure Drop of: 5.0 inches W.C.
(based on a 0.60 specific gravity gas)

	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
Tubing Length (Ft.)	5	208	421	833	1536	2646	6450	11823
	10	145	298	593	1076	1895	4583	8527
	15	118	244	486	874	1559	3753	7044
	20	102	211	423	754	1357	3256	6151
	25	90	189	379	673	1219	2917	5536
	30	82	173	346	613	1116	2666	5080
	40	71	150	301	528	972	2314	4436
	50	63	134	270	471	873	2073	3993
	60	57	122	247	429	800	1895	3664
	70	53	113	229	397	742	1756	3407
	80	49	106	214	370	696	1644	3200
	90	46	100	202	349	658	1551	3027
	100	44	95	192	330	625	1473	2880
	125	39	85	172	294	561	1319	2592
	150	36	77	157	268	514	1206	2379
	200	31	67	137	231	447	1046	2077
	250	27	60	122	206	402	937	1870
	300	25	55	112	188	368	857	1716
	400	21	47	97	162	320	743	1498
	500	19	42	87	144	288	666	1348
	600	17	39	80	131	263	609	1237
	700	16	36	74	121	245	564	1151
	800	15	33	69	113	230	528	1080
	900	14	31	65	107	217	498	1022
	1000	13	30	62	101	206	473	972
	1100	12	28	59	96	197	451	930
	1200	12	27	57	92	189	432	892
	1300	11	26	54	88	182	416	859
	1400	11	25	52	85	175	401	830
	1500	10	24	51	82	170	387	803

Table includes losses for four 90 degree bends and 2 end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number of feet to the actual run length using the following formula:
L = 1.3 (n) L = Numbers of feet to be added to actual run length. n = Number of bends and/or fittings over six.

Maximum Capacitiy of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) of Natural Gas (Approximately 1000 BTU per cubic foot)

Table A-9

Gas Pressure of: 0.5 psi or Less

Pressure Drop of: 6.0 inches W.C.

(based on a 0.60 specific gravity gas)

	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
Tubing Length (Ft.)	5	229	461	911	1687	2889	7057	12884
	10	160	327	649	1182	2069	5014	9293
	15	130	267	532	960	1702	4106	7676
	20	112	231	462	828	1481	3563	6703
	25	99	207	414	739	1331	3192	6033
	30	90	189	379	673	1219	2917	5536
	40	78	164	329	580	1061	2531	4834
	50	69	147	295	518	953	2268	4352
	60	63	134	270	471	873	2073	3993
	70	58	124	250	435	811	1921	3713
	80	54	116	234	407	759	1799	3487
	90	51	109	221	383	718	1697	3298
	100	48	104	210	363	683	1611	3139
	125	43	93	188	323	613	1443	2825
	150	39	85	172	294	561	1319	2592
	200	34	73	149	254	489	1145	2264
	250	30	66	134	226	439	1025	2038
	300	27	60	122	206	402	937	1870
	400	23	52	106	178	350	813	1633
	500	21	46	95	159	315	729	1470
	600	19	42	87	144	288	666	1348
	700	17	39	81	133	267	617	1254
	800	16	37	76	124	250	578	1177
	900	15	34	71	117	237	545	1114
	1000	14	33	68	111	225	518	1060
	1100	14	31	65	106	214	494	1013
	1200	13	30	62	101	206	473	972
	1300	12	29	60	97	198	455	936
	1400	12	28	57	93	191	438	904
	1500	12	27	55	90	185	424	875

Table includes losses for four 90 degree bends and 2 end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number of feet to the actual run length using the following formula:
L = 1.3 (n) L = Numbers of feet to be added to actual run length. n = Number of bends and/or fittings over six.

7.2 NATURAL GAS - **ELEVATED PRESSURE**

Maximum Capacitiy of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) of Natural Gas (Approximately 1000 BTU per cubic foot)

Table A-10

Gas Pressure of: 1.0 psi
Pressure Drop of: 13.0 inches W.C.
(based on a 0.60 specific gravity gas)

Tubing Length (Ft.)	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
	5	342	678	1329	2507	4193	10331	18550
	10	239	480	947	1757	3003	7341	13379
	15	193	392	776	1427	2470	6011	11052
	20	167	340	675	1231	2150	5216	9650
	25	148	304	605	1098	1931	4673	8687
	30	135	278	553	1000	1769	4271	7971
	40	116	241	480	863	1540	3706	6960
	50	104	215	431	770	1383	3320	6265
	60	94	197	394	701	1267	3035	5749
	70	87	182	365	648	1176	2813	5346
	80	81	170	342	605	1103	2633	5020
	90	76	161	323	569	1042	2485	4749
	100	72	152	307	539	991	2359	4519
	125	64	136	275	481	889	2113	4068
	150	59	125	251	438	815	1932	3733
	200	50	108	218	378	709	1676	3259
	250	45	97	196	337	637	1501	2934
	300	41	88	179	307	583	1372	2692
	400	35	76	155	265	508	1191	2351
	500	31	68	139	236	456	1067	2116
	600	28	62	127	215	418	975	1942
	700	26	58	118	198	388	904	1806
	800	24	54	111	185	363	846	1695
	900	23	51	104	174	343	798	1604
	1000	22	48	99	165	327	758	1526
	1100	21	46	95	157	312	723	1459
	1200	20	44	91	150	299	693	1400
	1300	19	42	87	144	288	666	1348
	1400	18	41	84	139	278	642	1302
	1500	17	39	81	134	269	620	1260

Table A-11

Gas Pressure of: 2.0 psi
Pressure Drop of: 1.0 psi
(based on a 0.60 specific gravity gas)

Tubing Length (Ft.)	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
	5	505	988	1926	3698	6038	15008	26511
	10	353	700	1372	2592	4325	10664	19122
	15	286	572	1125	2105	3557	8732	15795
	20	247	496	977	1816	3097	7578	13792
	25	220	444	876	1620	2782	6788	12415
	30	200	405	801	1475	2547	6205	11392
	40	172	351	696	1273	2218	5384	9948
	50	154	314	624	1135	1992	4823	8954
	60	140	287	571	1034	1825	4409	8217
	70	129	266	529	955	1694	4086	7641
	80	120	249	496	892	1589	3826	7175
	90	113	234	468	840	1501	3610	6787
	100	107	222	445	795	1427	3427	6459
	125	95	199	398	709	1281	3070	5814
	150	87	182	364	646	1173	2806	5335
	200	75	157	317	557	1022	2435	4658
	250	67	141	284	497	917	2181	4193
	300	61	129	260	453	840	1994	3848
	400	52	111	225	390	731	1730	3360
	500	46	100	202	348	657	1550	3024
	600	42	91	185	317	602	1417	2775
	700	39	84	171	293	559	1313	2581
	800	36	79	160	274	524	1229	2423
	900	34	74	151	257	495	1160	2292
	1000	32	70	144	244	471	1101	2181
	1100	31	67	137	232	449	1051	2085
	1200	29	64	131	222	431	1006	2002
	1300	28	62	126	213	415	968	1927
	1400	27	60	122	205	400	933	1861
	1500	26	58	118	198	387	902	1802

Table includes losses for four 90 degree bends and 2 end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number of feet to the actual run length using the following formula:
L = 1.3 (n) L = Numbers of feet to be added to actual run length. n = Number of bends and/or fittings over six.

Maximum Capacitiy of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) of Natural Gas (Approximately 1000 BTU per cubic foot)

Table A-12

Gas Pressure of: 2.0 psi
Pressure Drop of: 1.5 psi
(based on a 0.60 specific gravity gas)

	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
Tubing Length (Ft.)	5	623	1209	2348	4553	7340	18329	32095
	10	435	856	1673	3191	5257	13024	23149
	15	353	700	1372	2592	4325	10664	19122
	20	304	607	1192	2236	3765	9254	16697
	25	271	543	1068	1994	3381	8290	15030
	30	247	496	977	1816	3097	7578	13792
	40	213	430	849	1567	2696	6576	12043
	50	189	384	761	1398	2422	5891	10840
	60	172	351	696	1273	2218	5384	9948
	70	159	325	646	1176	2059	4990	9250
	80	148	304	605	1098	1931	4672	8686
	90	140	287	571	1034	1825	4409	8217
	100	132	272	542	979	1734	4186	7819
	125	118	244	486	873	1557	3750	7038
	150	107	222	445	795	1427	3427	6459
	200	92	193	386	686	1242	2974	5639
	250	82	172	346	612	1116	2664	5076
	300	75	157	317	557	1022	2435	4658
	400	64	136	275	481	889	2113	4067
	500	57	122	246	429	799	1893	3661
	600	52	111	225	390	731	1730	3360
	700	48	103	209	361	679	1604	3124
	800	45	97	196	337	637	1501	2934
	900	42	91	185	317	602	1417	2775
	1000	40	86	175	300	572	1345	2641
	1100	38	82	167	286	547	1283	2525
	1200	36	79	160	274	524	1229	2423
	1300	35	76	154	263	504	1182	2333
	1400	33	73	149	253	487	1139	2253
	1500	32	70	144	244	471	1101	2181

Table A-13

Gas Pressure of: 5.0 psi
Pressure Drop of: 3.5 psi
(based on a 0.60 specific gravity gas)

	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
Tubing Length (Ft.)	5	965	1842	3554	7030	11040	27832	47851
	10	675	1305	2532	4927	7906	19776	34514
	15	547	1067	2076	4002	6504	16193	28509
	20	472	925	1804	3453	5662	14052	24894
	25	420	827	1617	3080	5085	12588	22408
	30	382	756	1479	2805	4658	11506	20563
	40	330	655	1285	2420	4055	9985	17955
	50	294	586	1152	2158	3642	8945	16163
	60	267	535	1054	1966	3336	8176	14831
	70	247	496	977	1816	3097	7578	13792
	80	230	464	915	1696	2904	7095	12951
	90	217	437	864	1597	2744	6695	12251
	100	205	415	821	1513	2608	6356	11658
	125	183	371	736	1349	2343	5694	10494
	150	166	339	673	1229	2146	5204	9629
	200	143	294	585	1060	1868	4516	8408
	250	128	263	524	945	1677	4046	7569
	300	116	240	479	861	1537	3698	6945
	400	100	208	416	743	1338	3209	6064
	500	89	186	373	662	1201	2875	5459
	600	81	170	341	603	1100	2627	5009
	700	75	157	317	557	1022	2435	4658
	800	70	147	297	520	958	2280	4374
	900	66	139	280	490	905	2151	4138
	1000	62	132	266	464	860	2042	3937
	1100	59	126	254	442	822	1949	3764
	1200	56	120	243	423	788	1867	3613
	1300	54	116	234	406	758	1795	3479
	1400	52	111	225	390	731	1730	3360
	1500	50	108	218	377	707	1672	3252

Table includes losses for four 90 degree bends and 2 end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number of feet to the actual run length using the following formula:
L = 1.3 (n) L = Numbers of feet to be added to actual run length. n = Number of bends and/or fittings over six.

7.3 PROPANE GAS - **LOW PRESSURE**

Maximum Capacitiy of WARDFLEX®/WARDFLEX® II CSST in Thousands of BTU (KBTU) for Propane Gas (LPG)

Table A-14

Gas Pressure of: 0.5 psi or Less
Pressure Drop of: 0.5 inches W.C.
(based on a 1.52 specific gravity gas)

Tubing Length (Ft.)	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
	5	100	212	427	745	1380	3277	6312
	10	70	150	304	522	988	2328	4553
	15	57	122	248	424	812	1906	3761
	20	49	106	217	365	707	1653	3283
	25	43	95	193	326	635	1481	2956
	30	40	87	177	297	582	1355	2713
	40	33	74	153	256	506	1175	2368
	50	30	66	138	228	455	1053	2131
	60	27	62	126	207	416	963	1955
	70	25	57	117	191	387	892	1819
	80	24	52	109	179	363	835	1707
	90	22	49	103	169	343	787	1616
	100	21	47	98	160	325	748	1536
	125	19	43	87	142	292	670	1383
	150	16	38	81	130	268	612	1269
	200	14	33	70	112	233	531	1108
	250	13	30	62	100	209	476	997
	300	11	27	57	90	191	435	915
	400	9	24	49	77	167	378	800
	500	8	21	44	70	149	338	719
	600	8	19	40	63	137	308	661
	700	6	17	38	58	128	286	613
	800	6	16	35	54	119	267	577
	900	6	16	33	51	113	253	545
	1000	6	14	32	49	108	240	518
	1100	5	14	30	46	102	229	496
	1200	5	13	28	44	97	220	476
	1300	5	13	27	43	94	210	458
	1400	5	13	27	41	91	202	443
	1500	5	11	25	40	87	196	428

Table A-15

Gas Pressure of: 0.5 psi or Less
Pressure Drop of: 1.0 inches W.C.
(based on a 1.52 specific gravity gas)

Tubing Length (Ft.)	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
	5	142	299	599	1064	1927	4611	8751
	10	100	212	427	745	1380	3277	6312
	15	81	172	349	605	1135	2683	5213
	20	70	150	304	522	988	2328	4553
	25	62	134	272	465	887	2085	4097
	30	57	122	248	424	812	1906	3761
	40	49	106	217	365	707	1653	3283
	50	43	95	193	326	635	1481	2956
	60	40	87	177	297	582	1355	2713
	70	36	81	164	273	540	1255	2521
	80	33	74	153	256	506	1175	2368
	90	32	71	145	240	478	1108	2240
	100	30	66	138	228	455	1053	2131
	125	27	60	123	204	409	942	1919
	150	24	54	112	185	374	862	1761
	200	21	47	98	160	325	748	1536
	250	19	43	87	142	292	670	1383
	300	16	38	81	130	268	612	1269
	400	14	33	70	112	233	531	1108
	500	13	30	62	100	209	476	997
	600	11	27	57	90	191	435	915
	700	11	25	52	84	178	403	852
	800	9	24	49	77	167	378	800
	900	9	22	46	73	157	356	756
	1000	8	21	44	70	149	338	719
	1100	8	19	43	66	143	322	688
	1200	8	19	40	63	137	308	661
	1300	8	17	38	60	132	297	635
	1400	6	17	38	58	128	286	613
	1500	6	17	36	57	123	277	594

Table includes losses for four 90 degree bends and 2 end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number of feet to the actual run length using the following formula:
L = 1.3 (n) L = Numbers of feet to be added to actual run length. n = Number of bends and/or fittings over six.

Maximum Capacitiy of WARDFLEX®/WARDFLEX® II CSST in Thousands of BTU (KBTU) for Propane Gas (LPG)

Table A-16

Gas Pressure of: 0.5 psi or Less
Pressure Drop of: 2.0 inches W.C.
(based on a 1.52 specific gravity gas)

	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
Tubing Length (Ft.)	5	205	422	841	1518	2691	6491	12134
	10	142	299	599	1064	1927	4611	8751
	15	115	243	492	863	1585	3776	7229
	20	100	212	427	745	1380	3277	6312
	25	89	190	383	664	1239	2935	5681
	30	81	172	349	605	1135	2683	5213
	40	70	150	304	522	988	2328	4553
	50	62	134	272	465	887	2085	4097
	60	57	122	248	424	812	1906	3761
	70	52	114	231	392	754	1767	3497
	80	49	106	217	365	707	1653	3283
	90	46	100	204	345	668	1560	3106
	100	43	95	193	326	635	1481	2956
	125	38	84	174	291	571	1328	2660
	150	35	77	158	264	522	1212	2441
	200	30	66	138	228	455	1053	2131
	250	27	60	123	204	409	942	1919
	300	24	54	112	185	374	862	1761
	400	21	47	98	160	325	748	1536
	500	19	43	87	142	292	670	1383
	600	16	38	81	130	268	612	1269
	700	16	35	74	120	248	567	1181
	800	14	33	70	112	233	531	1108
	900	13	32	65	104	220	501	1048
	1000	13	30	62	100	209	476	997
	1100	13	28	60	95	200	454	953
	1200	11	27	57	90	191	435	915
	1300	11	25	55	87	185	417	882
	1400	11	25	52	84	178	403	852
	1500	9	24	51	81	172	389	824

Table A-17

Gas Pressure of: 0.5 psi or Less
Pressure Drop of: 2.5 inches W.C.
(based on a 1.52 specific gravity gas)

	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
Tubing Length (Ft.)	5	229	471	937	1701	2996	7245	13479
	10	161	334	669	1192	2146	5147	9723
	15	130	273	547	969	1765	4214	8030
	20	112	237	476	835	1536	3658	7012
	25	100	212	427	745	1380	3277	6312
	30	90	193	390	678	1264	2996	5792
	40	77	168	338	585	1101	2599	5058
	50	70	150	304	522	988	2328	4553
	60	63	136	278	476	905	2128	4178
	70	58	126	258	439	840	1973	3885
	80	54	119	240	409	788	1846	3648
	90	51	112	228	386	744	1742	3451
	100	49	106	217	365	707	1653	3283
	125	43	95	193	326	635	1481	2956
	150	40	87	177	297	582	1355	2713
	200	33	74	153	256	506	1175	2368
	250	30	66	138	228	455	1053	2131
	300	27	62	126	207	416	963	1955
	400	24	52	109	179	363	835	1707
	500	21	47	98	160	325	748	1536
	600	19	43	90	145	299	683	1410
	700	17	40	82	134	277	634	1312
	800	16	36	77	125	259	593	1231
	900	14	35	73	119	245	560	1165
	1000	14	33	70	112	233	531	1108
	1100	14	32	66	106	223	507	1059
	1200	13	30	63	101	214	485	1016
	1300	13	28	62	98	205	466	980
	1400	11	28	58	93	199	451	945
	1500	11	27	57	90	191	435	915

Table includes losses for four 90 degree bends and 2 end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number of feet to the actual run length using the following formula:
L = 1.3 (n) L = Numbers of feet to be added to actual run length. n = Number of bends and/or fittings over six.

Maximum Capacitiy of WARDFLEX®/WARDFLEX® II CSST in Thousands of BTU (KBTU) for Propane Gas (LPG)

Table A-18

Gas Pressure of: 0.5 psi or Less

Pressure Drop of: 3.0 inches W.C.

(based on a 1.52 specific gravity gas)

Tubing Length (Ft.)	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
	5	253	517	1026	1868	3270	7926	14690
	10	177	365	730	1309	2342	5632	10596
	15	142	299	599	1064	1927	4611	8751
	20	123	259	520	917	1678	4001	7641
	25	109	232	466	819	1507	3585	6879
	30	100	212	427	745	1380	3277	6312
	40	85	183	370	643	1201	2844	5512
	50	76	164	332	574	1079	2547	4962
	60	70	150	304	522	988	2328	4553
	70	65	139	281	482	917	2158	4233
	80	60	130	264	451	860	2020	3976
	90	57	122	248	424	812	1906	3761
	100	54	115	236	402	773	1810	3579
	125	47	104	212	357	693	1620	3222
	150	43	95	193	326	635	1481	2956
	200	36	82	168	281	553	1285	2581
	250	33	73	150	251	497	1152	2324
	300	30	66	138	228	455	1053	2131
	400	25	58	120	196	396	914	1861
	500	22	52	107	175	355	819	1676
	600	21	47	98	160	325	748	1536
	700	19	44	90	147	302	692	1429
	800	17	41	85	138	283	648	1342
	900	16	38	81	130	268	612	1269
	1000	16	36	76	123	254	582	1208
	1100	14	35	73	117	243	555	1156
	1200	14	33	70	112	233	531	1108
	1300	14	32	66	107	224	511	1067
	1400	13	30	65	103	216	492	1031
	1500	13	30	62	100	209	476	997

Table includes losses for four 90 degree bends and 2 end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number of feet to the actual run length using the following formula:
L = 1.3 (n) L = Numbers of feet to be added to actual run length. n = Number of bends and/or fittings over six.

7.4 PROPANE GAS - **ELEVATED PRESSURE**

Maximum Capacitiy of WARDFLEX®/WARDFLEX® II CSST in Thousands of BTU (KBTU) for Propane Gas (LPG)

Table A-19

Gas Pressure of: 2.0 psi
Pressure Drop of: 1.0 psi
(based on a 1.52 specific gravity gas)

	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
Tubing Length (Ft.)	5	798	1562	3045	5846	9545	23724	41907
	10	558	1107	2169	4097	6837	16857	30227
	15	452	904	1778	3327	5623	13803	24968
	20	390	784	1544	2871	4896	11979	21802
	25	348	702	1385	2561	4397	10730	19625
	30	316	640	1266	2332	4027	9809	18008
	40	272	555	1100	2012	3507	8511	15725
	50	243	496	986	1794	3149	7624	14154
	60	221	454	903	1635	2884	6970	12989
	70	204	420	836	1510	2678	6459	12079
	80	190	394	784	1410	2511	6048	11342
	90	179	370	740	1328	2372	5707	10729
	100	169	351	703	1257	2256	5417	10210
	125	150	315	629	1121	2025	4853	9191
	150	138	288	575	1021	1855	4436	8433
	200	119	248	501	880	1616	3849	7363
	250	106	223	449	786	1450	3448	6628
	300	96	204	411	716	1328	3152	6083
	400	82	175	356	616	1156	2735	5311
	500	73	158	319	550	1039	2450	4780
	600	66	144	292	501	951	2240	4387
	700	62	133	270	463	883	2076	4080
	800	57	125	253	433	829	1943	3830
	900	54	117	239	406	782	1834	3623
	1000	51	111	228	386	744	1740	3448
	1100	49	106	217	367	710	1661	3296
	1200	46	101	207	351	681	1590	3165
	1300	44	98	199	337	655	1530	3046
	1400	43	95	193	324	633	1475	2942
	1500	41	92	187	313	611	1426	2849

Table A-20

Gas Pressure of: 5.0 psi
Pressure Drop of: 3.5 psi
(based on a 1.52 specific gravity gas)

	Size	10A	15A	20A	25A	32A	38A	50A
		3/8"	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
	EHD	15	19	25	30	37	48	62
Tubing Length (Ft.)	5	1525	2912	5618	11113	17451	43996	75641
	10	1067	2063	4002	7788	12498	31261	54558
	15	865	1687	3282	6326	10281	25597	45066
	20	746	1462	2852	5458	8951	22213	39351
	25	664	1307	2556	4869	8038	19899	35422
	30	604	1195	2338	4434	7363	18188	32505
	40	522	1035	2031	3825	6410	15784	28382
	50	465	926	1821	3411	5757	14140	25550
	60	422	846	1666	3108	5273	12924	23444
	70	390	784	1544	2871	4896	11979	21802
	80	364	733	1446	2681	4591	11215	20472
	90	343	691	1366	2524	4338	10583	19366
	100	324	656	1298	2392	4123	10047	18428
	125	289	586	1163	2132	3703	9001	16588
	150	262	536	1064	1943	3392	8226	15221
	200	226	465	925	1676	2953	7139	13291
	250	202	416	828	1494	2652	6396	11965
	300	183	379	757	1361	2429	5846	10978
	400	158	329	658	1175	2115	5073	9586
	500	141	294	590	1046	1899	4545	8629
	600	128	269	539	953	1740	4153	7918
	700	119	248	501	880	1616	3849	7363
	800	111	232	469	822	1514	3604	6914
	900	104	220	443	775	1431	3400	6541
	1000	98	209	420	733	1360	3228	6223
	1100	93	199	402	699	1299	3081	5950
	1200	89	190	384	669	1246	2951	5711
	1300	85	183	370	642	1198	2837	5499
	1400	82	175	356	616	1156	2735	5311
	1500	79	171	345	596	1118	2643	5141

Table includes losses for four 90 degree bends and 2 end fittings. To compute flow capacity for tubing runs with a larger number of bends and/or fittings, add the appropriate number of feet to the actual run length using the following formula:
L = 1.3 (n) L = Numbers of feet to be added to actual run length. n = Number of bends and/or fittings over six.

7.5 STEEL PIPE CAPACITIES

Maximum Capacitiy of steel pipe in Cubic Feet per Hour (CFH) of Natural Gas
(Approximately 1000 BTU per cubic foot)

Table A-21

Gas Pressure of: 0.5 psi or Less
Pressure Drop of: 0.5 inches W.C.
(based on a 0.60 specific gravity gas)

	Size	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4
Tubing Length (Ft.)	10	173	361	682	1,401	2,099	4,045	6,449	11,406	16,704	23,275
	20	118	248	468	963	1,443	2,781	4,433	7,841	11,483	16,000
	30	95	199	376	773	1,159	2,233	3,561	6,297	9,222	12,850
	40	81	171	322	662	992	1,911	3,048	5,390	7,894	10,999
	50	72	151	285	586	879	1,694	2,701	4,777	6,997	9,749
	60	65	137	258	531	796	1,535	2,448	4,329	6,340	8,834
	70	60	126	238	489	733	1,412	2,252	3,983	5,833	8,127
	80	56	117	221	455	682	1,314	2,095	3,705	5,426	7,561
	90	52	110	207	427	640	1,233	1,966	3,476	5,092	7,095
	100	49	104	196	403	604	1,164	1,857	3,284	4,810	6,702
	125	44	92	174	357	535	1,032	1,646	2,911	4,263	5,940
	150	40	83	157	324	485	935	1,491	2,637	3,863	5,382
	175	36	77	145	298	446	860	1,372	2,426	3,554	4,952
	200	34	71	135	277	415	800	1,276	2,257	3,306	4,607

Maximum Capacity of steel pipe in Thousands of BTU (KBTU) of Propane Gas (LPG
(Approximately 2500 BTU per cubic foot)

Table A-22

Gas Pressure of: 0.5 psi or Less
Pressure Drop of: 1.0 inches W.C.
(based on a 1.52 specific gravity gas)

	Size	1/2	3/4	1	1-1/4	1-1/2	2	1-1/2	3	3-1/2	4
Tubing Length (Ft.)	5	618	1,295	2,440	5,012	7,512	14,477	23,082	40,821	59,782	83,300
	10	423	889	1,676	3,446	5,164	9,953	15,866	28,062	41,097	57,265
	15	341	715	1,347	2,766	4,148	7,993	12,744	22,537	33,007	45,990
	20	291	610	1,153	2,368	3,551	6,840	10,909	19,290	28,252	39,364
	25	259	540	1,021	2,099	3,147	6,063	9,669	17,099	25,039	34,892
	30	234	491	926	1,902	2,851	5,493	8,760	15,493	22,689	31,616
	40	199	421	792	1,628	2,440	4,704	7,497	13,262	19,422	27,061
	50	177	371	702	1,442	2,164	4,168	6,646	11,753	17,213	23,986
	60	159	336	635	1,307	1,960	3,777	6,021	10,650	15,597	21,733
	70	147	309	585	1,203	1,803	3,474	5,540	9,798	14,350	19,995
	80	137	289	543	1,118	1,678	3,232	5,154	9,116	13,351	18,603
	90	129	271	510	1,048	1,574	3,033	4,836	8,553	12,527	17,455
	100	122	254	483	991	1,487	2,866	4,569	8,080	11,832	16,489
	125	107	227	428	879	1,317	2,540	4,049	7,161	10,488	14,614

7.6 PRESSURE DROP PER FOOT TABLES

WARDFLEX®/WARDFLEX® II Pressure Drop per Foot

TABLE A-23

Pressure drop in inches of water column per foot ("WC per foot) at given CFH Flow
based on natural gas specific gravity of 0.60

Natural Gas Flow in CFH	10A 3/8"	15A 1/2"	20A 3/4"	25A 1"	32A 1-1/4"	38A 1-1/2"	50A 2"
EHD	15	19	25	30	37	48	62
10	0.003	0.001	0.000	0.000	0.000	0.000	0.000
20	0.011	0.002	0.000	0.000	0.000	0.000	0.000
30	0.023	0.005	0.001	0.000	0.000	0.000	0.000
40	0.041	0.009	0.002	0.001	0.000	0.000	0.000
50	0.063	0.014	0.003	0.001	0.000	0.000	0.000
60	0.089	0.020	0.005	0.002	0.000	0.000	0.000
70	0.120	0.027	0.006	0.002	0.000	0.000	0.000
80	0.156	0.035	0.008	0.003	0.001	0.000	0.000
90	0.196	0.045	0.011	0.004	0.001	0.000	0.000
100	0.240	0.055	0.013	0.005	0.001	0.000	0.000
110	0.289	0.067	0.016	0.006	0.001	0.000	0.000
120	0.342	0.080	0.019	0.007	0.001	0.000	0.000
130	0.399	0.094	0.022	0.008	0.002	0.000	0.000
140	0.461	0.109	0.026	0.009	0.002	0.000	0.000
150	0.527	0.125	0.030	0.011	0.002	0.000	0.000
160	0.597	0.142	0.034	0.012	0.002	0.001	0.000
170	0.671	0.161	0.039	0.014	0.003	0.001	0.000
180	0.750	0.180	0.044	0.015	0.003	0.001	0.000
190	0.833	0.201	0.049	0.017	0.003	0.001	0.000
200	0.920	0.223	0.054	0.019	0.004	0.001	0.000
225	1.155	0.282	0.069	0.024	0.005	0.001	0.000
250	1.417	0.349	0.085	0.029	0.006	0.001	0.000
275	1.704	0.423	0.104	0.035	0.007	0.002	0.000
300	2.017	0.504	0.124	0.041	0.009	0.002	0.000
325	2.355	0.592	0.146	0.048	0.010	0.002	0.000
350	2.719	0.687	0.170	0.056	0.012	0.003	0.001
375	3.107	0.789	0.195	0.064	0.014	0.003	0.001
400	3.521	0.899	0.223	0.072	0.016	0.004	0.001
425	3.960	1.015	0.252	0.082	0.018	0.004	0.001
450	4.423	1.139	0.284	0.091	0.020	0.005	0.001
475	4.911	1.270	0.317	0.101	0.022	0.005	0.001
500	5.424	1.408	0.352	0.112	0.025	0.006	0.001
525	5.962	1.553	0.389	0.123	0.027	0.006	0.001
550	6.524	1.705	0.428	0.135	0.030	0.007	0.001
575	7.110	1.865	0.468	0.147	0.033	0.007	0.002
600	7.721	2.031	0.511	0.160	0.036	0.008	0.002
625	8.356	2.205	0.555	0.173	0.039	0.009	0.002
650	9.015	2.386	0.602	0.187	0.043	0.010	0.002
675	9.699	2.575	0.650	0.201	0.046	0.010	0.002
700	10.407	2.770	0.700	0.216	0.050	0.011	0.002
725	11.139	2.973	0.752	0.231	0.053	0.012	0.003
750	11.894	3.182	0.806	0.247	0.057	0.013	0.003
775	12.674	3.399	0.862	0.263	0.061	0.014	0.003
800	13.478	3.624	0.920	0.280	0.066	0.014	0.003
825	14.306	3.855	0.980	0.297	0.070	0.015	0.004

Natural Gas Flow in CFH	10A 3/8"	15A 1/2"	20A 3/4"	25A 1"	32A 1-1/4"	38A 1-1/2"	50A 2"
EHD	15	19	25	30	37	48	62
850	15.157	4.094	1.041	0.315	0.074	0.016	0.004
875	16.032	4.339	1.105	0.334	0.079	0.017	0.004
900	16.931	4.592	1.170	0.352	0.084	0.018	0.004
925	17.854	4.853	1.238	0.372	0.089	0.019	0.004
950	18.800	5.120	1.307	0.392	0.094	0.021	0.005
975	19.770	5.395	1.379	0.412	0.099	0.022	0.005
1000	20.763	5.677	1.452	0.433	0.104	0.023	0.005
1050	22.821	6.262	1.604	0.476	0.115	0.025	0.006
1100	24.972	6.876	1.764	0.521	0.127	0.028	0.006
1150	27.217	7.519	1.932	0.568	0.139	0.030	0.007
1200	29.556	8.191	2.108	0.618	0.152	0.033	0.008
1250	31.987	8.893	2.291	0.669	0.166	0.036	0.009
1300	34.511	9.623	2.483	0.722	0.180	0.039	0.009
1350	37.128	10.381	2.682	0.777	0.194	0.042	0.010
1400	39.837	11.169	2.889	0.834	0.210	0.045	0.011
1450	42.638	11.986	3.104	0.893	0.226	0.048	0.012
1500	45.532	12.832	3.326	0.954	0.242	0.052	0.013
1550	48.517	13.707	3.557	1.017	0.259	0.055	0.013
1600	51.593	14.611	3.796	1.082	0.277	0.059	0.014
1650	54.761	15.544	4.042	1.149	0.295	0.063	0.015
1700	58.020	16.506	4.296	1.218	0.314	0.067	0.016
1750	61.371	17.497	4.559	1.289	0.333	0.071	0.017
1800	64.812	18.518	4.829	1.362	0.353	0.075	0.018
1850	68.344	19.567	5.107	1.436	0.374	0.079	0.020
1900	71.966	20.645	5.394	1.513	0.395	0.084	0.021
1950	75.679	21.753	5.688	1.592	0.417	0.088	0.022
2000	79.482	22.889	5.990	1.672	0.440	0.093	0.023
2050	83.375	24.055	6.300	1.755	0.463	0.098	0.024
2100	87.358	25.250	6.618	1.839	0.487	0.103	0.026
2150	91.431	26.473	6.945	1.926	0.511	0.108	0.027
2200	95.593	27.726	7.279	2.014	0.536	0.113	0.028
2250	99.846	29.009	7.621	2.104	0.562	0.118	0.030
2300	######	30.320	7.971	2.196	0.588	0.123	0.031
2350	######	31.660	8.330	2.290	0.615	0.129	0.032
2400	######	33.030	8.696	2.386	0.642	0.135	0.034
2450	######	34.429	9.071	2.484	0.670	0.140	0.035
2500	######	35.857	9.453	2.584	0.699	0.146	0.037
2550	######	37.314	9.844	2.686	0.728	0.152	0.039
2600	######	38.800	10.242	2.789	0.758	0.158	0.040
2650	######	40.316	10.649	2.895	0.789	0.165	0.042
2700	######	41.861	11.064	3.002	0.820	0.171	0.044
2750	######	43.435	11.487	3.112	0.852	0.177	0.045
2800	######	45.038	11.918	3.223	0.884	0.184	0.047
2850	######	46.670	12.357	3.336	0.918	0.191	0.049

TABLE A-23

Pressure drop in inches of water column per foot ("WC per foot) at given CFH Flow
based on natural gas specific gravity of 0.60

Natural Gas Flow in CFH	10A 3/8"	15A 1/2"	20A 3/4"	25A 1"	32A 1-1/4"	38A 1-1/2"	50A 2"
EHD	15	19	25	30	37	48	62
2900	######	48.332	12.805	3.451	0.951	0.198	0.051
2950	######	50.023	13.260	3.568	0.986	0.205	0.053
3000	######	51.743	13.724	3.687	1.021	0.212	0.055
3050	######	53.493	14.195	3.808	1.056	0.219	0.056
3100	######	55.271	14.675	3.931	1.093	0.226	0.058
3150	######	57.079	15.163	4.055	1.130	0.234	0.060
3200	######	58.916	15.660	4.182	1.167	0.241	0.062
3250	######	60.783	16.164	4.310	1.205	0.249	0.065
3300	######	62.678	16.677	4.440	1.244	0.257	0.067
3350	######	64.603	17.197	4.573	1.284	0.265	0.069
3400	######	66.558	17.726	4.707	1.324	0.273	0.071
3450	######	68.541	18.263	4.842	1.364	0.281	0.073
3500	######	70.554	18.809	4.980	1.406	0.289	0.076
3550	######	72.596	19.362	5.120	1.448	0.298	0.078
3600	######	74.668	19.924	5.262	1.490	0.306	0.080
3650	######	76.768	20.494	5.405	1.534	0.315	0.083
3700	######	78.899	21.072	5.550	1.578	0.324	0.085
3750	######	81.058	21.658	5.698	1.622	0.333	0.087
3800	######	83.247	22.253	5.847	1.668	0.342	0.090
3850	######	85.465	22.855	5.998	1.713	0.351	0.093
3900	######	87.712	23.466	6.150	1.760	0.360	0.095
3950	######	89.989	24.086	6.305	1.807	0.370	0.098
4000	######	92.295	24.713	6.462	1.855	0.379	0.100
4050	######	94.630	25.349	6.620	1.903	0.389	0.103
4100	######	96.995	25.993	6.780	1.953	0.399	0.106
4150	######	99.389	26.645	6.943	2.002	0.409	0.108
4200	######	######	27.306	7.107	2.053	0.419	0.111
4250	######	######	27.975	7.273	2.104	0.429	0.114
4300	######	######	28.652	7.440	2.156	0.439	0.117
4350	######	######	29.337	7.610	2.208	0.450	0.120
4400	######	######	30.031	7.782	2.261	0.460	0.123
4450	######	######	30.732	7.955	2.315	0.471	0.126
4500	######	######	31.443	8.130	2.369	0.482	0.129
4550	######	######	32.161	8.307	2.424	0.493	0.132
4600	######	######	32.888	8.486	2.480	0.504	0.135
4650	######	######	33.623	8.667	2.536	0.515	0.138
4700	######	######	34.366	8.850	2.593	0.526	0.141
4750	######	######	35.118	9.034	2.650	0.538	0.144
4800	######	######	35.878	9.221	2.709	0.549	0.148
4850	######	######	36.646	9.409	2.768	0.561	0.151
4900	######	######	37.423	9.599	2.827	0.572	0.154
4950	######	######	38.208	9.791	2.887	0.584	0.158
5000	######	######	39.001	9.985	2.948	0.596	0.161
5100	######	######	40.613	10.378	3.072	0.621	0.168

Natural Gas Flow in CFH	10A 3/8"	15A 1/2"	20A 3/4"	25A 1"	32A 1-1/4"	38A 1-1/2"	50A 2"
EHD	15	19	25	30	37	48	62
5200	######	######	42.258	10.778	3.199	0.646	0.175
5300	######	######	43.936	11.186	3.328	0.671	0.182
5400	######	######	45.648	11.602	3.459	0.697	0.190
5500	######	######	47.393	12.024	3.594	0.724	0.197
5600	######	######	49.171	12.454	3.731	0.751	0.205
5700	######	######	50.983	12.892	3.870	0.778	0.213
5800	######	######	52.829	13.336	4.013	0.806	0.221
5900	######	######	54.708	13.789	4.158	0.834	0.229
6000	######	######	56.621	14.248	4.305	0.863	0.237
6100	######	######	58.567	14.715	4.456	0.893	0.246
6200	######	######	60.547	15.189	4.609	0.923	0.254
6300	######	######	62.561	15.670	4.764	0.953	0.263
6400	######	######	64.608	16.159	4.923	0.984	0.272
6500	######	######	66.689	16.655	5.084	1.016	0.281
6600	######	######	68.803	17.158	5.248	1.048	0.290
6700	######	######	70.952	17.669	5.414	1.080	0.300
6800	######	######	73.134	18.187	5.583	1.113	0.309
6900	######	######	75.350	18.712	5.755	1.146	0.319
7000	######	######	77.600	19.245	5.930	1.180	0.329
7100	######	######	79.883	19.784	6.107	1.215	0.339
7200	######	######	82.201	20.331	6.287	1.250	0.349
7300	######	######	84.552	20.886	6.470	1.285	0.360
7400	######	######	86.937	21.447	6.655	1.321	0.370
7500	######	######	89.356	22.016	6.843	1.358	0.381
7750	######	######	95.552	23.470	7.325	1.451	0.408
8000	######	######	######	24.969	7.825	1.548	0.437
8250	######	######	######	26.513	8.341	1.647	0.466
8500	######	######	######	28.103	8.874	1.750	0.497
8750	######	######	######	29.737	9.425	1.856	0.528
9000	######	######	######	31.416	9.993	1.965	0.561
9250	######	######	######	33.141	10.578	2.078	0.594
9500	######	######	######	34.910	11.180	2.193	0.629
9750	######	######	######	36.724	11.800	2.312	0.664
10000	######	######	######	38.583	12.437	2.434	0.701
10500	######	######	######	42.434	13.763	2.687	0.777
11000	######	######	######	46.464	15.159	2.953	0.858
11500	######	######	######	50.671	16.624	3.231	0.943
12000	######	######	######	55.056	18.161	3.523	1.032
12500	######	######	######	59.618	19.767	3.827	1.125
13000	######	######	######	64.357	21.444	4.144	1.223
13500	######	######	######	69.273	23.193	4.473	1.325
14000	######	######	######	74.364	25.012	4.816	1.431
14500	######	######	######	79.631	26.903	5.171	1.542
15000	######	######	######	85.074	28.865	5.539	1.657

SCHEDULE 40 BLACK IRON PIPE PRESSURE DROP PER FOOT

TABLE A-24

Pressure drop in inches of water column per foot ("WC per foot) at given CFH Flow
based on natural gas specific gravity of 0.60
Calculations based on NFPA 54 Low-Pressure Gas Formula

Natural Gas Flow in CFH	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
60	0.007	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
70	0.009	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80	0.012	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
90	0.015	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
100	0.018	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
110	0.022	0.006	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120	0.026	0.007	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
130	0.030	0.008	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
140	0.034	0.009	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000
150	0.039	0.010	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000
160	0.044	0.011	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000
170	0.049	0.013	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000
180	0.054	0.014	0.004	0.001	0.001	0.000	0.000	0.000	0.000	0.000
190	0.060	0.015	0.005	0.001	0.001	0.000	0.000	0.000	0.000	0.000
200	0.066	0.017	0.005	0.001	0.001	0.000	0.000	0.000	0.000	0.000
225	0.082	0.021	0.007	0.002	0.001	0.000	0.000	0.000	0.000	0.000
250	0.100	0.025	0.008	0.002	0.001	0.000	0.000	0.000	0.000	0.000
275	0.119	0.030	0.009	0.002	0.001	0.000	0.000	0.000	0.000	0.000
300	0.140	0.036	0.011	0.003	0.001	0.000	0.000	0.000	0.000	0.000
325	0.162	0.041	0.013	0.003	0.002	0.000	0.000	0.000	0.000	0.000
350	0.186	0.047	0.015	0.004	0.002	0.001	0.000	0.000	0.000	0.000
375	0.211	0.054	0.017	0.004	0.002	0.001	0.000	0.000	0.000	0.000
400	0.238	0.061	0.019	0.005	0.002	0.001	0.000	0.000	0.000	0.000
425	0.266	0.068	0.021	0.006	0.003	0.001	0.000	0.000	0.000	0.000
450	0.295	0.076	0.023	0.006	0.003	0.001	0.000	0.000	0.000	0.000
475	0.327	0.084	0.026	0.007	0.003	0.001	0.000	0.000	0.000	0.000
500	0.359	0.092	0.028	0.008	0.004	0.001	0.000	0.000	0.000	0.000
525	0.393	0.100	0.031	0.008	0.004	0.001	0.000	0.000	0.000	0.000
550	0.428	0.110	0.034	0.009	0.004	0.001	0.001	0.000	0.000	0.000
575	0.465	0.119	0.037	0.010	0.005	0.001	0.001	0.000	0.000	0.000
600	0.503	0.129	0.040	0.011	0.005	0.001	0.001	0.000	0.000	0.000
625	0.542	0.139	0.043	0.011	0.005	0.002	0.001	0.000	0.000	0.000
650	0.583	0.149	0.046	0.012	0.006	0.002	0.001	0.000	0.000	0.000
675	0.625	0.160	0.050	0.013	0.006	0.002	0.001	0.000	0.000	0.000
700	0.669	0.171	0.053	0.014	0.007	0.002	0.001	0.000	0.000	0.000
725	0.714	0.182	0.057	0.015	0.007	0.002	0.001	0.000	0.000	0.000
750	0.760	0.194	0.060	0.016	0.008	0.002	0.001	0.000	0.000	0.000
775	0.807	0.206	0.064	0.017	0.008	0.002	0.001	0.000	0.000	0.000
800	0.856	0.219	0.068	0.018	0.009	0.003	0.001	0.000	0.000	0.000
825	0.906	0.232	0.072	0.019	0.009	0.003	0.001	0.000	0.000	0.000

Natural Gas Flow in CFH	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4
850	0.957	0.245	0.076	0.020	0.010	0.003	0.001	0.000	0.000	0.000
875	1.010	0.258	0.080	0.021	0.010	0.003	0.001	0.000	0.000	0.000
900	1.064	0.272	0.084	0.022	0.011	0.003	0.001	0.000	0.000	0.000
925	1.119	0.286	0.089	0.023	0.011	0.003	0.001	0.000	0.000	0.000
950	1.176	0.301	0.093	0.025	0.012	0.003	0.001	0.001	0.000	0.000
975	1.234	0.316	0.098	0.026	0.012	0.004	0.002	0.001	0.000	0.000
1000	1.293	0.331	0.103	0.027	0.013	0.004	0.002	0.001	0.000	0.000
1050	1.415	0.362	0.112	0.030	0.014	0.004	0.002	0.001	0.000	0.000
1100	1.542	0.394	0.122	0.032	0.015	0.005	0.002	0.001	0.000	0.000
1150	1.674	0.428	0.133	0.035	0.017	0.005	0.002	0.001	0.000	0.000
1200	1.811	0.463	0.144	0.038	0.018	0.005	0.002	0.001	0.000	0.000
1250	1.953	0.499	0.155	0.041	0.019	0.006	0.002	0.001	0.000	0.000
1300	2.100	0.537	0.167	0.044	0.021	0.006	0.003	0.001	0.000	0.000
1350	2.251	0.576	0.179	0.047	0.022	0.007	0.003	0.001	0.000	0.000
1400	2.408	0.616	0.191	0.051	0.024	0.007	0.003	0.001	0.001	0.000
1450	2.569	0.657	0.204	0.054	0.026	0.008	0.003	0.001	0.001	0.000
1500	2.736	0.700	0.217	0.057	0.027	0.008	0.003	0.001	0.001	0.000
1550	2.906	0.743	0.231	0.061	0.029	0.009	0.004	0.001	0.001	0.000
1600	3.082	0.788	0.245	0.065	0.031	0.009	0.004	0.001	0.001	0.000
1650	3.263	0.834	0.259	0.068	0.032	0.010	0.004	0.001	0.001	0.000
1700	3.448	0.882	0.274	0.072	0.034	0.010	0.004	0.002	0.001	0.000
1750	3.637	0.930	0.289	0.076	0.036	0.011	0.005	0.002	0.001	0.000
1800	3.832	0.980	0.304	0.080	0.038	0.011	0.005	0.002	0.001	0.000
1850	4.031	1.031	0.320	0.085	0.040	0.012	0.005	0.002	0.001	0.000
1900	4.235	1.083	0.336	0.089	0.042	0.013	0.005	0.002	0.001	0.000
1950	4.443	1.136	0.352	0.093	0.044	0.013	0.006	0.002	0.001	0.001
2000	4.656	1.191	0.369	0.098	0.046	0.014	0.006	0.002	0.001	0.001
2050	4.873	1.246	0.387	0.102	0.048	0.014	0.006	0.002	0.001	0.001
2100	5.095	1.303	0.404	0.107	0.051	0.015	0.006	0.002	0.001	0.001
2150	5.322	1.361	0.422	0.112	0.053	0.016	0.007	0.002	0.001	0.001
2200	5.553	1.420	0.441	0.117	0.055	0.016	0.007	0.002	0.001	0.001
2250	5.788	1.480	0.459	0.121	0.058	0.017	0.007	0.003	0.001	0.001
2300	6.028	1.542	0.478	0.127	0.060	0.018	0.008	0.003	0.001	0.001
2350	6.273	1.604	0.498	0.132	0.062	0.019	0.008	0.003	0.001	0.001
2400	6.522	1.668	0.517	0.137	0.065	0.019	0.008	0.003	0.001	0.001
2450	6.775	1.733	0.538	0.142	0.067	0.020	0.008	0.003	0.001	0.001
2500	7.033	1.799	0.558	0.148	0.070	0.021	0.009	0.003	0.002	0.001
2550	7.295	1.866	0.579	0.153	0.073	0.022	0.009	0.003	0.002	0.001
2600	7.561	1.934	0.600	0.159	0.075	0.022	0.009	0.003	0.002	0.001
2650	7.832	2.003	0.621	0.164	0.078	0.023	0.010	0.003	0.002	0.001
2700	8.108	2.074	0.643	0.170	0.081	0.024	0.010	0.004	0.002	0.001
2750	8.387	2.145	0.665	0.176	0.083	0.025	0.010	0.004	0.002	0.001
2800	8.672	2.218	0.688	0.182	0.086	0.026	0.011	0.004	0.002	0.001
2850	8.960	2.292	0.711	0.188	0.089	0.027	0.011	0.004	0.002	0.001
2900	9.253	2.366	0.734	0.194	0.092	0.027	0.012	0.004	0.002	0.001

SCHEDULE 40 BLACK IRON PIPE PRESSURE DROP PER FOOT

TABLE A-24

Pressure drop in inches of water column per foot ("WC per foot) at given CFH Flow
based on natural gas specific gravity of 0.60
Calculations based on NFPA 54 Low-Pressure Gas Formula

Natural Gas Flow in CFH	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4
2950	9.550	2.442	0.758	0.200	0.095	0.028	0.012	0.004	0.002	0.001
3000	9.851	2.519	0.782	0.207	0.098	0.029	0.012	0.004	0.002	0.001
3050	10.157	2.598	0.806	0.213	0.101	0.030	0.013	0.004	0.002	0.001
3100	10.467	2.677	0.830	0.220	0.104	0.031	0.013	0.005	0.002	0.001
3150	10.781	2.757	0.855	0.226	0.107	0.032	0.013	0.005	0.002	0.001
3200	11.099	2.839	0.881	0.233	0.110	0.033	0.014	0.005	0.002	0.001
3250	11.422	2.921	0.906	0.240	0.114	0.034	0.014	0.005	0.002	0.001
3300	11.749	3.005	0.932	0.247	0.117	0.035	0.015	0.005	0.003	0.001
3350	12.080	3.090	0.958	0.254	0.120	0.036	0.015	0.005	0.003	0.001
3400	12.415	3.175	0.985	0.261	0.123	0.037	0.016	0.005	0.003	0.001
3450	12.755	3.262	1.012	0.268	0.127	0.038	0.016	0.006	0.003	0.001
3500	13.099	3.350	1.039	0.275	0.130	0.039	0.016	0.006	0.003	0.002
3550	13.447	3.439	1.067	0.282	0.134	0.040	0.017	0.006	0.003	0.002
3600	13.799	3.529	1.095	0.290	0.137	0.041	0.017	0.006	0.003	0.002
3650	14.155	3.620	1.123	0.297	0.141	0.042	0.018	0.006	0.003	0.002
3700	14.516	3.712	1.152	0.305	0.144	0.043	0.018	0.006	0.003	0.002
3750	14.880	3.806	1.181	0.312	0.148	0.044	0.019	0.006	0.003	0.002
3800	15.249	3.900	1.210	0.320	0.152	0.045	0.019	0.007	0.003	0.002
3850	15.622	3.995	1.239	0.328	0.155	0.046	0.020	0.007	0.003	0.002
3900	15.999	4.092	1.269	0.336	0.159	0.047	0.020	0.007	0.003	0.002
3950	16.380	4.189	1.300	0.344	0.163	0.048	0.020	0.007	0.004	0.002
4000	16.766	4.288	1.330	0.352	0.167	0.050	0.021	0.007	0.004	0.002
4050	17.155	4.388	1.361	0.360	0.171	0.051	0.021	0.007	0.004	0.002
4100	17.549	4.488	1.392	0.368	0.174	0.052	0.022	0.008	0.004	0.002
4150	17.946	4.590	1.424	0.377	0.178	0.053	0.022	0.008	0.004	0.002
4200	18.348	4.693	1.456	0.385	0.182	0.054	0.023	0.008	0.004	0.002
4250	18.754	4.796	1.488	0.394	0.186	0.056	0.023	0.008	0.004	0.002
4300	19.164	4.901	1.520	0.402	0.191	0.057	0.024	0.008	0.004	0.002
4350	19.577	5.007	1.553	0.411	0.195	0.058	0.024	0.009	0.004	0.002
4400	19.995	5.114	1.586	0.420	0.199	0.059	0.025	0.009	0.004	0.002
4450	20.417	5.222	1.620	0.429	0.203	0.060	0.026	0.009	0.004	0.002
4500	20.844	5.331	1.654	0.438	0.207	0.062	0.026	0.009	0.004	0.002
4550	21.274	5.441	1.688	0.447	0.211	0.063	0.027	0.009	0.005	0.002
4600	21.708	5.552	1.722	0.456	0.216	0.064	0.027	0.009	0.005	0.003
4650	22.146	5.664	1.757	0.465	0.220	0.066	0.028	0.010	0.005	0.003
4700	22.588	5.777	1.792	0.474	0.225	0.067	0.028	0.010	0.005	0.003
4750	23.034	5.891	1.827	0.483	0.229	0.068	0.029	0.010	0.005	0.003
4800	23.484	6.006	1.863	0.493	0.233	0.070	0.029	0.010	0.005	0.003
4850	23.939	6.122	1.899	0.502	0.238	0.071	0.030	0.010	0.005	0.003
4900	24.397	6.240	1.936	0.512	0.243	0.072	0.031	0.011	0.005	0.003
4950	24.859	6.358	1.972	0.522	0.247	0.074	0.031	0.011	0.005	0.003
5000	25.325	6.477	2.009	0.532	0.252	0.075	0.032	0.011	0.005	0.003
5100	26.269	6.719	2.084	0.551	0.261	0.078	0.033	0.011	0.006	0.003
5200	27.229	6.964	2.160	0.572	0.271	0.081	0.034	0.012	0.006	0.003

Natural Gas Flow in CFH	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4
5300	28.205	7.214	2.238	0.592	0.280	0.083	0.035	0.012	0.006	0.003
5400	29.197	7.467	2.316	0.613	0.290	0.086	0.037	0.013	0.006	0.003
5500	30.204	7.725	2.396	0.634	0.300	0.089	0.038	0.013	0.007	0.004
5600	31.227	7.986	2.477	0.655	0.310	0.092	0.039	0.014	0.007	0.004
5700	32.265	8.252	2.560	0.677	0.321	0.096	0.040	0.014	0.007	0.004
5800	33.319	8.522	2.643	0.699	0.331	0.099	0.042	0.015	0.007	0.004
5900	34.389	8.795	2.728	0.722	0.342	0.102	0.043	0.015	0.007	0.004
6000	35.474	9.073	2.814	0.745	0.353	0.105	0.044	0.015	0.008	0.004
6100	36.575	9.354	2.902	0.768	0.364	0.108	0.046	0.016	0.008	0.004
6200	37.691	9.640	2.990	0.791	0.375	0.112	0.047	0.016	0.008	0.004
6300	38.822	9.929	3.080	0.815	0.386	0.115	0.049	0.017	0.008	0.005
6400	39.969	10.222	3.171	0.839	0.397	0.118	0.050	0.017	0.009	0.005
6500	41.131	10.520	3.263	0.863	0.409	0.122	0.051	0.018	0.009	0.005
6600	42.308	10.821	3.357	0.888	0.421	0.125	0.053	0.018	0.009	0.005
6700	43.501	11.126	3.451	0.913	0.432	0.129	0.054	0.019	0.009	0.005
6800	44.708	11.434	3.547	0.938	0.444	0.132	0.056	0.020	0.010	0.005
6900	45.931	11.747	3.644	0.964	0.457	0.136	0.057	0.020	0.010	0.005
7000	47.169	12.064	3.742	0.990	0.469	0.140	0.059	0.021	0.010	0.006
7100	48.422	12.384	3.842	1.016	0.481	0.143	0.061	0.021	0.010	0.006
7200	49.690	12.709	3.942	1.043	0.494	0.147	0.062	0.022	0.011	0.006
7300	50.974	13.037	4.044	1.070	0.507	0.151	0.064	0.022	0.011	0.006
7400	52.272	13.369	4.147	1.097	0.520	0.155	0.065	0.023	0.011	0.006
7500	53.585	13.705	4.251	1.125	0.533	0.159	0.067	0.023	0.012	0.006
7750	56.933	14.561	4.517	1.195	0.566	0.169	0.071	0.025	0.012	0.007
8000	60.374	15.441	4.790	1.267	0.600	0.179	0.076	0.026	0.013	0.007
8250	63.908	16.345	5.070	1.341	0.635	0.189	0.080	0.028	0.014	0.007
8500	67.533	17.272	5.358	1.418	0.671	0.200	0.084	0.029	0.015	0.008
8750	71.251	18.223	5.653	1.496	0.708	0.211	0.089	0.031	0.015	0.008
9000	75.059	19.197	5.955	1.575	0.746	0.222	0.094	0.033	0.016	0.009
9250	78.958	20.194	6.264	1.657	0.785	0.234	0.099	0.034	0.017	0.009
9500	82.948	21.215	6.581	1.741	0.825	0.246	0.104	0.036	0.018	0.010
9750	87.028	22.258	6.905	1.827	0.865	0.258	0.109	0.038	0.019	0.010
10000	91.198	23.324	7.235	1.914	0.907	0.270	0.114	0.040	0.020	0.011
10500	99.805	25.526	7.918	2.095	0.992	0.295	0.125	0.044	0.022	0.012
11000	108.766	27.818	8.629	2.283	1.081	0.322	0.136	0.047	0.023	0.013
11500	118.081	30.200	9.368	2.479	1.174	0.350	0.148	0.052	0.025	0.014
12000	127.745	32.672	10.135	2.681	1.270	0.378	0.160	0.056	0.028	0.015
12500	137.757	35.232	10.929	2.892	1.369	0.408	0.172	0.060	0.030	0.016
13000	148.115	37.882	11.751	3.109	1.472	0.438	0.185	0.065	0.032	0.017
13500	158.817	40.619	12.600	3.334	1.579	0.470	0.199	0.069	0.034	0.019
14000	169.860	43.443	13.476	3.565	1.689	0.503	0.212	0.074	0.037	0.020
14500	181.243	46.354	14.379	3.804	1.802	0.536	0.227	0.079	0.039	0.021
15000	192.964	49.352	15.309	4.050	1.918	0.571	0.241	0.084	0.042	0.023

POLYETHYLENE PIPE PRESSURE DROP PER FOOT

TABLE A-25

Pressure drop in inches of water column per foot ("WC per foot) at given CFH Flow
based on natural gas specific gravity of 0.60
Calculations based on NFPA 54 Low-Pressure Gas Formula

Natural Gas Flow in CFH	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
60	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
70	0.007	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80	0.009	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
90	0.011	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
100	0.014	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
110	0.016	0.005	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
120	0.019	0.005	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
130	0.022	0.006	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
140	0.026	0.007	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
150	0.029	0.008	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000
160	0.033	0.009	0.003	0.001	0.001	0.000	0.000	0.000	0.000	0.000
170	0.037	0.010	0.003	0.001	0.001	0.000	0.000	0.000	0.000	0.000
180	0.041	0.011	0.004	0.001	0.001	0.000	0.000	0.000	0.000	0.000
190	0.045	0.012	0.004	0.002	0.001	0.000	0.000	0.000	0.000	0.000
200	0.050	0.014	0.005	0.002	0.001	0.000	0.000	0.000	0.000	0.000
225	0.062	0.017	0.006	0.002	0.001	0.000	0.000	0.000	0.000	0.000
250	0.075	0.021	0.007	0.003	0.001	0.000	0.000	0.000	0.000	0.000
275	0.089	0.025	0.008	0.003	0.001	0.000	0.000	0.000	0.000	0.000
300	0.105	0.029	0.010	0.004	0.002	0.001	0.000	0.000	0.000	0.000
325	0.121	0.034	0.011	0.004	0.002	0.001	0.000	0.000	0.000	0.000
350	0.139	0.039	0.013	0.005	0.002	0.001	0.000	0.000	0.000	0.000
375	0.158	0.044	0.015	0.005	0.002	0.001	0.000	0.000	0.000	0.000
400	0.178	0.049	0.017	0.006	0.003	0.001	0.000	0.000	0.000	0.000
425	0.199	0.055	0.019	0.007	0.003	0.001	0.000	0.000	0.000	0.000
450	0.222	0.061	0.021	0.007	0.003	0.001	0.000	0.000	0.000	0.000
475	0.245	0.068	0.023	0.008	0.004	0.001	0.000	0.000	0.000	0.000
500	0.269	0.075	0.025	0.009	0.004	0.001	0.000	0.000	0.000	0.000
525	0.295	0.082	0.027	0.010	0.005	0.002	0.000	0.000	0.000	0.000
550	0.321	0.089	0.030	0.011	0.005	0.002	0.000	0.000	0.000	0.000
575	0.349	0.097	0.032	0.012	0.005	0.002	0.000	0.000	0.000	0.000
600	0.377	0.105	0.035	0.013	0.006	0.002	0.000	0.000	0.000	0.000
625	0.407	0.113	0.038	0.014	0.006	0.002	0.000	0.000	0.000	0.000
650	0.437	0.121	0.041	0.015	0.007	0.002	0.000	0.000	0.000	0.000
675	0.469	0.130	0.044	0.016	0.007	0.002	0.000	0.000	0.000	0.000
700	0.502	0.139	0.047	0.017	0.008	0.003	0.000	0.000	0.000	0.000
725	0.535	0.148	0.050	0.018	0.008	0.003	0.000	0.000	0.000	0.000
750	0.570	0.158	0.053	0.019	0.009	0.003	0.000	0.000	0.000	0.000
775	0.605	0.168	0.056	0.020	0.010	0.003	0.000	0.000	0.000	0.000
800	0.642	0.178	0.060	0.022	0.010	0.003	0.001	0.000	0.000	0.000
825	0.680	0.188	0.063	0.023	0.011	0.004	0.001	0.000	0.000	0.000

Natural Gas Flow in CFH	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4
850	0.718	0.199	0.067	0.024	0.011	0.004	0.001	0.000	0.000	0.000
875	0.758	0.210	0.071	0.026	0.012	0.004	0.001	0.000	0.000	0.000
900	0.798	0.221	0.074	0.027	0.013	0.004	0.001	0.000	0.000	0.000
925	0.840	0.233	0.078	0.028	0.013	0.004	0.001	0.000	0.000	0.000
950	0.882	0.244	0.082	0.030	0.014	0.005	0.001	0.000	0.000	0.000
975	0.925	0.256	0.086	0.031	0.015	0.005	0.001	0.000	0.000	0.000
1000	0.970	0.269	0.090	0.033	0.015	0.005	0.001	0.000	0.000	0.000
1050	1.061	0.294	0.099	0.036	0.017	0.006	0.001	0.000	0.000	0.000
1100	1.157	0.321	0.108	0.039	0.018	0.006	0.001	0.000	0.000	0.000
1150	1.256	0.348	0.117	0.042	0.020	0.007	0.001	0.000	0.000	0.000
1200	1.358	0.376	0.126	0.046	0.021	0.007	0.001	0.000	0.000	0.000
1250	1.465	0.406	0.136	0.049	0.023	0.008	0.001	0.000	0.000	0.000
1300	1.575	0.436	0.147	0.053	0.025	0.008	0.001	0.000	0.000	0.000
1350	1.689	0.468	0.157	0.057	0.027	0.009	0.001	0.000	0.000	0.000
1400	1.806	0.501	0.168	0.061	0.028	0.010	0.001	0.000	0.001	0.000
1450	1.927	0.534	0.179	0.065	0.030	0.010	0.002	0.000	0.001	0.000
1500	2.052	0.569	0.191	0.069	0.032	0.011	0.002	0.000	0.001	0.000
1550	2.180	0.604	0.203	0.073	0.034	0.012	0.002	0.001	0.001	0.000
1600	2.312	0.641	0.215	0.078	0.036	0.012	0.002	0.001	0.001	0.000
1650	2.447	0.678	0.228	0.082	0.039	0.013	0.002	0.001	0.001	0.000
1700	2.586	0.717	0.241	0.087	0.041	0.014	0.002	0.001	0.001	0.000
1750	2.729	0.756	0.254	0.092	0.043	0.015	0.002	0.001	0.001	0.000
1800	2.874	0.797	0.268	0.097	0.045	0.015	0.002	0.001	0.001	0.000
1850	3.024	0.838	0.281	0.102	0.048	0.016	0.002	0.001	0.001	0.000
1900	3.176	0.880	0.296	0.107	0.050	0.017	0.003	0.001	0.001	0.000
1950	3.333	0.924	0.310	0.112	0.052	0.018	0.003	0.001	0.001	0.001
2000	3.492	0.968	0.325	0.118	0.055	0.019	0.003	0.001	0.001	0.001
2050	3.655	1.013	0.340	0.123	0.058	0.019	0.003	0.001	0.001	0.001
2100	3.822	1.059	0.356	0.129	0.060	0.020	0.003	0.001	0.001	0.001
2150	3.992	1.106	0.372	0.135	0.063	0.021	0.003	0.001	0.001	0.001
2200	4.165	1.154	0.388	0.140	0.066	0.022	0.003	0.001	0.001	0.001
2250	4.342	1.203	0.404	0.146	0.068	0.023	0.004	0.001	0.001	0.001
2300	4.522	1.253	0.421	0.152	0.071	0.024	0.004	0.001	0.001	0.001
2350	4.705	1.304	0.438	0.159	0.074	0.025	0.004	0.001	0.001	0.001
2400	4.892	1.356	0.455	0.165	0.077	0.026	0.004	0.001	0.001	0.001
2450	5.082	1.408	0.473	0.171	0.080	0.027	0.004	0.001	0.001	0.001
2500	5.275	1.462	0.491	0.178	0.083	0.028	0.004	0.001	0.002	0.001
2550	5.472	1.516	0.509	0.184	0.086	0.029	0.004	0.001	0.002	0.001
2600	5.672	1.572	0.528	0.191	0.089	0.030	0.005	0.001	0.002	0.001
2650	5.875	1.628	0.547	0.198	0.092	0.031	0.005	0.001	0.002	0.001
2700	6.082	1.685	0.566	0.205	0.096	0.032	0.005	0.001	0.002	0.001
2750	6.292	1.743	0.586	0.212	0.099	0.034	0.005	0.002	0.002	0.001
2800	6.505	1.803	0.605	0.219	0.102	0.035	0.005	0.002	0.002	0.001
2850	6.721	1.862	0.626	0.227	0.106	0.036	0.005	0.002	0.002	0.001
2900	6.941	1.923	0.646	0.234	0.109	0.037	0.006	0.002	0.002	0.001

POLYETHYLENE PIPE PRESSURE DROP PER FOOT

TABLE A-25

Pressure drop in inches of water column per foot ("WC per foot) at given CFH Flow
based on natural gas specific gravity of 0.60
Calculations based on NFPA 54 Low-Pressure Gas Formula

Natural Gas Flow in CFH	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4
2950	7.163	1.985	0.667	0.241	0.113	0.038	0.006	0.002	0.002	0.001
3000	7.389	2.048	0.688	0.249	0.116	0.039	0.006	0.002	0.002	0.001
3050	7.619	2.111	0.709	0.257	0.120	0.041	0.006	0.002	0.002	0.001
3100	7.851	2.176	0.731	0.265	0.124	0.042	0.006	0.002	0.002	0.001
3150	8.087	2.241	0.753	0.273	0.127	0.043	0.007	0.002	0.002	0.001
3200	8.326	2.307	0.775	0.281	0.131	0.044	0.007	0.002	0.002	0.001
3250	8.568	2.374	0.798	0.289	0.135	0.046	0.007	0.002	0.002	0.001
3300	8.813	2.442	0.820	0.297	0.139	0.047	0.007	0.002	0.003	0.001
3350	9.061	2.511	0.843	0.305	0.143	0.048	0.007	0.002	0.003	0.001
3400	9.313	2.581	0.867	0.314	0.147	0.050	0.008	0.002	0.003	0.001
3450	9.568	2.651	0.891	0.323	0.151	0.051	0.008	0.002	0.003	0.001
3500	9.826	2.723	0.915	0.331	0.155	0.052	0.008	0.002	0.003	0.002
3550	10.087	2.795	0.939	0.340	0.159	0.054	0.008	0.002	0.003	0.002
3600	10.351	2.868	0.964	0.349	0.163	0.055	0.008	0.002	0.003	0.002
3650	10.618	2.942	0.988	0.358	0.167	0.057	0.009	0.003	0.003	0.002
3700	10.889	3.017	1.014	0.367	0.171	0.058	0.009	0.003	0.003	0.002
3750	11.162	3.093	1.039	0.376	0.176	0.059	0.009	0.003	0.003	0.002
3800	11.439	3.170	1.065	0.386	0.180	0.061	0.009	0.003	0.003	0.002
3850	11.719	3.247	1.091	0.395	0.184	0.062	0.010	0.003	0.003	0.002
3900	12.001	3.326	1.117	0.405	0.189	0.064	0.010	0.003	0.003	0.002
3950	12.287	3.405	1.144	0.414	0.193	0.065	0.010	0.003	0.004	0.002
4000	12.576	3.485	1.171	0.424	0.198	0.067	0.010	0.003	0.004	0.002
4050	12.868	3.566	1.198	0.434	0.202	0.069	0.010	0.003	0.004	0.002
4100	13.164	3.648	1.225	0.444	0.207	0.070	0.011	0.003	0.004	0.002
4150	13.462	3.730	1.253	0.454	0.212	0.072	0.011	0.003	0.004	0.002
4200	13.763	3.814	1.281	0.464	0.217	0.073	0.011	0.003	0.004	0.002
4250	14.068	3.898	1.309	0.474	0.221	0.075	0.011	0.003	0.004	0.002
4300	14.375	3.983	1.338	0.485	0.226	0.077	0.012	0.003	0.004	0.002
4350	14.686	4.070	1.367	0.495	0.231	0.078	0.012	0.004	0.004	0.002
4400	14.999	4.156	1.396	0.506	0.236	0.080	0.012	0.004	0.004	0.002
4450	15.316	4.244	1.426	0.516	0.241	0.082	0.012	0.004	0.004	0.002
4500	15.635	4.333	1.455	0.527	0.246	0.083	0.013	0.004	0.004	0.002
4550	15.958	4.422	1.485	0.538	0.251	0.085	0.013	0.004	0.005	0.002
4600	16.284	4.512	1.516	0.549	0.256	0.087	0.013	0.004	0.005	0.003
4650	16.612	4.603	1.546	0.560	0.261	0.088	0.013	0.004	0.005	0.003
4700	16.944	4.695	1.577	0.571	0.267	0.090	0.014	0.004	0.005	0.003
4750	17.279	4.788	1.608	0.582	0.272	0.092	0.014	0.004	0.005	0.003
4800	17.616	4.882	1.640	0.594	0.277	0.094	0.014	0.004	0.005	0.003
4850	17.957	4.976	1.672	0.605	0.283	0.096	0.015	0.004	0.005	0.003
4900	18.301	5.071	1.704	0.617	0.288	0.097	0.015	0.004	0.005	0.003
4950	18.647	5.167	1.736	0.629	0.293	0.099	0.015	0.004	0.005	0.003
5000	18.997	5.264	1.768	0.640	0.299	0.101	0.015	0.005	0.005	0.003
5100	19.705	5.461	1.834	0.664	0.310	0.105	0.016	0.005	0.006	0.003
5200	20.425	5.660	1.901	0.689	0.321	0.109	0.017	0.005	0.006	0.003

Natural Gas Flow in CFH	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4
5300	21.157	5.863	1.969	0.713	0.333	0.113	0.017	0.005	0.006	0.003
5400	21.901	6.069	2.039	0.738	0.345	0.117	0.018	0.005	0.006	0.003
5500	22.657	6.278	2.109	0.764	0.356	0.121	0.018	0.005	0.007	0.004
5600	23.424	6.491	2.180	0.790	0.369	0.125	0.019	0.006	0.007	0.004
5700	24.203	6.707	2.253	0.816	0.381	0.129	0.020	0.006	0.007	0.004
5800	24.994	6.926	2.327	0.843	0.393	0.133	0.020	0.006	0.007	0.004
5900	25.796	7.148	2.401	0.870	0.406	0.137	0.021	0.006	0.007	0.004
6000	26.610	7.374	2.477	0.897	0.419	0.142	0.022	0.006	0.008	0.004
6100	27.436	7.603	2.554	0.925	0.432	0.146	0.022	0.007	0.008	0.004
6200	28.273	7.835	2.632	0.953	0.445	0.151	0.023	0.007	0.008	0.004
6300	29.122	8.070	2.711	0.982	0.458	0.155	0.024	0.007	0.008	0.005
6400	29.982	8.308	2.791	1.011	0.472	0.160	0.024	0.007	0.009	0.005
6500	30.853	8.550	2.872	1.040	0.485	0.164	0.025	0.007	0.009	0.005
6600	31.736	8.794	2.954	1.070	0.499	0.169	0.026	0.008	0.009	0.005
6700	32.631	9.042	3.037	1.100	0.513	0.174	0.026	0.008	0.009	0.005
6800	33.537	9.293	3.122	1.131	0.528	0.179	0.027	0.008	0.010	0.005
6900	34.454	9.548	3.207	1.161	0.542	0.184	0.028	0.008	0.010	0.005
7000	35.383	9.805	3.294	1.193	0.557	0.188	0.029	0.008	0.010	0.006
7100	36.323	10.065	3.381	1.224	0.571	0.193	0.029	0.009	0.010	0.006
7200	37.274	10.329	3.470	1.257	0.586	0.199	0.030	0.009	0.011	0.006
7300	38.237	10.596	3.559	1.289	0.602	0.204	0.031	0.009	0.011	0.006
7400	39.211	10.866	3.650	1.322	0.617	0.209	0.032	0.009	0.011	0.006
7500	40.196	11.139	3.742	1.355	0.632	0.214	0.033	0.010	0.012	0.006
7750	42.707	11.835	3.975	1.440	0.672	0.227	0.035	0.010	0.012	0.007
8000	45.288	12.550	4.216	1.527	0.713	0.241	0.037	0.011	0.013	0.007
8250	47.939	13.284	4.462	1.616	0.754	0.255	0.039	0.012	0.014	0.007
8500	50.659	14.038	4.716	1.708	0.797	0.270	0.041	0.012	0.015	0.008
8750	53.447	14.811	4.975	1.802	0.841	0.285	0.043	0.013	0.015	0.008
9000	56.304	15.602	5.241	1.898	0.886	0.300	0.046	0.014	0.016	0.009
9250	59.229	16.413	5.513	1.997	0.932	0.315	0.048	0.014	0.017	0.009
9500	62.222	17.242	5.792	2.097	0.979	0.331	0.051	0.015	0.018	0.010
9750	65.282	18.090	6.077	2.201	1.027	0.348	0.053	0.016	0.019	0.010
10000	68.410	18.957	6.368	2.306	1.076	0.364	0.056	0.016	0.020	0.011
10500	74.866	20.746	6.969	2.524	1.178	0.399	0.061	0.018	0.022	0.012
11000	81.589	22.609	7.595	2.750	1.284	0.435	0.066	0.020	0.023	0.013
11500	88.576	24.545	8.245	2.986	1.394	0.472	0.072	0.021	0.025	0.014
12000	95.825	26.554	8.920	3.230	1.508	0.510	0.078	0.023	0.028	0.015
12500	103.336	28.635	9.619	3.483	1.626	0.550	0.084	0.025	0.030	0.016
13000	111.105	30.788	10.342	3.745	1.748	0.592	0.090	0.027	0.032	0.017
13500	119.133	33.013	11.089	4.016	1.874	0.635	0.097	0.029	0.034	0.019
14000	127.417	35.308	11.860	4.295	2.005	0.679	0.103	0.031	0.037	0.020
14500	135.955	37.675	12.655	4.583	2.139	0.724	0.110	0.033	0.039	0.021
15000	144.748	40.111	13.474	4.879	2.277	0.771	0.118	0.035	0.042	0.023

TABLE A-26

Pressure drop in inches of water column per foot ("WC per foot) at given KBTU
based on propane gas specific gravity of 1.52

Propane Gas Flow in KBTU	10A 3/8"	15A 1/2"	20A 3/4"	25A 1"	32A 1-1/4"	38A 1-1/2"	50A 2"
EHD	15	19	25	30	37	48	62
10	0.001	0.000	0.000	0.000	0.000	0.000	0.000
20	0.004	0.001	0.000	0.000	0.000	0.000	0.000
30	0.010	0.002	0.000	0.000	0.000	0.000	0.000
40	0.017	0.003	0.001	0.000	0.000	0.000	0.000
50	0.026	0.005	0.001	0.001	0.000	0.000	0.000
60	0.037	0.008	0.002	0.001	0.000	0.000	0.000
70	0.050	0.011	0.002	0.001	0.000	0.000	0.000
80	0.064	0.014	0.003	0.001	0.000	0.000	0.000
90	0.081	0.018	0.004	0.002	0.000	0.000	0.000
100	0.099	0.022	0.005	0.002	0.000	0.000	0.000
110	0.119	0.027	0.006	0.002	0.000	0.000	0.000
120	0.141	0.032	0.007	0.003	0.000	0.000	0.000
130	0.164	0.037	0.009	0.003	0.001	0.000	0.000
140	0.190	0.043	0.010	0.004	0.001	0.000	0.000
150	0.217	0.050	0.012	0.004	0.001	0.000	0.000
160	0.246	0.057	0.013	0.005	0.001	0.000	0.000
170	0.277	0.064	0.015	0.006	0.001	0.000	0.000
180	0.309	0.072	0.017	0.006	0.001	0.000	0.000
190	0.343	0.080	0.019	0.007	0.001	0.000	0.000
200	0.379	0.089	0.021	0.008	0.001	0.000	0.000
225	0.476	0.112	0.027	0.010	0.002	0.000	0.000
250	0.584	0.139	0.033	0.012	0.002	0.001	0.000
275	0.702	0.168	0.041	0.014	0.003	0.001	0.000
300	0.831	0.200	0.049	0.017	0.003	0.001	0.000
325	0.970	0.236	0.057	0.020	0.004	0.001	0.000
350	1.120	0.273	0.067	0.023	0.005	0.001	0.000
375	1.280	0.314	0.077	0.026	0.005	0.001	0.000
400	1.450	0.358	0.087	0.030	0.006	0.001	0.000
425	1.631	0.404	0.099	0.033	0.007	0.002	0.000
450	1.822	0.453	0.111	0.037	0.008	0.002	0.000
475	2.023	0.505	0.124	0.041	0.009	0.002	0.000
500	2.234	0.560	0.138	0.046	0.010	0.002	0.000
525	2.455	0.618	0.152	0.050	0.011	0.002	0.001
550	2.687	0.679	0.168	0.055	0.012	0.003	0.001
575	2.928	0.742	0.184	0.060	0.013	0.003	0.001
600	3.180	0.808	0.200	0.065	0.014	0.003	0.001
625	3.442	0.878	0.218	0.071	0.015	0.003	0.001
650	3.713	0.950	0.236	0.076	0.016	0.004	0.001
675	3.995	1.025	0.255	0.082	0.018	0.004	0.001
700	4.286	1.102	0.274	0.088	0.019	0.004	0.001
725	4.588	1.183	0.295	0.095	0.021	0.005	0.001
750	4.899	1.266	0.316	0.101	0.022	0.005	0.001
775	5.220	1.353	0.338	0.108	0.024	0.005	0.001
800	5.551	1.442	0.361	0.115	0.025	0.006	0.001
825	5.892	1.534	0.384	0.122	0.027	0.006	0.001

Propane Gas Flow in KBTU	10A 3/8"	15A 1/2"	20A 3/4"	25A 1"	32A 1-1/4"	38A 1-1/2"	50A 2"
EHD	15	19	25	30	37	48	62
850	6.243	1.629	0.408	0.129	0.029	0.006	0.001
875	6.603	1.727	0.433	0.137	0.031	0.007	0.002
900	6.973	1.828	0.459	0.144	0.032	0.007	0.002
925	7.353	1.931	0.485	0.152	0.034	0.008	0.002
950	7.743	2.038	0.512	0.160	0.036	0.008	0.002
975	8.142	2.147	0.540	0.169	0.038	0.009	0.002
1000	8.552	2.259	0.569	0.177	0.040	0.009	0.002
1050	9.399	2.492	0.629	0.195	0.045	0.010	0.002
1100	10.285	2.736	0.692	0.213	0.049	0.011	0.002
1150	11.210	2.992	0.757	0.233	0.054	0.012	0.003
1200	12.173	3.260	0.826	0.253	0.059	0.013	0.003
1250	13.174	3.539	0.898	0.274	0.064	0.014	0.003
1300	14.214	3.829	0.973	0.295	0.069	0.015	0.003
1350		4.131	1.051	0.318	0.075	0.017	0.004
1400		4.445	1.132	0.341	0.081	0.018	0.004
1450		4.770	1.217	0.366	0.087	0.019	0.004
1500		5.107	1.304	0.391	0.093	0.020	0.005
1550		5.455	1.394	0.416	0.100	0.022	0.005
1600		5.815	1.488	0.443	0.107	0.023	0.005
1650		6.186	1.584	0.470	0.114	0.025	0.006
1700		6.569	1.684	0.499	0.121	0.026	0.006
1750		6.963	1.787	0.528	0.129	0.028	0.007
1800		7.369	1.893	0.557	0.136	0.030	0.007
1850		7.787	2.002	0.588	0.144	0.031	0.007
1900		8.216	2.114	0.619	0.153	0.033	0.008
1950		8.657	2.229	0.651	0.161	0.035	0.008
2000		9.109	2.348	0.684	0.170	0.037	0.009
2050		9.573	2.469	0.718	0.179	0.039	0.009
2100		10.048	2.594	0.753	0.188	0.041	0.010
2150		10.535	2.722	0.788	0.197	0.043	0.010
2200		11.034	2.853	0.824	0.207	0.045	0.011
2250		11.544	2.987	0.861	0.217	0.047	0.011
2300		12.066	3.125	0.899	0.227	0.049	0.012
2350		12.599	3.265	0.937	0.237	0.051	0.012
2400		13.144	3.409	0.977	0.248	0.053	0.013
2450		13.701	3.555	1.017	0.259	0.055	0.013
2500		14.269	3.705	1.058	0.270	0.058	0.014
2550			3.858	1.099	0.281	0.060	0.015
2600			4.015	1.142	0.293	0.063	0.015
2650			4.174	1.185	0.305	0.065	0.016
2700			4.337	1.229	0.317	0.067	0.016
2750			4.503	1.274	0.329	0.070	0.017
2800			4.672	1.319	0.342	0.073	0.018
2850			4.844	1.366	0.354	0.075	0.018
2900			5.019	1.413	0.367	0.078	0.019

TABLE A-26

Pressure drop in inches of water column per foot ("WC per foot) at given KBTU based on propane gas specific gravity of 1.52

Propane Gas Flow in KBTU	10A 3/8"	15A 1/2"	20A 3/4"	25A 1"	32A 1-1/4"	38A 1-1/2"	50A 2"
EHD	15	19	25	30	37	48	62
2950			5.198	1.461	0.381	0.081	0.020
3000			5.379	1.509	0.394	0.084	0.021
3050			5.564	1.559	0.408	0.086	0.021
3100			5.752	1.609	0.422	0.089	0.022
3150			5.944	1.660	0.436	0.092	0.023
3200			6.138	1.712	0.451	0.095	0.024
3250			6.336	1.764	0.466	0.098	0.024
3300			6.537	1.817	0.481	0.101	0.025
3350			6.741	1.872	0.496	0.105	0.026
3400			6.948	1.926	0.511	0.108	0.027
3450			7.159	1.982	0.527	0.111	0.028
3500			7.372	2.038	0.543	0.114	0.029
3550			7.589	2.096	0.559	0.118	0.029
3600			7.809	2.154	0.576	0.121	0.030
3650			8.033	2.212	0.592	0.124	0.031
3700			8.259	2.272	0.609	0.128	0.032
3750			8.489	2.332	0.627	0.131	0.033
3800			8.722	2.393	0.644	0.135	0.034
3850			8.959	2.455	0.662	0.139	0.035
3900			9.198	2.517	0.680	0.142	0.036
3950			9.441	2.581	0.698	0.146	0.037
4000			9.687	2.645	0.717	0.150	0.038
4050			9.936	2.710	0.735	0.154	0.039
4100			10.188	2.775	0.754	0.157	0.040
4150			10.444	2.842	0.773	0.161	0.041
4200			10.703	2.909	0.793	0.165	0.042
4250			10.965	2.977	0.813	0.169	0.043
4300			11.231	3.045	0.833	0.173	0.044
4350			11.499	3.115	0.853	0.178	0.045
4400			11.771	3.185	0.873	0.182	0.046
4450			12.046	3.256	0.894	0.186	0.048
4500			12.325	3.328	0.915	0.190	0.049
4550			12.606	3.400	0.936	0.195	0.050
4600			12.891	3.474	0.958	0.199	0.051
4650			13.179	3.548	0.980	0.203	0.052
4700			13.471	3.622	1.002	0.208	0.053
4750			13.765	3.698	1.024	0.212	0.055
4800			14.063	3.774	1.046	0.217	0.056
4850				3.851	1.069	0.221	0.057
4900				3.929	1.092	0.226	0.058
4950				4.008	1.115	0.231	0.060
5000				4.087	1.139	0.236	0.061
5100				4.248	1.187	0.245	0.064
5200				4.412	1.236	0.255	0.066

Propane Gas Flow in KBTU	10A 3/8"	15A 1/2"	20A 3/4"	25A 1"	32A 1-1/4"	38A 1-1/2"	50A 2"
EHD	15	19	25	30	37	48	62
5300				4.579	1.285	0.265	0.069
5400				4.749	1.336	0.275	0.072
5500				4.922	1.388	0.286	0.075
5600				5.098	1.441	0.296	0.078
5700				5.277	1.495	0.307	0.080
5800				5.459	1.550	0.318	0.084
5900				5.644	1.606	0.329	0.087
6000				5.832	1.663	0.341	0.090
6100				6.023	1.721	0.353	0.093
6200				6.217	1.780	0.364	0.096
6300				6.414	1.840	0.376	0.100
6400				6.614	1.902	0.389	0.103
6500				6.817	1.964	0.401	0.106
6600				7.023	2.027	0.414	0.110
6700				7.232	2.091	0.426	0.113
6800				7.444	2.157	0.439	0.117
6900				7.659	2.223	0.453	0.121
7000				7.877	2.290	0.466	0.124
7100				8.098	2.359	0.480	0.128
7200				8.322	2.428	0.493	0.132
7300				8.549	2.499	0.507	0.136
7400				8.779	2.571	0.522	0.140
7500				9.011	2.643	0.536	0.144
7750				9.607	2.830	0.573	0.154
8000				10.220	3.022	0.611	0.165
8250				10.852	3.222	0.650	0.176
8500				11.503	3.428	0.691	0.188
8750				12.172	3.641	0.733	0.200
9000				12.859	3.860	0.776	0.212
9250				13.565	4.086	0.820	0.225
9500				14.289	4.319	0.866	0.238
9750					4.558	0.913	0.251
10000					4.804	0.961	0.265
10500					5.316	1.061	0.294
11000					5.855	1.166	0.325
11500					6.422	1.276	0.357
12000					7.015	1.391	0.391
12500					7.636	1.511	0.426
13000					8.283	1.636	0.463
13500					8.959	1.766	0.501
14000					9.662	1.902	0.542
14500					10.392	2.042	0.583
15000					11.150	2.187	0.627

SCHEDULE 40 BLACK IRON PIPE Pressure Drop per Foot Propane Gas

TABLE A-27

Pressure drop in inches of water column per foot ("WC per foot) at given KBTU
based on propane gas specific gravity of 1.52
Calculations based on NFPA 54 Low Pressure Gas Formula

Natural Gas Flow in CFH	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
60	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
70	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
80	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
90	0.006	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
100	0.007	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
110	0.008	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120	0.010	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
130	0.011	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
140	0.013	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
150	0.015	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
160	0.016	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
170	0.018	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
180	0.020	0.005	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
190	0.023	0.006	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
200	0.025	0.006	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
225	0.031	0.008	0.002	0.001	0.000	0.000	0.000	0.000	0.000	0.000
250	0.037	0.010	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000
275	0.045	0.011	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.000
300	0.053	0.013	0.004	0.001	0.001	0.000	0.000	0.000	0.000	0.000
325	0.061	0.016	0.005	0.001	0.001	0.000	0.000	0.000	0.000	0.000
350	0.070	0.018	0.006	0.001	0.001	0.000	0.000	0.000	0.000	0.000
375	0.079	0.020	0.006	0.002	0.001	0.000	0.000	0.000	0.000	0.000
400	0.089	0.023	0.007	0.002	0.001	0.000	0.000	0.000	0.000	0.000
425	0.100	0.026	0.008	0.002	0.001	0.000	0.000	0.000	0.000	0.000
450	0.111	0.028	0.009	0.002	0.001	0.000	0.000	0.000	0.000	0.000
475	0.123	0.031	0.010	0.003	0.001	0.000	0.000	0.000	0.000	0.000
500	0.135	0.035	0.011	0.003	0.001	0.000	0.000	0.000	0.000	0.000
525	0.148	0.038	0.012	0.003	0.001	0.000	0.000	0.000	0.000	0.000
550	0.161	0.041	0.013	0.003	0.002	0.000	0.000	0.000	0.000	0.000
575	0.175	0.045	0.014	0.004	0.002	0.001	0.000	0.000	0.000	0.000
600	0.189	0.048	0.015	0.004	0.002	0.001	0.000	0.000	0.000	0.000
625	0.204	0.052	0.016	0.004	0.002	0.001	0.000	0.000	0.000	0.000
650	0.219	0.056	0.017	0.005	0.002	0.001	0.000	0.000	0.000	0.000
675	0.235	0.060	0.019	0.005	0.002	0.001	0.000	0.000	0.000	0.000
700	0.251	0.064	0.020	0.005	0.002	0.001	0.000	0.000	0.000	0.000
725	0.268	0.069	0.021	0.006	0.003	0.001	0.000	0.000	0.000	0.000
750	0.286	0.073	0.023	0.006	0.003	0.001	0.000	0.000	0.000	0.000
775	0.303	0.078	0.024	0.006	0.003	0.001	0.000	0.000	0.000	0.000
800	0.322	0.082	0.026	0.007	0.003	0.001	0.000	0.000	0.000	0.000
825	0.341	0.087	0.027	0.007	0.003	0.001	0.000	0.000	0.000	0.000

Natural Gas Flow in CFH	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4
850	0.360	0.092	0.029	0.008	0.004	0.001	0.000	0.000	0.000	0.000
875	0.380	0.097	0.030	0.008	0.004	0.001	0.000	0.000	0.000	0.000
900	0.400	0.102	0.032	0.008	0.004	0.001	0.001	0.000	0.000	0.000
925	0.421	0.108	0.033	0.009	0.004	0.001	0.001	0.000	0.000	0.000
950	0.442	0.113	0.035	0.009	0.004	0.001	0.001	0.000	0.000	0.000
975	0.464	0.119	0.037	0.010	0.005	0.001	0.001	0.000	0.000	0.000
1000	0.486	0.124	0.039	0.010	0.005	0.001	0.001	0.000	0.000	0.000
1050	0.532	0.136	0.042	0.011	0.005	0.002	0.001	0.000	0.000	0.000
1100	0.580	0.148	0.046	0.012	0.006	0.002	0.001	0.000	0.000	0.000
1150	0.629	0.161	0.050	0.013	0.006	0.002	0.001	0.000	0.000	0.000
1200	0.681	0.174	0.054	0.014	0.007	0.002	0.001	0.000	0.000	0.000
1250	0.734	0.188	0.058	0.015	0.007	0.002	0.001	0.000	0.000	0.000
1300	0.789	0.202	0.063	0.017	0.008	0.002	0.001	0.000	0.000	0.000
1350	0.846	0.216	0.067	0.018	0.008	0.003	0.001	0.000	0.000	0.000
1400	0.905	0.232	0.072	0.019	0.009	0.003	0.001	0.000	0.000	0.000
1450	0.966	0.247	0.077	0.020	0.010	0.003	0.001	0.000	0.000	0.000
1500	1.028	0.263	0.082	0.022	0.010	0.003	0.001	0.000	0.000	0.000
1550	1.093	0.279	0.087	0.023	0.011	0.003	0.001	0.000	0.000	0.000
1600	1.159	0.296	0.092	0.024	0.012	0.003	0.001	0.001	0.000	0.000
1650	1.226	0.314	0.097	0.026	0.012	0.004	0.002	0.001	0.000	0.000
1700	1.296	0.331	0.103	0.027	0.013	0.004	0.002	0.001	0.000	0.000
1750	1.367	0.350	0.108	0.029	0.014	0.004	0.002	0.001	0.000	0.000
1800	1.441	0.368	0.114	0.030	0.014	0.004	0.002	0.001	0.000	0.000
1850	1.515	0.388	0.120	0.032	0.015	0.004	0.002	0.001	0.000	0.000
1900	1.592	0.407	0.126	0.033	0.016	0.005	0.002	0.001	0.000	0.000
1950	1.670	0.427	0.133	0.035	0.017	0.005	0.002	0.001	0.000	0.000
2000	1.750	0.448	0.139	0.037	0.017	0.005	0.002	0.001	0.000	0.000
2050	1.832	0.469	0.145	0.038	0.018	0.005	0.002	0.001	0.000	0.000
2100	1.915	0.490	0.152	0.040	0.019	0.006	0.002	0.001	0.000	0.000
2150	2.001	0.512	0.159	0.042	0.020	0.006	0.003	0.001	0.000	0.000
2200	2.087	0.534	0.166	0.044	0.021	0.006	0.003	0.001	0.000	0.000
2250	2.176	0.557	0.173	0.046	0.022	0.006	0.003	0.001	0.000	0.000
2300	2.266	0.580	0.180	0.048	0.023	0.007	0.003	0.001	0.000	0.000
2350	2.358	0.603	0.187	0.049	0.023	0.007	0.003	0.001	0.001	0.000
2400	2.452	0.627	0.195	0.051	0.024	0.007	0.003	0.001	0.001	0.000
2450	2.547	0.651	0.202	0.053	0.025	0.008	0.003	0.001	0.001	0.000
2500	2.644	0.676	0.210	0.055	0.026	0.008	0.003	0.001	0.001	0.000
2550	2.742	0.701	0.218	0.058	0.027	0.008	0.003	0.001	0.001	0.000
2600	2.843	0.727	0.226	0.060	0.028	0.008	0.004	0.001	0.001	0.000
2650	2.944	0.753	0.234	0.062	0.029	0.009	0.004	0.001	0.001	0.000
2700	3.048	0.780	0.242	0.064	0.030	0.009	0.004	0.001	0.001	0.000
2750	3.153	0.806	0.250	0.066	0.031	0.009	0.004	0.001	0.001	0.000
2800	3.260	0.834	0.259	0.068	0.032	0.010	0.004	0.001	0.001	0.000
2850	3.368	0.861	0.267	0.071	0.033	0.010	0.004	0.001	0.001	0.000
2900	3.478	0.890	0.276	0.073	0.035	0.010	0.004	0.002	0.001	0.000

SCHEDULE 40 BLACK IRON PIPE Pressure Drop per Foot Propane Gas

TABLE A-27

Pressure drop in inches of water column per foot ("WC per foot) at given KBTU
based on propane gas specific gravity of 1.52
Calculations based on NFPA 54 Low Pressure Gas Formula

Natural Gas Flow in CFH	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4
2950	3.590	0.918	0.285	0.075	0.036	0.011	0.004	0.002	0.001	0.000
3000	3.703	0.947	0.294	0.078	0.037	0.011	0.005	0.002	0.001	0.000
3050	3.818	0.977	0.303	0.080	0.038	0.011	0.005	0.002	0.001	0.000
3100	3.935	1.006	0.312	0.083	0.039	0.012	0.005	0.002	0.001	0.000
3150	4.053	1.037	0.322	0.085	0.040	0.012	0.005	0.002	0.001	0.000
3200	4.173	1.067	0.331	0.088	0.041	0.012	0.005	0.002	0.001	0.000
3250	4.294	1.098	0.341	0.090	0.043	0.013	0.005	0.002	0.001	0.001
3300	4.417	1.130	0.350	0.093	0.044	0.013	0.006	0.002	0.001	0.001
3350	4.541	1.161	0.360	0.095	0.045	0.013	0.006	0.002	0.001	0.001
3400	4.667	1.194	0.370	0.098	0.046	0.014	0.006	0.002	0.001	0.001
3450	4.795	1.226	0.380	0.101	0.048	0.014	0.006	0.002	0.001	0.001
3500	4.924	1.259	0.391	0.103	0.049	0.015	0.006	0.002	0.001	0.001
3550	5.055	1.293	0.401	0.106	0.050	0.015	0.006	0.002	0.001	0.001
3600	5.187	1.327	0.412	0.109	0.052	0.015	0.006	0.002	0.001	0.001
3650	5.321	1.361	0.422	0.112	0.053	0.016	0.007	0.002	0.001	0.001
3700	5.457	1.396	0.433	0.115	0.054	0.016	0.007	0.002	0.001	0.001
3750	5.594	1.431	0.444	0.117	0.056	0.017	0.007	0.002	0.001	0.001
3800	5.733	1.466	0.455	0.120	0.057	0.017	0.007	0.003	0.001	0.001
3850	5.873	1.502	0.466	0.123	0.058	0.017	0.007	0.003	0.001	0.001
3900	6.015	1.538	0.477	0.126	0.060	0.018	0.008	0.003	0.001	0.001
3950	6.158	1.575	0.489	0.129	0.061	0.018	0.008	0.003	0.001	0.001
4000	6.303	1.612	0.500	0.132	0.063	0.019	0.008	0.003	0.001	0.001
4050	6.449	1.649	0.512	0.135	0.064	0.019	0.008	0.003	0.001	0.001
4100	6.597	1.687	0.523	0.138	0.066	0.020	0.008	0.003	0.001	0.001
4150	6.747	1.725	0.535	0.142	0.067	0.020	0.008	0.003	0.001	0.001
4200	6.898	1.764	0.547	0.145	0.069	0.020	0.009	0.003	0.001	0.001
4250	7.050	1.803	0.559	0.148	0.070	0.021	0.009	0.003	0.002	0.001
4300	7.204	1.843	0.572	0.151	0.072	0.021	0.009	0.003	0.002	0.001
4350	7.360	1.882	0.584	0.154	0.073	0.022	0.009	0.003	0.002	0.001
4400	7.517	1.923	0.596	0.158	0.075	0.022	0.009	0.003	0.002	0.001
4450	7.676	1.963	0.609	0.161	0.076	0.023	0.010	0.003	0.002	0.001
4500	7.836	2.004	0.622	0.164	0.078	0.023	0.010	0.003	0.002	0.001
4550	7.997	2.045	0.634	0.168	0.080	0.024	0.010	0.003	0.002	0.001
4600	8.161	2.087	0.647	0.171	0.081	0.024	0.010	0.004	0.002	0.001
4650	8.325	2.129	0.661	0.175	0.083	0.025	0.010	0.004	0.002	0.001
4700	8.492	2.172	0.674	0.178	0.084	0.025	0.011	0.004	0.002	0.001
4750	8.659	2.215	0.687	0.182	0.086	0.026	0.011	0.004	0.002	0.001
4800	8.829	2.258	0.700	0.185	0.088	0.026	0.011	0.004	0.002	0.001
4850	8.999	2.302	0.714	0.189	0.089	0.027	0.011	0.004	0.002	0.001
4900	9.172	2.346	0.728	0.193	0.091	0.027	0.011	0.004	0.002	0.001
4950	9.345	2.390	0.741	0.196	0.093	0.028	0.012	0.004	0.002	0.001
5000	9.521	2.435	0.755	0.200	0.095	0.028	0.012	0.004	0.002	0.001
5100	9.875	2.526	0.783	0.207	0.098	0.029	0.012	0.004	0.002	0.001
5200	10.236	2.618	0.812	0.215	0.102	0.030	0.013	0.004	0.002	0.001

Natural Gas Flow in CFH	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4
5300	10.603	2.712	0.841	0.223	0.105	0.031	0.013	0.005	0.002	0.001
5400	10.976	2.807	0.871	0.230	0.109	0.032	0.014	0.005	0.002	0.001
5500	11.355	2.904	0.901	0.238	0.113	0.034	0.014	0.005	0.002	0.001
5600	11.739	3.002	0.931	0.246	0.117	0.035	0.015	0.005	0.003	0.001
5700	12.130	3.102	0.962	0.255	0.121	0.036	0.015	0.005	0.003	0.001
5800	12.526	3.204	0.994	0.263	0.125	0.037	0.016	0.005	0.003	0.001
5900	12.928	3.306	1.026	0.271	0.129	0.038	0.016	0.006	0.003	0.002
6000	13.336	3.411	1.058	0.280	0.133	0.039	0.017	0.006	0.003	0.002
6100	13.750	3.517	1.091	0.289	0.137	0.041	0.017	0.006	0.003	0.002
6200	14.169	3.624	1.124	0.297	0.141	0.042	0.018	0.006	0.003	0.002
6300		3.733	1.158	0.306	0.145	0.043	0.018	0.006	0.003	0.002
6400		3.843	1.192	0.315	0.149	0.044	0.019	0.007	0.003	0.002
6500		3.955	1.227	0.325	0.154	0.046	0.019	0.007	0.003	0.002
6600		4.068	1.262	0.334	0.158	0.047	0.020	0.007	0.003	0.002
6700		4.182	1.297	0.343	0.163	0.048	0.020	0.007	0.004	0.002
6800		4.299	1.333	0.353	0.167	0.050	0.021	0.007	0.004	0.002
6900		4.416	1.370	0.362	0.172	0.051	0.022	0.008	0.004	0.002
7000		4.535	1.407	0.372	0.176	0.052	0.022	0.008	0.004	0.002
7100		4.656	1.444	0.382	0.181	0.054	0.023	0.008	0.004	0.002
7200		4.778	1.482	0.392	0.186	0.055	0.023	0.008	0.004	0.002
7300		4.901	1.520	0.402	0.190	0.057	0.024	0.008	0.004	0.002
7400		5.026	1.559	0.412	0.195	0.058	0.025	0.009	0.004	0.002
7500		5.152	1.598	0.423	0.200	0.060	0.025	0.009	0.004	0.002
7750		5.474	1.698	0.449	0.213	0.063	0.027	0.009	0.005	0.003
8000		5.805	1.801	0.476	0.226	0.067	0.028	0.010	0.005	0.003
8250		6.145	1.906	0.504	0.239	0.071	0.030	0.010	0.005	0.003
8500		6.493	2.014	0.533	0.252	0.075	0.032	0.011	0.005	0.003
8750		6.851	2.125	0.562	0.266	0.079	0.033	0.012	0.006	0.003
9000		7.217	2.239	0.592	0.281	0.084	0.035	0.012	0.006	0.003
9250		7.592	2.355	0.623	0.295	0.088	0.037	0.013	0.006	0.003
9500		7.975	2.474	0.655	0.310	0.092	0.039	0.014	0.007	0.004
9750		8.368	2.596	0.687	0.325	0.097	0.041	0.014	0.007	0.004
10000		8.768	2.720	0.720	0.341	0.101	0.043	0.015	0.007	0.004
10500		9.596	2.977	0.788	0.373	0.111	0.047	0.016	0.008	0.004
11000		10.458	3.244	0.858	0.406	0.121	0.051	0.018	0.009	0.005
11500		11.353	3.522	0.932	0.441	0.131	0.056	0.019	0.010	0.005
12000		12.282	3.810	1.008	0.477	0.142	0.060	0.021	0.010	0.006
12500		13.245	4.109	1.087	0.515	0.153	0.065	0.023	0.011	0.006
13000		14.241	4.418	1.169	0.554	0.165	0.070	0.024	0.012	0.007
13500			4.737	1.253	0.594	0.177	0.075	0.026	0.013	0.007
14000			5.066	1.340	0.635	0.189	0.080	0.028	0.014	0.007
14500			5.406	1.430	0.677	0.202	0.085	0.030	0.015	0.008
15000			5.755	1.523	0.721	0.215	0.091	0.032	0.016	0.008

8.1 DEFINITION OF TERMINOLOGY IN THIS GUIDE

AGA - American Gas Association

ANSI - American National Standards Institute

ANSI/AGA LC 1b- CGA 6.26b - M01 - Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST)

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 - Any device which utilizes gas as a fuel or raw material to produce light, heat, power, refrigeration or air conditioning.

ASME - American Society of Mechanical Engineers

Authority Having Jurisdiction - The organization, office or individual responsible for approving equipment, installations, or procedures.

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

CFH - Gas flow rate stated in cubic feet per hour. A CFH of natural gas typically contains 1000 BTU's and LPG typically contains 2500 BTU's.

CGA - Canadian Gas Association

CAN/CGA - B149.1 - Natural Gas Installation code - most current edition

CAN/CGA - B149.2 - Propane Installation code - most current edition

CSA - Canadian Standards Association

CSST - Corrugated stainless steel tubing.

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 cleanout.

EHD - Equivalent Hydraulic Diameter. A measure of the relative hydraulic efficiency between different tubing sizes. The larger the value of EHD, the greater the flow capacity.

Elevated Pressure System - Term for any pressure above 1/2 PSIG, but less than 5 PSIG.

Full Lockup Regulator - Specifically designed regulator capable of stopping gas flow if the load goes to zero, thus, preventing the downstream from increasing more than 2"(in.) WC pressure above the set point.

Joint - A connection between two lengths of tubing or a length of tubing and fitting.

Joint Compound - Non-hardening material used on pipe threads to ensure a seal.

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

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

Meter - An instrument installed to measure the volume of gas delivered through a piping system.

NFPA - National Fire Protection Agency

Piping - As used in this guide, either pipe or tubing or both.

A. Pipe - Rigid conduit of iron, steel, copper, brass or aluminum.
B. Tubing - Semirigid conduit of corrugated stainless steel (CSST).

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

Pressure Drop - The loss in gas pressure due to friction or obstruction in tubing, valves, fittings, regulators and burners.

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 simply referred to as PSI.

Purge - To completely displace an existing gas with a new gas.

Regulator, Gas Appliance Pressure - A device for controlling and maintaining a uniform pressure to the manifold of gas burning equipment.

Regulator, Line Gas Pressure - A device installed between the service pressure regulator and the gas appliance regulator for controlling, maintaining or reducing the pressure in that portion of the piping system downstream of the device. This device is used in elevated pressure systems and is simply referred to as a pressure regulator in this guide.

Regulator, Service Pressure - A device installed by the serving 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.

Specific Gravity - Applied to a gas it is the ratio of the weight of a given volume to that of the same volume of air, both measured under the same conditions.

Tubing - ASTM A240 Type 304 annular corrugated stainless steel tubing, which is bendable and comes in 50, 100, 180, 250, 500 and 1,000 foot coils depending on the diameter.

Valve - A device used to shut-off gas flow to the system.

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.

Water Column, Inches (in. WC) - A method of stating pressure measured in inches of water column by a manometer or pressure gauge. Commonly used in the gas industry when the pressure is less than 1 PSIG. Approximate conversion between PSIG and in. WC:

1 PSIG = 28 in. WC
1/2 PSIG = 14 in. WC
1/4 PSIG = 7 in. WC

APPENDIX A

- Specific Gravity Factor
- Pressure Drop Curves for Corrugated Tubing Fittings
- Equivalent Lengths Factor for Fittings and Valves

Specific Gravity Correction Factor

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

Such application is accomplished by multiplying the capacities given in Tables A-1 through A-13 and Table A-29 by the appropriate multiplier from Table A-28. In case the exact specific gravity does not appear in the table, choose the next higher value specific gravity shown.

Table A-28 Multipliers to be Used with Tables A-1 through A-13 and Table A-29

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

Table A-29 Natural Gas Flow in CFH

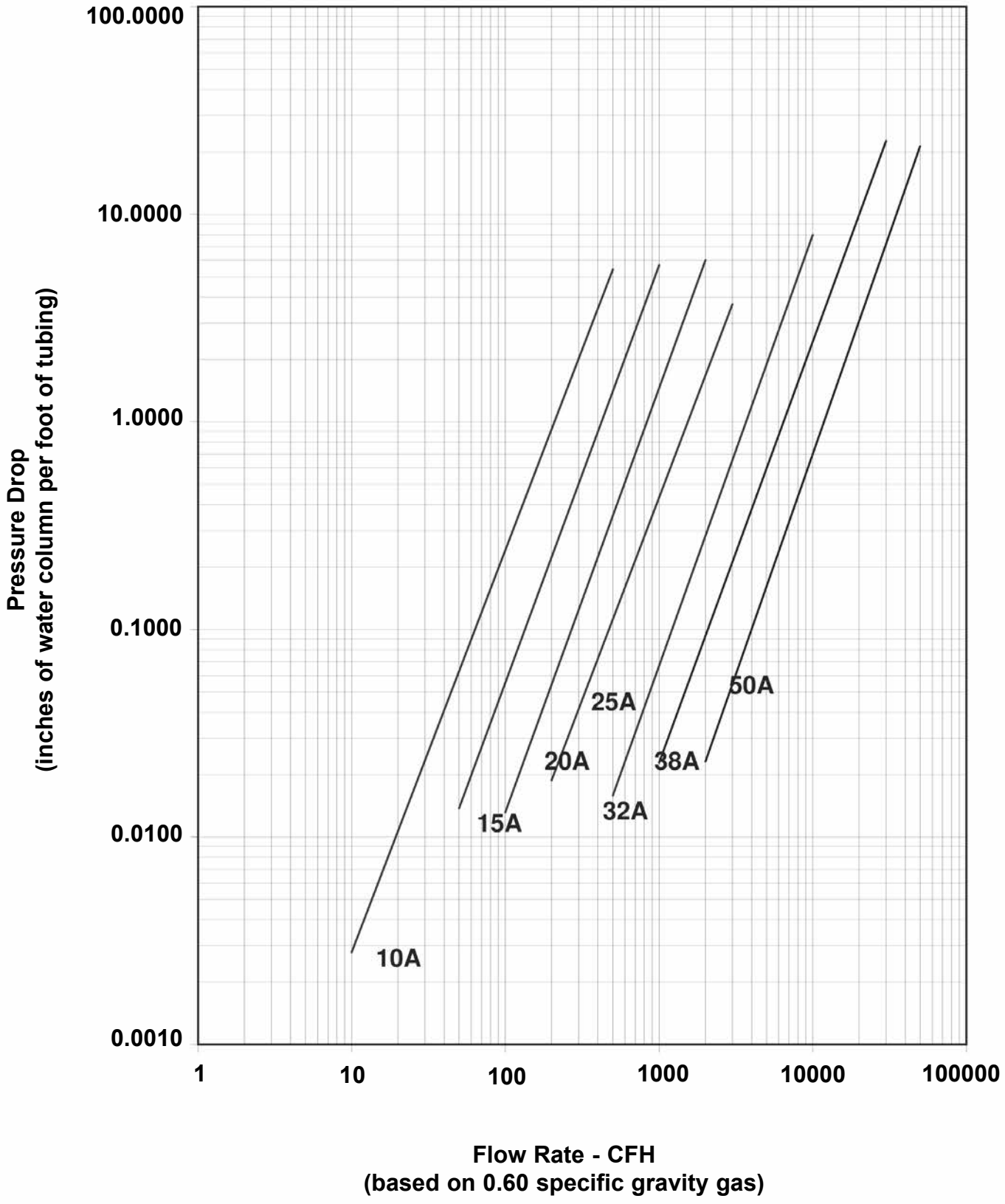
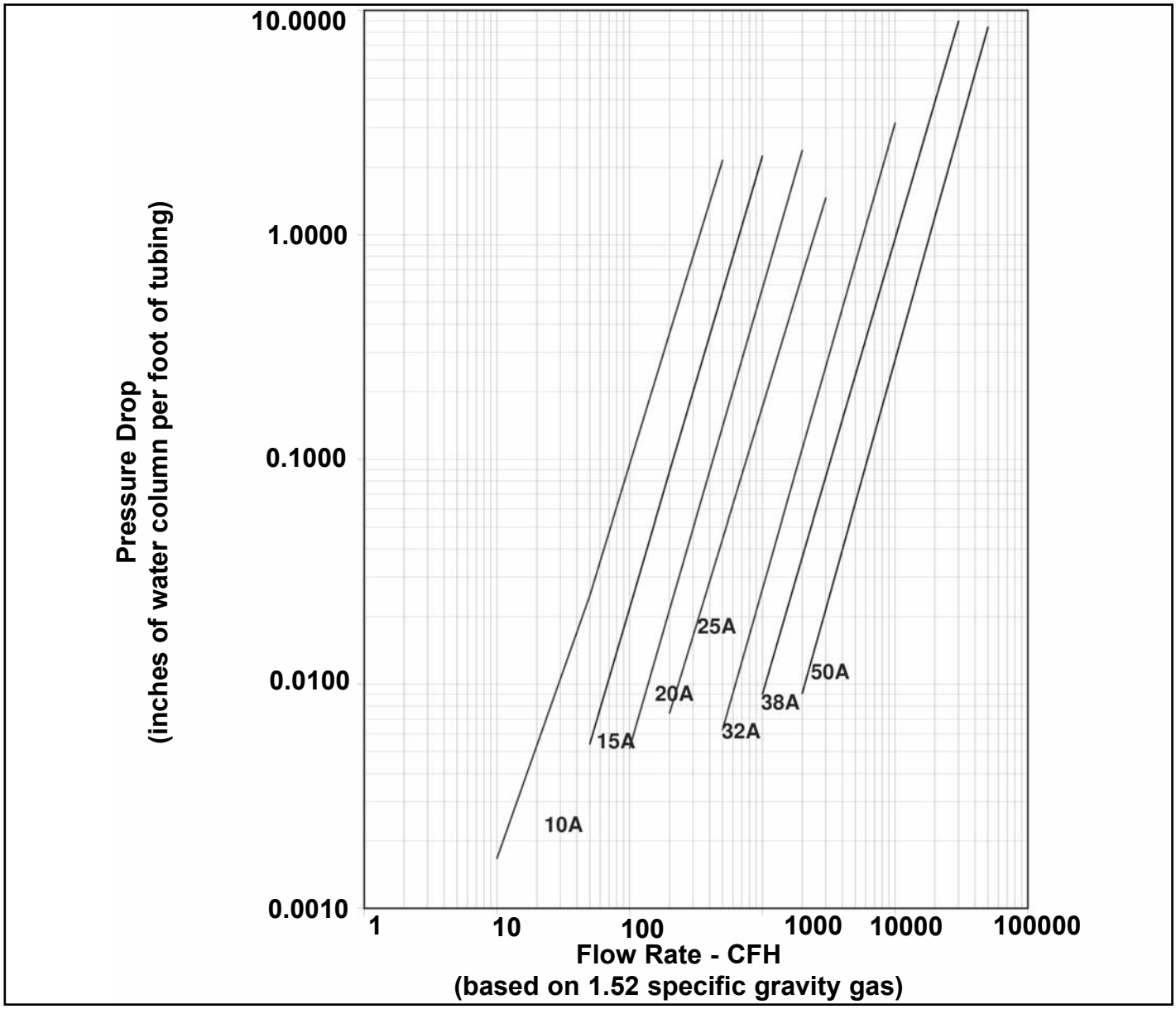


Table A-30 Propane Flow in CFH



Equivalent Lengths Factor for Fittings and Valves

For additional pipe sizing information concerning equivalent lengths in feet of corrugated stainless steel tubing for fittings and valves refer to the "National Fuel Gas Code" ANSI Z223.1 NFPA 54 In Canada, refer to the applicable sections of the CAN/CGA B149 Installation Codes. Apply the following coefficients to the equivalent length in feet of 1/2 in. nominal schedule 40 straight pipe to convert to corrugated tubing.

Table A-17 Equivalent Lengths Factor for Fittings and Valves

10A Tubing $L2^{1} = L1^{2} (0.08)n^{3}$
15A Tubing L2 = L1 (0.4)n
25A, 32A , 38A, 50A Tubing L2 = L1 (6.0)n
[1] L1 = Length in feet of 1/2 in. schedule 40 (standard weight) straight pipe (Table C.2.2).
[2] L2 = Equivalent length in feet of 10A/15, 15A/19, 20A/25, 25A/30, 32A/37, 38A/48 or 50A/62 tubing for fittings and valves.
[3] n = Number of fittings or valves.

CHAPTER 7 "INSPECTION, TESTING AND PURGING" OF THE NATIONAL GAS CODE, NFPA 54, ANSI Z223.1 In CANADA, refer to the applicable sections of the CAN/CGA B149 Installation codes.

National Fuel Gas Code

CHAPTER 4
Inspection, Testing and Purging

7.1 Pressure Testing and Inspection.

7.1.1* General.

7.1.1.1 Prior to acceptance and initial operation, all piping installations shall be inspected and pressure tested to determine that the materials, design, fabrication, and installation practices comply with the requirements of this code.

7.1.1.2 Inspection shall consist of visual examination, during or after manufacture, fabrication, assembly, or pressure tests as appropriate. Supplementary types of non-destructive inspection techniques, such as magnetic-particle, radiographic, and ultrasonic, shall not be required unless specifically listed herein or in the engineering design.

7.1.1.3 Where repairs or additions are made following the pressure test, the affected piping shall be tested. Minor repairs and additions are not required to be pressure tested provided that the work is inspected and connections are tested with a non-corrosive leak-detecting fluid or other leak-detecting fluid or other leak-detecting methods approved by the authority having jurisdiction.

7.1.1.4 Where new branches are installed from the point of delivery to new appliance(s), only the newly installed branch(es) shall be required to be pressure tested. Connections between the new piping and the existing piping shall be tested with a non-corrosive leak-detecting fluid or approved leak-detecting methods.

7.1.1.5 A piping system shall be tested as a complete unit or in sections. Under no circumstances shall a valve in a line be used as a bulkhead between gas in one section of the piping system and test medium in an adjacent section, unless two valves are installed in series with a valved "tell tale" located between these valves. A valve shall not be subjected test pressure unless it can be determined that the valve, including the valve closing mechanism, is designed to safely withstand the pressure.

7.1.1.6 Regulator and valve assemblies fabricated independently of the piping system in which they are to be installed shall be permitted to be tested with inert gas or air at the time of fabrication

7.1.2 Test Medium.

The test medium shall be air, nitrogen, carbon dioxide or an inert gas. OXYGEN SHALL NEVER BE USED.

7.1.3 Test Preparation.

7.1.3.1 Pipe joints, including welds, shall be left exposed for examination during the test.

Exception: If the pipe end joints have been previously tested in accordance with this code, they shall be permitted to be covered or concealed.

7.1.3.2 Expansion joints shall be provided with temporary restraints, if required, for the additional thrust load under test.

7.1.3.3 Appliances and equipment that is not to be included in the test shall be either disconnected from the piping or isolated by blanks, blind flanges, or caps. Flanged joints at which blinds are inserted to blank off other equipment during the test shall not be required to be tested.

7.1.3.4 Where the piping system is connected to appliances, equipment or equipment components designed for operating pressures of less than the test pressure, such appliances, equipment or equipment components shall be isolated from the piping system by disconnecting them and capping the outlet(s).

7.1.3.5 Where the piping system is connected to appliances, equipment, or equipment components designed for operating pressures equal to or greater than the test pressure, such appliances and equipment shall be isolated from the piping system by closing the individual equipment shutoff valve(s).

7.1.3.6 All testing of piping systems shall be done with due regard for the safety of employees and the public during the test. Bulkheads, anchorage and bracing suitably designed to resist test pressures shall be installed if necessary. Prior to testing, the interior of the pipe shall be cleared of all foreign material.

7.1.4 Test Pressure.

7.1.4.1 Test pressure shall be measured with a manometer or with a pressure measuring device designed and calibrated to read, record, or indicate a pressure loss due to leakage during the test period. The source of pressure shall be isolated before the pressure tests are made. Mechanical gauges used to measure test pressures shall have a range such that the highest end of the scale is not greater than 5 times the test pressure.

7.1.4.2 The test pressure to be used shall be no less than 1 1/2 times the proposed maximum working pressure, but not less than 3 psi (20 kPa), irrespective of design pressure. Where the test pressure exceeds 125 psi (862 kPa), the test pressure shall not exceed a value that produces a hoop stress in the piping greater than 50 percent of the specified minimum yield strength of the pipe.

7.1.4.3 Test Duration Test duration shall not be less than 1/2 hour for each 500 cubic feet (14 m^3) of pipe volume or fraction thereof. When testing a system having a volume less than 10 cubic feet (0.28m^3) or a system in a single-family dwelling, the test duration shall be permitted to be reduced to 10 minutes. For piping systems having a volume of more than 24,000 cubic feet (680 m^3), the duration of the test shall not be required to exceed 24 hours.

7.1.5 Detection of Leaks and Defects.

7.1.5.1 The piping system shall withstand the test pressure specified without showing any evidence of leakage or other defects. Any reduction of test pressures as indicated by pressure gages shall be deemed to indicate the presence of a leak unless such reduction can be readily attributed to some other cause.

7.1.5.2 The leakage shall be located by means of an approved gas detector, a non-corrosive leak detection fluid, or other approved leak detection methods. ***Matches, candles, open flames, or other methods that provide a source of ignition shall not be used.***

7.1.5.3 Where leakage or other defects are located, the affected portion of the piping system shall be repaired or replaced and retested. *(See General 7.1.1.3).*

7.2 System and Equipment Leakage Test.

7.2.1 Test Gasses. Fuel gas shall be permitted to be used for leak checks in piping systems that have been tested in accordance with Section 7.1.

7.2.2 Before Turning Gas On. Before gas is introduced into a system of new gas piping, the entire system shall be inspected to determine that there are no open fittings or ends and that all manual valves at outlets on equipment are closed and all unused valves at outlets are closed and plugged or capped.

7.2.3* Test for Leakage. Immediately after the gas is turned on into a new system or into a system that has been initially restored after an interruption of service, the piping system shall be tested for leakage. If leakage is indicated, the gas supply shall be shut off until the necessary repairs have been made.

7.2.4 Placing Equipment in Operation. Gas utilization equipment shall not be placed in operation until after the piping system has been tested in accordance with 7.2.3 and purged in accordance with 7.3.2.

7.3* Purging.

7.3.1 Removal from Service. When gas piping is to be opened for servicing, addition or modification, the section to be worked on shall be turned off from the gas supply at the nearest convenient point, and the line pressure vented to the outdoors, or to ventilated areas sufficient size to prevent accumulation of flammable mixtures.

If this section exceeds the lengths shown in Table 7.3.1, the remaining gas shall be displaced with an inert gas.

Table 7.3.1 Length of Piping Requiring Purging Before Placing in Operation

For Si units: 1 foot = 0.305 m

Nominal Pipe Size, Inches	Minimum Length of Piping Requiring Purging
2 1/2″	50 feet
3″	30 feet
4″	15 feet
6″	10 feet
8″ or Larger	Any Length

7.3.2 Placing in Operation

When piping full of air is placed in operation, the air in the piping shall be displaced with fuel gas, except where such piping is required by Table 7.3.2 to be purged with an inert gas prior to introduction of fuel gas. The air can be safely displaced with fuel gas provided that a moderately rapid and continuous flow of fuel gas is introduced at one end of the line and air is vented out at the other end. The fuel gas flow shall be continued without interruption until the vented gas is free of air. The point of discharge shall not be left unattended during purging. After purging, the vent shall then be closed. Where required by Table 7.3.2, the air in the piping shall first be displaced with an inert gas, and the inert gas shall be displaced with fuel gas.

Table 7.3.2 Length of Piping Requiring Purging Before Placing in Operation

For Si units: 1 foot = 0.305 m

Nominal Pipe Size, Inches	Minimum Length of Piping Requiring Purging
3″	30 feet
4″	15 feet
6″	10 feet
8″ or Larger	Any Length

7.3.3 Discharge of Purged Gases.

The open end of piping systems being purged shall not discharge into confined spaces or areas where there are sources of ignition unless precautions are taken to perform this operation in a safe manner by ventilation of the space, control of purging rate, and elimination of all hazardous conditions.

7.3.4 Placing Equipment in Operation.

After the piping has been placed in operation, all equipment shall be purged and then placed in operation, as necessary.

NOTICE An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Appendix A of the Natural Fuel Gas Code.

Notes:

WARDFLEX®

WARDFLEX® II

WARRANTY

WARDFLEX®/WARDFLEX® II Gas Piping System

Ward Manufacturing, LLC ("SELLER") warrants that its WARDFLEX® and WARDFLEX® II Gas Piping System products ("Product" or "Products") will conform to SELLER'S applicable specifications and will be free from defects in materials and workmanship. The exclusive and sole remedy for any claim shall be a refund of the amount of the purchase price paid for the Product in respect of which damages are claimed, and in no event shall SELLER'S liability for any claim be greater than that amount. No charge for labor or expense required to repair defective goods will be allowed. EXCEPT AS EXPRESSLY PROVIDED HEREIN, SELLER MAKES NO EXPRESS OR IMPLIED WARRANTY, INCLUDING, WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

This warranty shall not apply to any products that are not installed in accordance with the applicable WARDFLEX®/WARDFLEX® II Design and Installation Guide, or that are altered, repaired or misused, through negligence or otherwise, in a manner that, in the reasonable opinion of SELLER, adversely affects the reliability or performance of the Product. Nor does this warranty cover replacements or repairs necessitated by loss or damage resulting from any cause beyond the reasonable control of SELLER, including, but not limited to, acts of God, acts of government, acts of war, floods or fire.

This warranty shall begin upon the original date of occupancy of a new building in which the Product is installed and shall extend for a period of two (2) years to the original owner, provided that the Product was installed by a qualified professional who is licensed to install gas piping and who has completed a WARDFLEX® training class.

For Product installations other than new construction, this warranty shall begin from date of purchase of the Product from the SELLER'S stocking distributor and shall extend for a period of two (2) years. If proof of purchase cannot be verified, the warranty will extend from the manufacturing date code listed on the installed Product(s) for a period of two (2) years.

The forgoing is in lieu of any other expressed, implied or statutory warranties, and SELLER neither assumes nor authorizes any person to assume for SELLER any other obligation or liability in connection with the sales of its Products. UNDER NO CIRCUMSTANCES SHALL SELLER BE LIABLE FOR ANY INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES.

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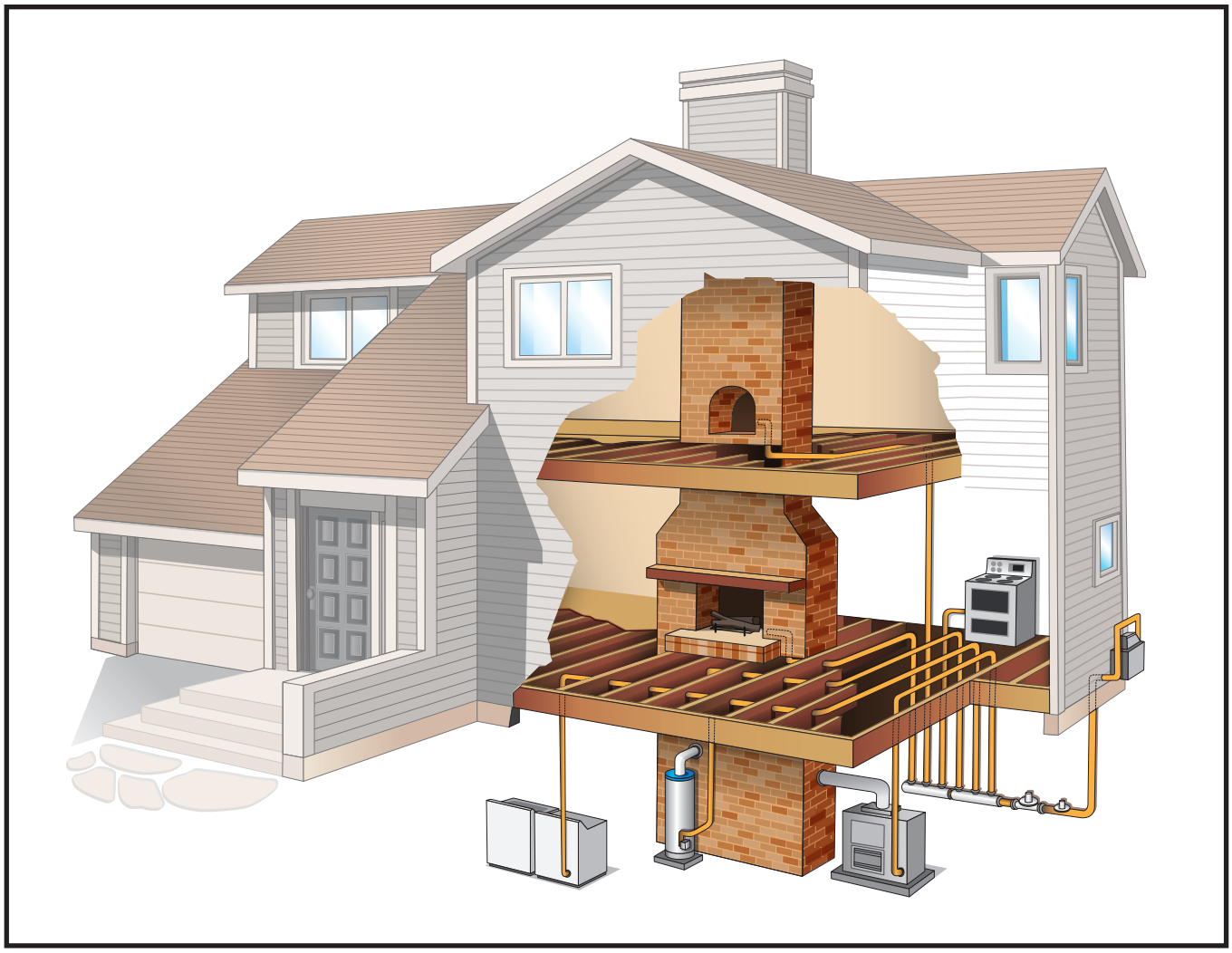

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