

WARD *Flex*

WARD *Flex II*

2014 DESIGN & INSTALLATION GUIDE

WFDI-072014 JULY, 2014



WARD Flex®

WARD Flex II

DESIGN AND INSTALLATION GUIDE

CORRUGATED STAINLESS STEEL TUBING FUEL GAS* PIPING

*Includes Natural Gas and Propane

WARD MFG

P.O. BOX 9
BLOSSBURG, PA. 16912
570 638-2131
WWW.WARDMFG.COM



Rev. 11 July 2014 ©Ward Manufacturing, LLC. All Rights Reserved.

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

IMPORTANT READ ENTIRE MANUAL

WARD Flex®

TABLE OF CONTENTS

1.0 Introduction	5
1.1 User Warnings	5
1.2 Limitations of Manual	6
1.3 Listing of Applicable Codes and Standards	6
2.0 Description of Systems and Components	7
2.1 System Description	7
2.1.1 WARDFLEX®/WARDFLEX®II Corrugated Stainless Steel Tubing (CSST)	7
WARDFLEX®/WARDFLEX®II Fittings Description	8
2.2 WARDFLEX®/WARDFLEX®II Components	9
2.2.1 WARDFLEX®/WARDFLEX®II Description & Sizes	9
2.2.2 Fittings	10
Mechanical Joints (Male Straight & Reducing, Female Straight & Reducing)	10
Couplings	11
Mechanical Tees (Straight & Reducing, Female Straight & Reducing)	11
Adapter Nut	12
Termination Fittings (Male Indoor and Outdoor, Female Indoor and Outdoor)	12
Floor Flange Termination Assemblies Male	12
2.2.3 Protection Devices	13
Striker Plates	13
Stripwound Conduit	13
2.2.4 Pressure Regulators	13
2.2.5 Manifolds	14
2.2.6 Shutoff Valves	15
2.2.7 Other Components	16
Appliance, Meter and Fireplace Stubouts	16
Manifold Bracket	16
Right Angle Mounting Bracket	17
Gas Outlet Box	17
Quick Connects	17
Bonding Clamps	17
3.0 System Configuration and Sizing	18
3.1 System Overview	18
3.1.1 Introduction	18
3.1.2 System Design	18
3.2 System Configurations	18
3.2.1 Introduction	18
3.2.2 Series Systems	19
3.2.3 Parallel Systems	19
3.2.4 Dual Pressure Systems	20
3.2.5 Hybrid Systems	20
3.2.6 Elevated Pressure System	21
3.3 System Sizing	21
3.3.1 Introduction	21
3.3.2 Longest Length Method	21
Low Pressure Parallel System Example	22
Low Pressure Series System Example	23
Dual Pressure Parallel System	24
Hybrid System Example	25
3.3.3 Summation Sizing Method	26
Low Pressure Example	26
3.3.4 Wardflex Sizing Software	27
4.0 Installation Practices	28
4.1 General Installation Practices	28
Bend Radius	28
Chemicals to Avoid	29
4.2 Fitting Assembly	30
4.2.1 WARDFLEX®/WARDFLEX®II Stepsaver Fitting	30
4.2.2 WARDFLEX®/WARDFLEX®II Fitting Reassembly	31
4.3 Tubing Routing	32
4.3.1 Vertical Runs	32
4.3.2 Horizontal Runs	32
4.3.3 Clearance Holes and Notching	32
4.3.4 Concealed Locations For Fittings	33
4.3.5 Modification to Existing System	34
4.3.6 Outdoor Installations	34
4.3.7 Fire Rated Construction	34
Firestop Listings	35
4.4 Protection	36
4.4.1 Introduction	36
4.4.2 Striker Plates	36
4.4.3 Stripwound Metal Conduit	39
4.4.4 Installation in Insulated Walls	40
4.5 Meter-Connections	41
4.5.1 Unsupported Meters	41
4.5.2 Self Supported Meter	42

TABLE OF CONTENTS

4.6	Appliance Connections.....	43
4.6.1	Moveable Appliances.....	43
4.6.2	Non-Moveable Appliance.....	44
4.6.3	Outdoor Appliances-Barbeque Grill and Gas Light Connection.....	44
4.6.4	Special Applications.....	45
	Roof Top Installations.....	45
	Infrared Heaters.....	46
	Pad Mounted Gas Appliances.....	47
4.6.5	Gas Fireplaces.....	48
4.7	Manifold Station.....	49
4.8	Pressure Regulators.....	50
4.8.1	Installation Requirements.....	50
4.8.2	Regulator Venting Requirements.....	51
	Vent Lines.....	51
4.8.3	Regulator Adjustment.....	52
4.8.4	Over Pressurization Protection.....	52
4.9	Underground Installations.....	52
4.9.1	General Information.....	52
	Burial Depths and Conduit Termination Height.....	53
4.10	CSST Electrical Bonding.....	54
5.0	Inspection, Repair and Replacement.....	56
5.1	Minimum Inspection Requirements (Checklist).....	56
5.2	Repair/Replacement of Damaged Tubing.....	56
6.0	Testing.....	58
6.1	Pressure Testing and Inspection Procedure.....	58
7.0	Sizing Tables (Natural and LP) Table of Contents.....	59
7.1	Natural Gas-Low Pressure.....	60-64
	Table A-1 Natural Gas-Low Pressure 0.5 PSI or less and Pressure Drop of 0.5 in.WC.....	60
	Table A-2 Natural Gas-Low Pressure 0.5 PSI or less and Pressure Drop of 1.0 in.WC.....	60
	Table A-3 Natural Gas-Low Pressure 0.5 PSI or less and Pressure Drop of 1.5 in.WC.....	61
	Table A-4 Natural Gas-Low Pressure 0.5 PSI or less and Pressure Drop of 2.0 in.WC.....	61
	Table A-5 Natural Gas-Low Pressure 0.5 PSI or less and Pressure Drop of 2.5 in.WC.....	62
	Table A-6 Natural Gas-Low Pressure 0.5 PSI or less and Pressure Drop of 3.0 in.WC.....	62
	Table A-7 Natural Gas-Low Pressure 0.5 PSI or less and Pressure Drop of 4.0 in.WC.....	63
	Table A-8 Natural Gas-Low Pressure 0.5 PSI or less and Pressure Drop of 5.0 in.WC.....	63
	Table A-9 Natural Gas-Low Pressure 0.5 PSI or less and Pressure Drop of 6.0 in.WC.....	64
7.2	Natural Gas-Elevated Pressure.....	65-67
	Table A-10 Natural Gas-Elevated Pressure 1.0 PSI and Pressure Drop of 13.0 in.WC.....	65
	Table A-11 Natural Gas-Elevated Pressure 2.0 PSI and Pressure Drop of 1.0 PSI.....	65
	Table A-12 Natural Gas-Elevated Pressure 2.0 PSI and Pressure Drop of 1.5 PSI.....	66
	Table A-13 Natural Gas-Elevated Pressure 5.0 PSI and Pressure Drop of 3.5 PSI.....	66
	Table A-14 Natural Gas-Elevated Pressure 10.0 PSI and Pressure Drop of 7.0 PSI.....	67
	Table A-15 Natural Gas-Elevated Pressure 25.0 PSI and Pressure Drop of 10.0 PSI.....	67
7.3	Propane Gas-Low Pressure.....	68-70
	Table A-16 Propane Gas-Low Pressure 0.5 PSI or less and Pressure Drop of 0.5 in.WC.....	68
	Table A-17 Propane Gas-Low Pressure 0.5 PSI or less and Pressure Drop of 1.0 in.WC.....	68
	Table A-18 Propane Gas-Low Pressure 0.5 PSI or less and Pressure Drop of 2.0 in.WC.....	69
	Table A-19 Propane Gas-Low Pressure 0.5 PSI or less and Pressure Drop of 2.5 in.WC.....	69
	Table A-20 Propane Gas-Low Pressure 0.5 PSI or less and Pressure Drop of 3.0 in.WC.....	70
	Table A-21 Propane Gas-Low Pressure 0.5 PSI or less and Pressure Drop of 6.0 in.WC.....	70
7.4	Propane Gas-Elevated Pressure.....	71-72
	Table A-22 Propane Gas-Elevated Pressure 2.0 PSI and Pressure Drop of 1.0 PSI.....	71
	Table A-23 Propane Gas-Elevated Pressure 5.0 PSI and Pressure Drop of 3.5 PSI.....	71
	Table A-24 Propane Gas-Elevated Pressure 10.0 PSI and Pressure Drop of 7.0 PSI.....	72
	Table A-25 Propane Gas-Elevated Pressure 25.0 PSI and Pressure Drop of 10.0 PSI.....	72
7.5	Steel Pipe Capacities.....	73
	Table A-26 Steel Pipe Capacities Pressure 0.5 PSI or less and Pressure Drop of 0.5 in.WC.....	73
	Table A-27 Steel Pipe Capacities Pressure 0.5 PSI or less and Pressure Drop of 1.0 in.WC.....	73
7.6	Pressure Drop Per Foot.....	74-83
	Table A-28 WARDFLEX/WARDFLEX II Pressure Drop per Foot.....	74-75
	Table A-29 SCHEDULE 40 Black Iron Pipe Pressure Drop per Foot.....	76-77
	Table A-30 Polyethylene Pipe Pressure Drop per Foot.....	78-79
	Table A-31 WARDFLEX/WARDFLEX II Pressure Drop per Foot Propane Gas.....	80-81
	Table A-32 SCHEDULE 40 Black Iron Pipe Pressure Drop per Foot Propane Gas.....	82-83
8.0	Definitions.....	84
8.1	Definitions of Terminology in this Guide.....	84-85
Appendix A	86
	Table A-33 Specific Gravity Correction Factors.....	86
	Table A-34 Natural Gas Flow in CFH.....	87
	Table A-35 Propane Flow in CFH.....	88
Appendix B	89



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

**This document is the sole property of WARD MANUFACTURING, LLC.
It shall not be copied or reproduced without the prior permission of
WARD MANUFACTURING, LLC.**



1.0 INTRODUCTION



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®II components 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.wardmfg.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 Liquefied Petroleum Gases
- 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
This document is the sole property of
WARD MANUFACTURING, LLC.
It shall not be copied or reproduced without the prior
permission of **WARD MANUFACTURING, LLC.**



2.0 DESCRIPTION OF SYSTEMS AND COMPONENTS

2.1 SYSTEM DESCRIPTION

2.1.1 WARDFLEX®/WARDFLEX® II SYSTEM DESCRIPTION

WARDFLEX® Tubing:

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 25 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 25 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 1/2 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	DESCRIPTION								
		TUBING Size	Item	10A	15A/15C	20A/20C	25A/25C	32A/32C	38A/38C	50A/50C
WARDFLEX® WARDFLEX® II Corrugated Stainless Steel Tubing (CSST)	Tubing: 304 Stainless Steel Jacket: Polyethylene	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	31	39	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") x 10M (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*) <small>*Outdoor models supplied with o-rings</small>	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*) <small>*Outdoor models supplied with o-rings</small>	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*) <small>*Outdoor models supplied with o-rings</small>	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 (pre-set 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	<ul style="list-style-type: none"> - 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	<ul style="list-style-type: none"> - 1/2 NPS x (4) 1/2 NPS Outlets - 3/4 NPS x (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 x 1 1/2 NPS x (4) 1 NPS Outlets 	

COMPONENT	MATERIAL	AVAILABLE SIZES	
Cross Manifolds (6 ports)	Body: Malleable Iron	<ul style="list-style-type: none"> - 1/2 NPS x (6) 1/2 NPS Outlets - 3/4 NPS x (4) 1/2 NPS & (2) 3/4 NPS Outlets - 1 x 3/4 NPS x (4) 1/2 NPS & (2) 3/4 NPS Outlets - 1 1/4 x 1 NPS x (4) 1/2 NPS & (2) 3/4 NPS Outlets 	


2.2.6 SHUTOFF VALVES


COMPONENT	MATERIAL	AVAILABLE SIZES	
AGA/CSA 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 - 20M (3/4") x 1/2 - 20M (3/4") x 3/4	

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	

3.0 SYSTEM CONFIGURATION AND SIZING

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.WARDMFG.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.

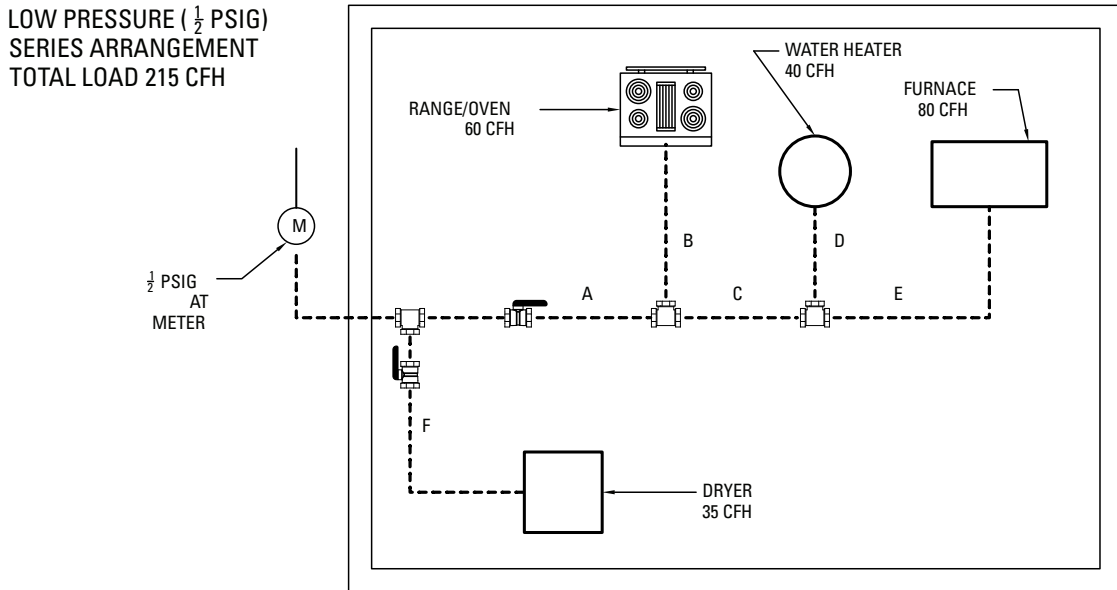


FIGURE 3.1

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.

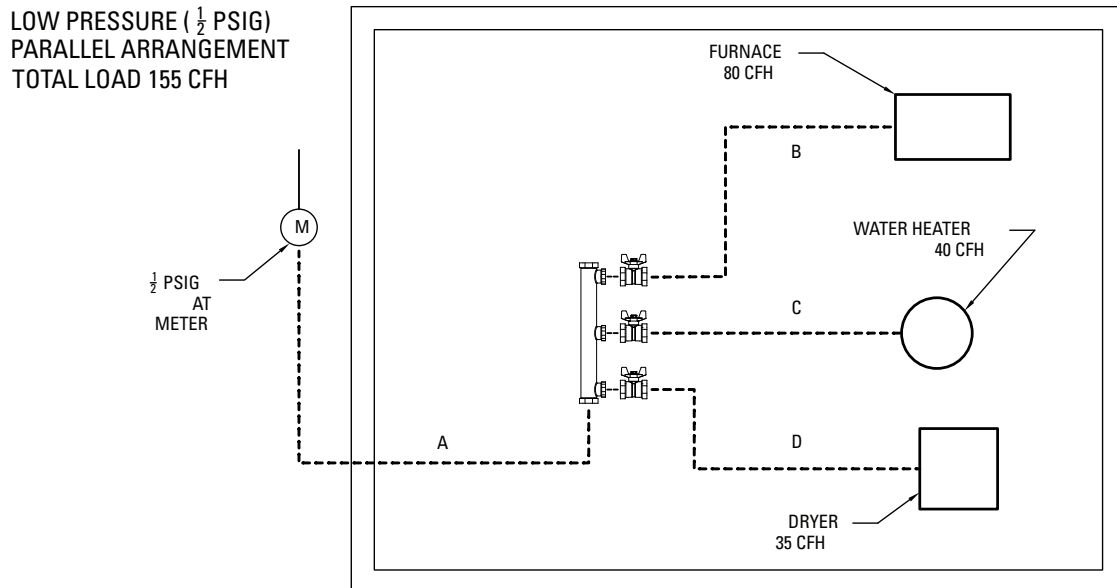


FIGURE 3.2

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.

HIGH PRESSURE (2 PSIG)
PARALLEL ARRANGEMENT
TOTAL LOAD 215 CFH

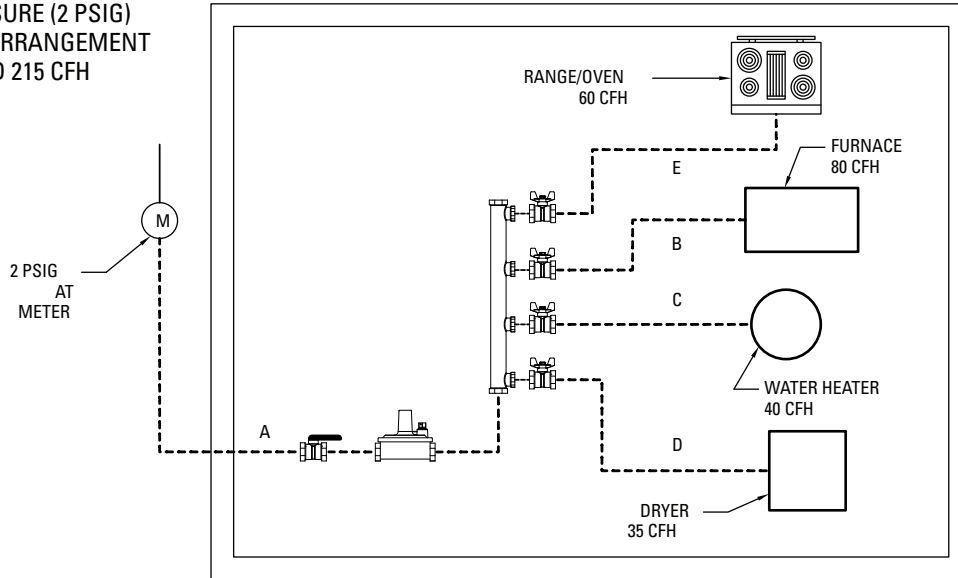


FIGURE 3.3

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.

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

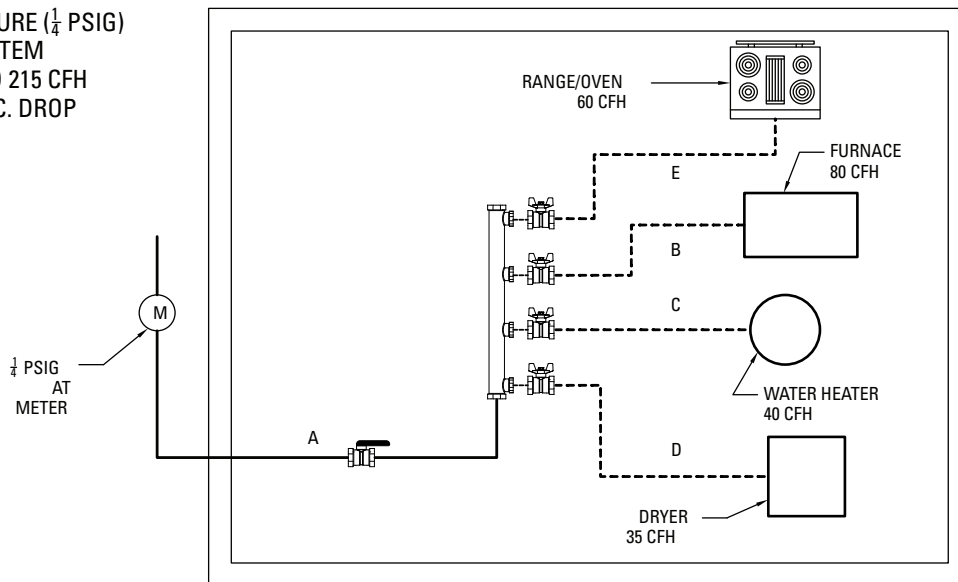


FIGURE 3.4

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.

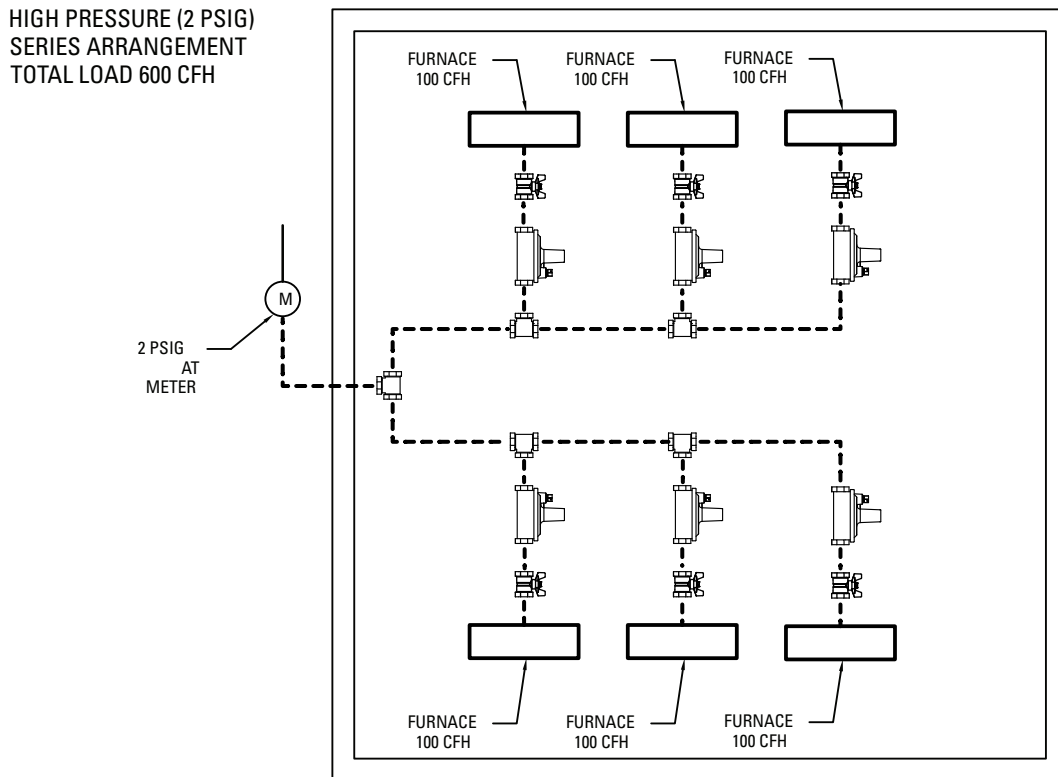


FIGURE 3.5

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.

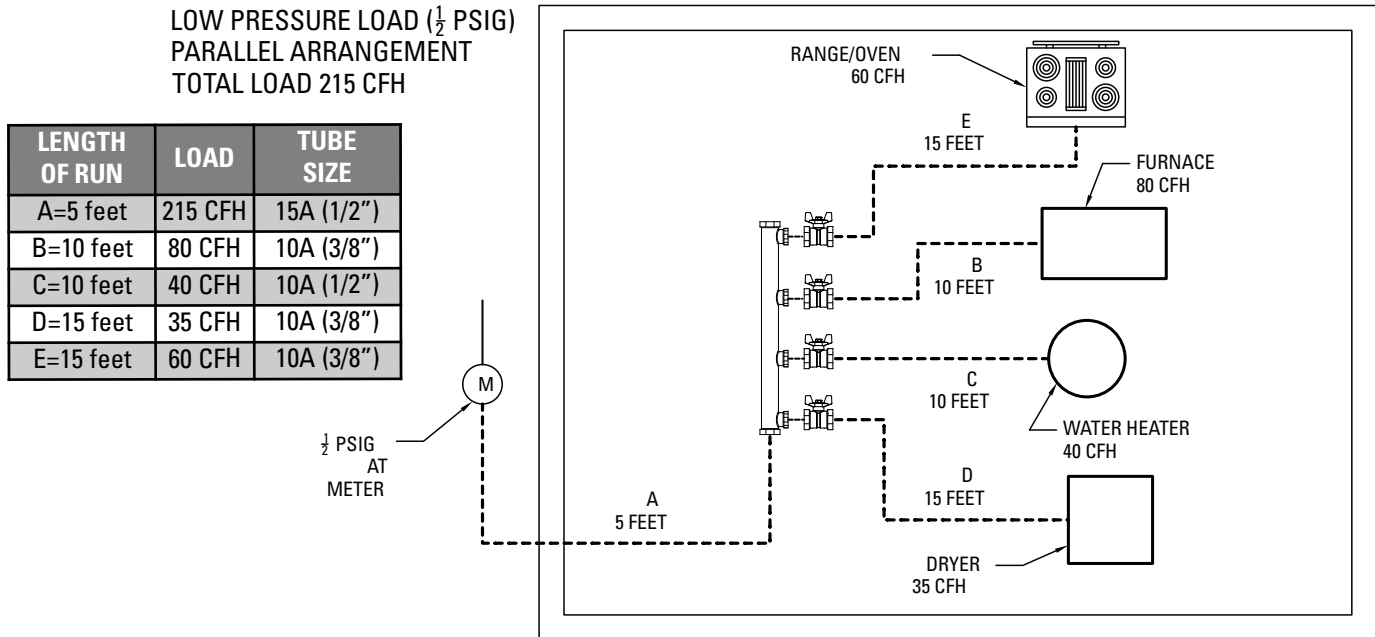


FIGURE 3.6

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")

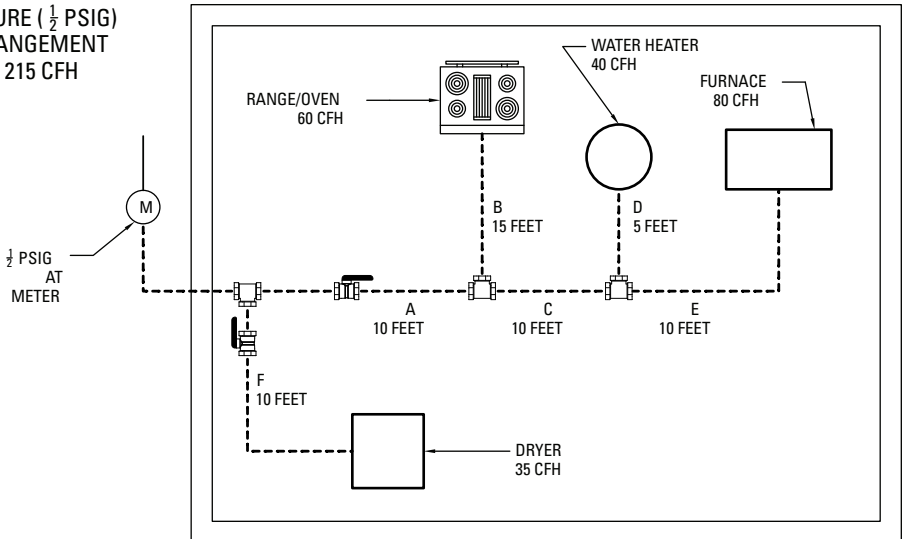


FIGURE 3.7

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 192 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.

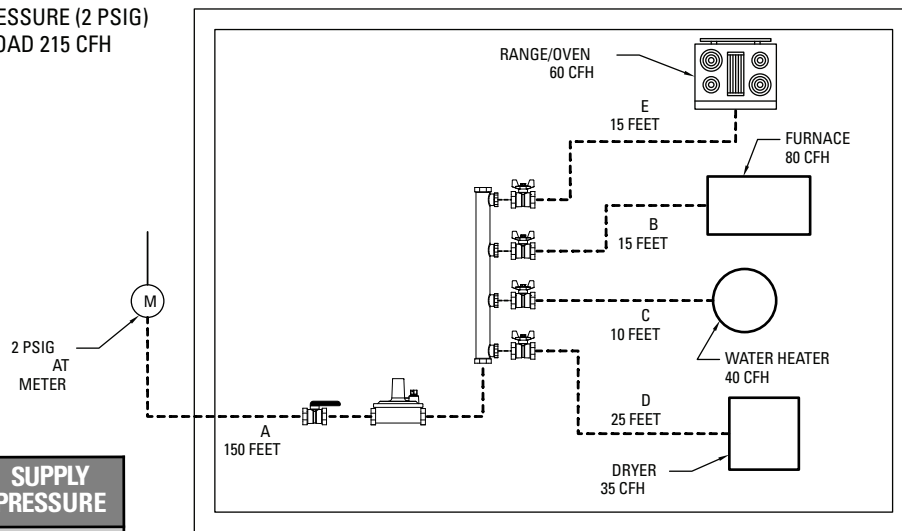
6. Size Section "F"

- 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.

HIGH PRESSURE (2 PSIG)
TOTAL LOAD 215 CFH



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.

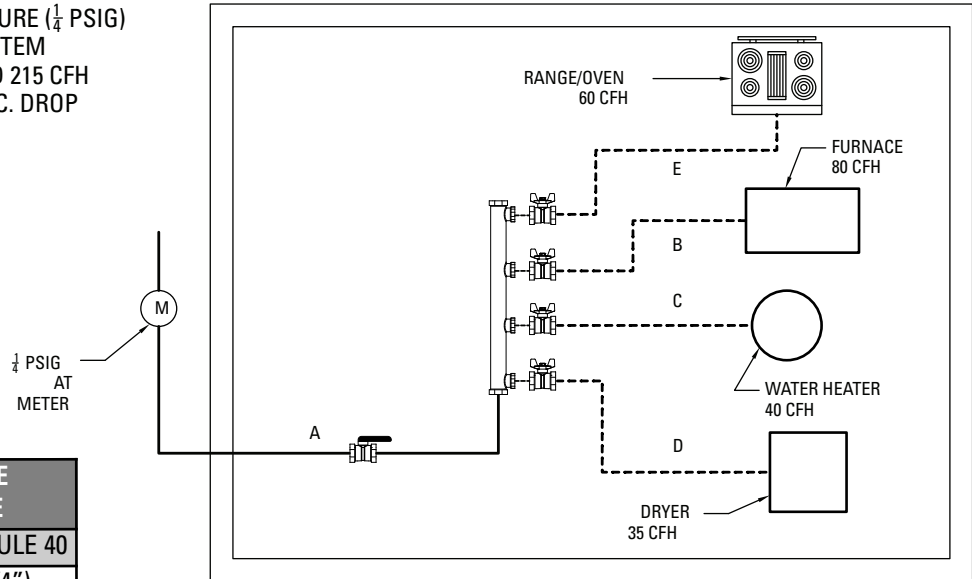
5. Size Section "E"

- 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-26 will be used for the black pipe section.

LOW PRESSURE (¼ 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-26 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.

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-28 through Table A-32 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:

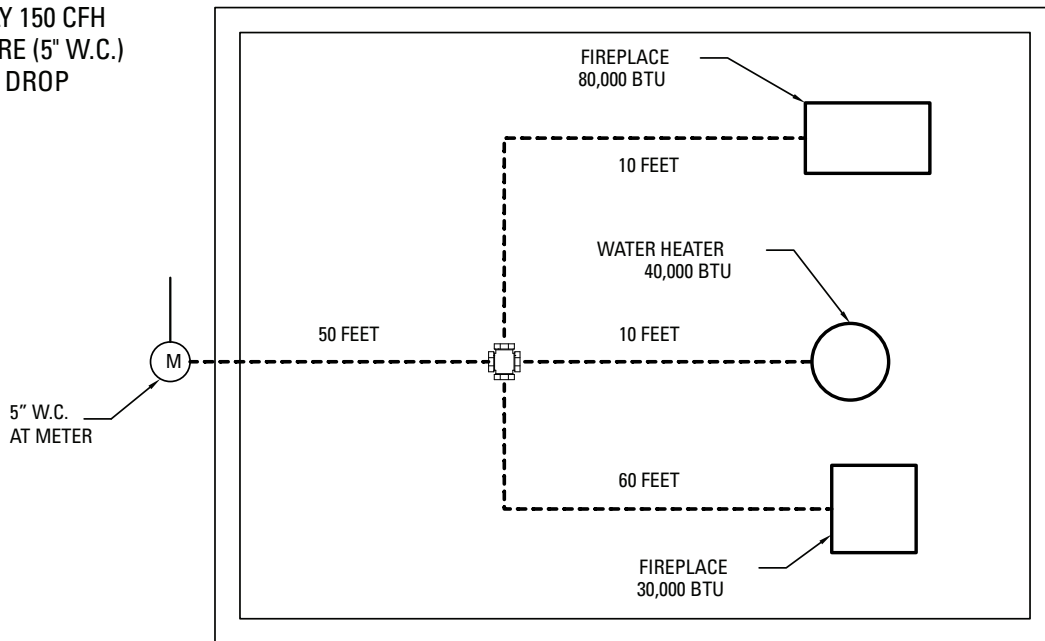
1. Make a sketch containing the load and lengths for your system.
2. Find the desired flow in the left hand column of Table A-28.
3. Now locate the desired tubing size in the top row of the table.
The point at which these two intersect is your pressure drop per foot of the selected tubing size.
4. Multiply 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.

TOTAL SUPPLY 150 CFH
LOW PRESSURE (5" W.C.)
0.5 INCH W.C. 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 3/2" @150 CFH is .001
- Multiply that by the length of the section
- Pressure drop for this section is .050 (50' x .001)

2. Size the Furnace Line

- Pressure drop per foot for 1/2" @ 80 CFH is .035
- Multiply that by the length of the section
- Pressure drop for this section is .350 (10' x .035)

3. Size the Water Heater Line

- Pressure drop per foot for 1/2" @ 40 CFH is .009
- Multiply that by the length of the section
- Pressure drop for this section is .090 (10' x .009)

4. Size the Fireplace Line

- Pressure drop per foot for 1/2" @30 CFH is .005
- Multiply that by the length of the section
- Pressure drop for this section is .300 (60' x .005)

5. Add the Main line pressure drop to the pressure drop of the individual appliance lines

- Pressure drop at Furnace = .400 (.050+.350)
- Pressure drop at Water Heater = .140 (.050+.090)
- Pressure drop at Fireplace = .350 (.050+.300)

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.

4.0 INSTALLATION PRACTICES

4.1 GENERAL INSTALLATION PRACTICES

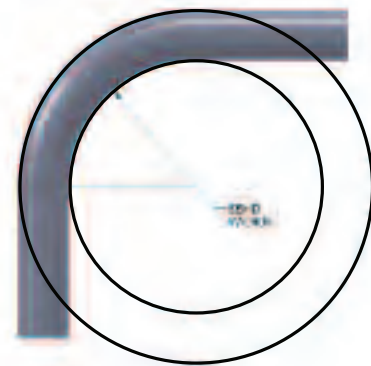
ATTENTION:

WARDFLEX® AND WARDFLEX® II ARE ENGINEERED FUEL GAS PIPING SYSTEMS AND AS SUCH, THE TUBING AND FITTINGS ARE NOT INTERCHANGEABLE WITH OTHER CSST MANUFACTURERS 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 prior 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 algacide)
- 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 1/2" 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.

- Holes drilled in vertical members of the wall framing should not exceed 1/4 the width of the member.
- Holes drilled in plates and other horizontal frame members should not exceed 1/2 the width of the member.
- 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.
- 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.
- 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.

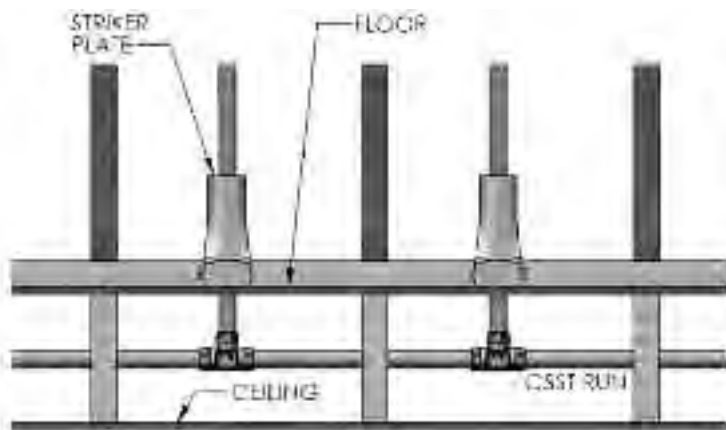


Figure 4.3 Multiple gas outlets connected to the same run of WARDFLEX®/ WARDFLEX® II. In this situation a tee-type fitting can be used and installed in a concealed location.

Figure 4.3

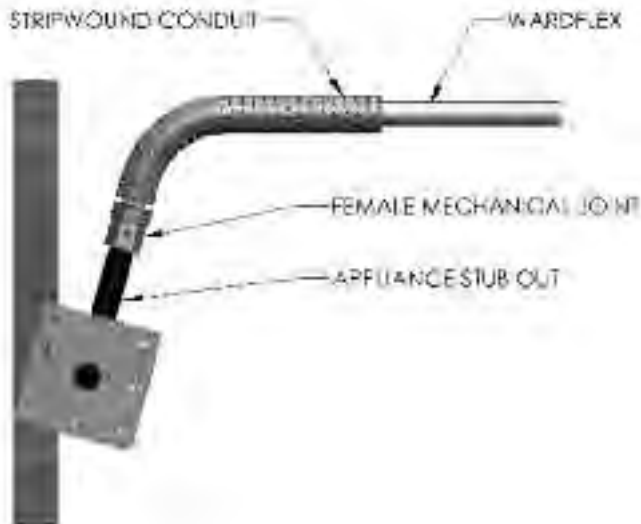


Figure 4.4 Appliance stub out with a WARDFLEX®/ WARDFLEX® II female mechanical fitting which can be installed in a concealed location. For this type of arrangement refer to section 4.4 on for protection details.

Figure 4.4

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 EXISTING 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

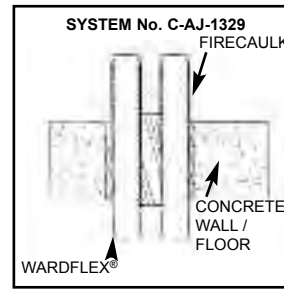
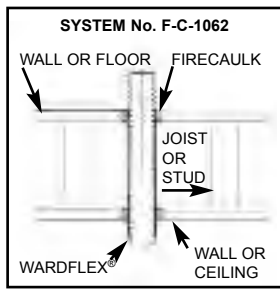
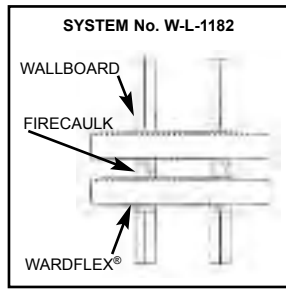
Per ANSI LC-1/CSA 6.26 WARDFLEX®/WARDFLEX® II CSST products are approved for installation where exposure to outdoor environments can occur. The following guidelines shall be followed when installing WARDFLEX®/WARDFLEX® II outdoors to protect tubing and fittings from the effects of weather.

- 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.

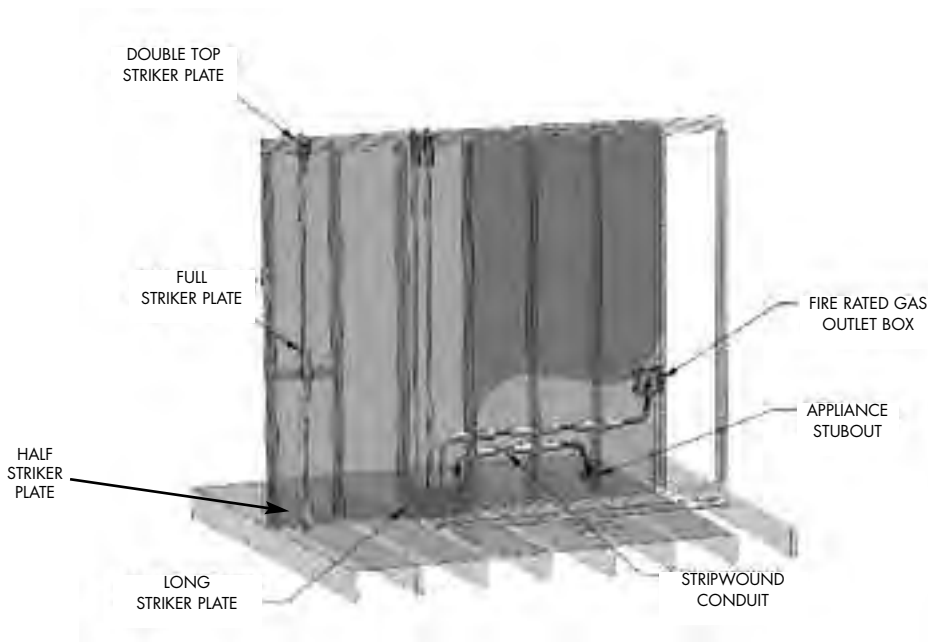


Figure 4.5

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.

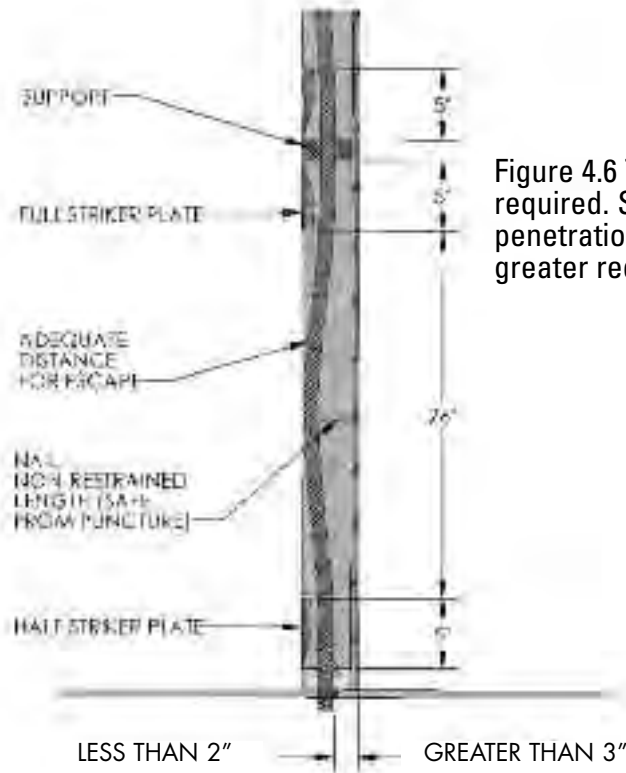


Figure 4.6 Typical locations where striker plates are required. Striker plates are installed at both horizontal penetrations unrestrained vertical runs of 26 inches or greater require no additional protection.

Figure 4.6

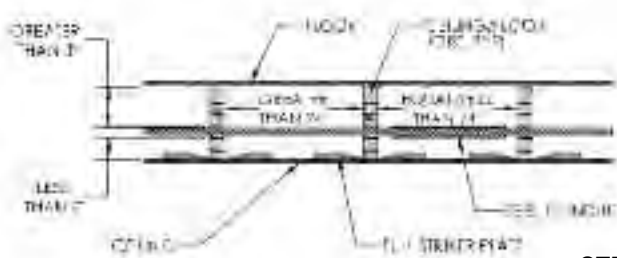


Figure 4.7

STRIPWOUND METAL CONDUIT

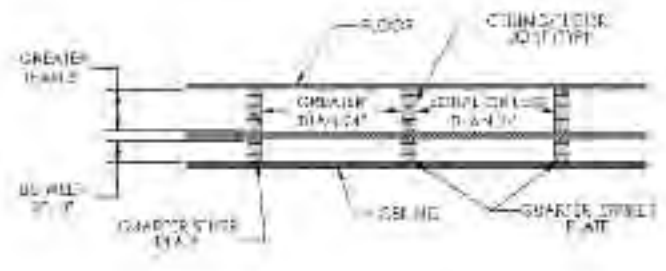


Figure 4.8

- 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.

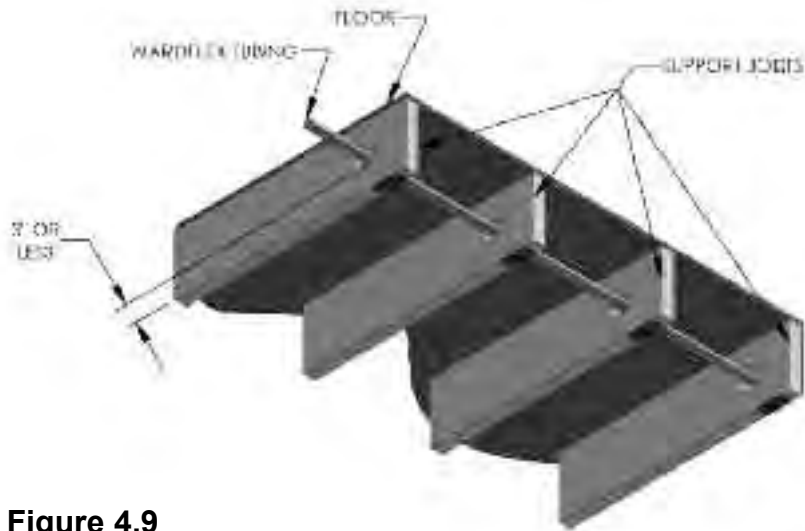


Figure 4.9

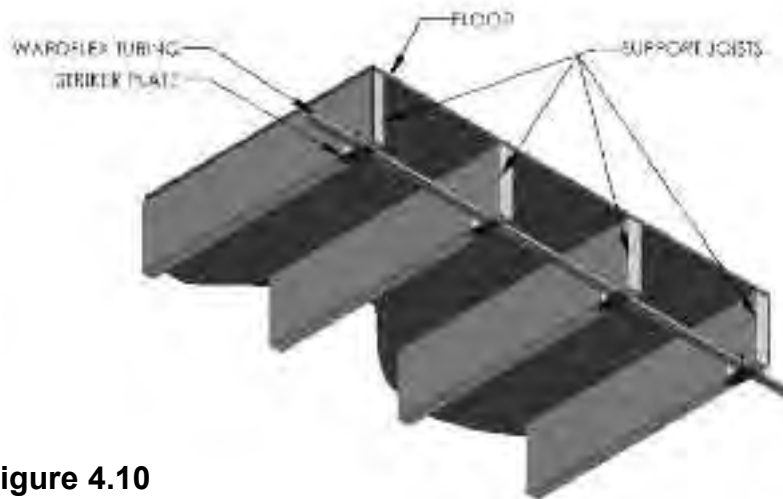


Figure 4.10

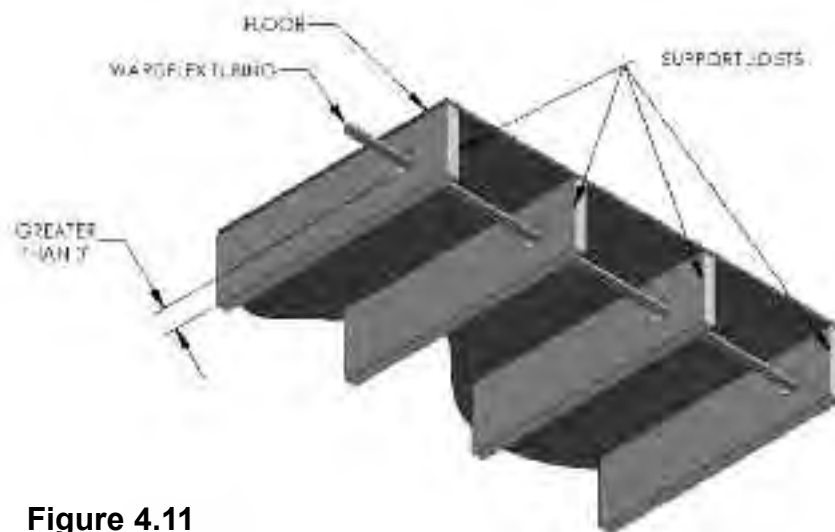


Figure 4.11

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.

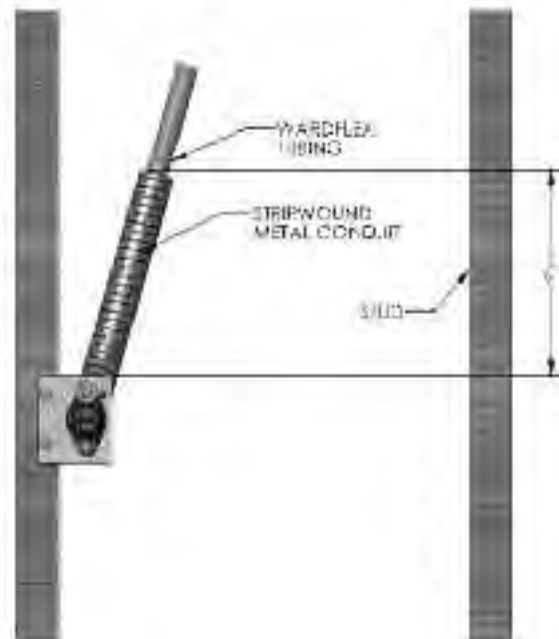


Figure 4.12

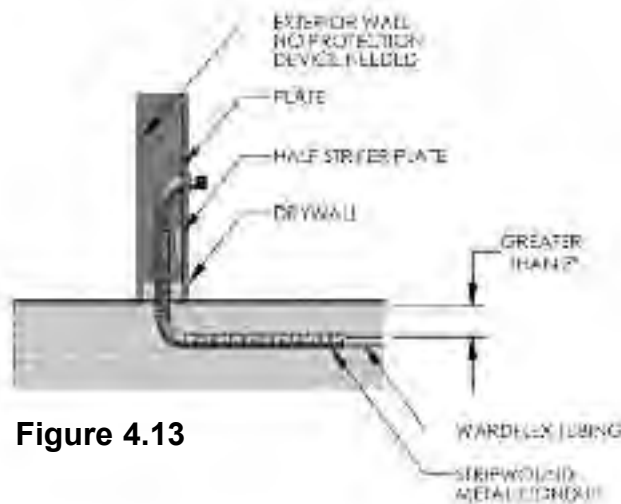


Figure 4.13

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.

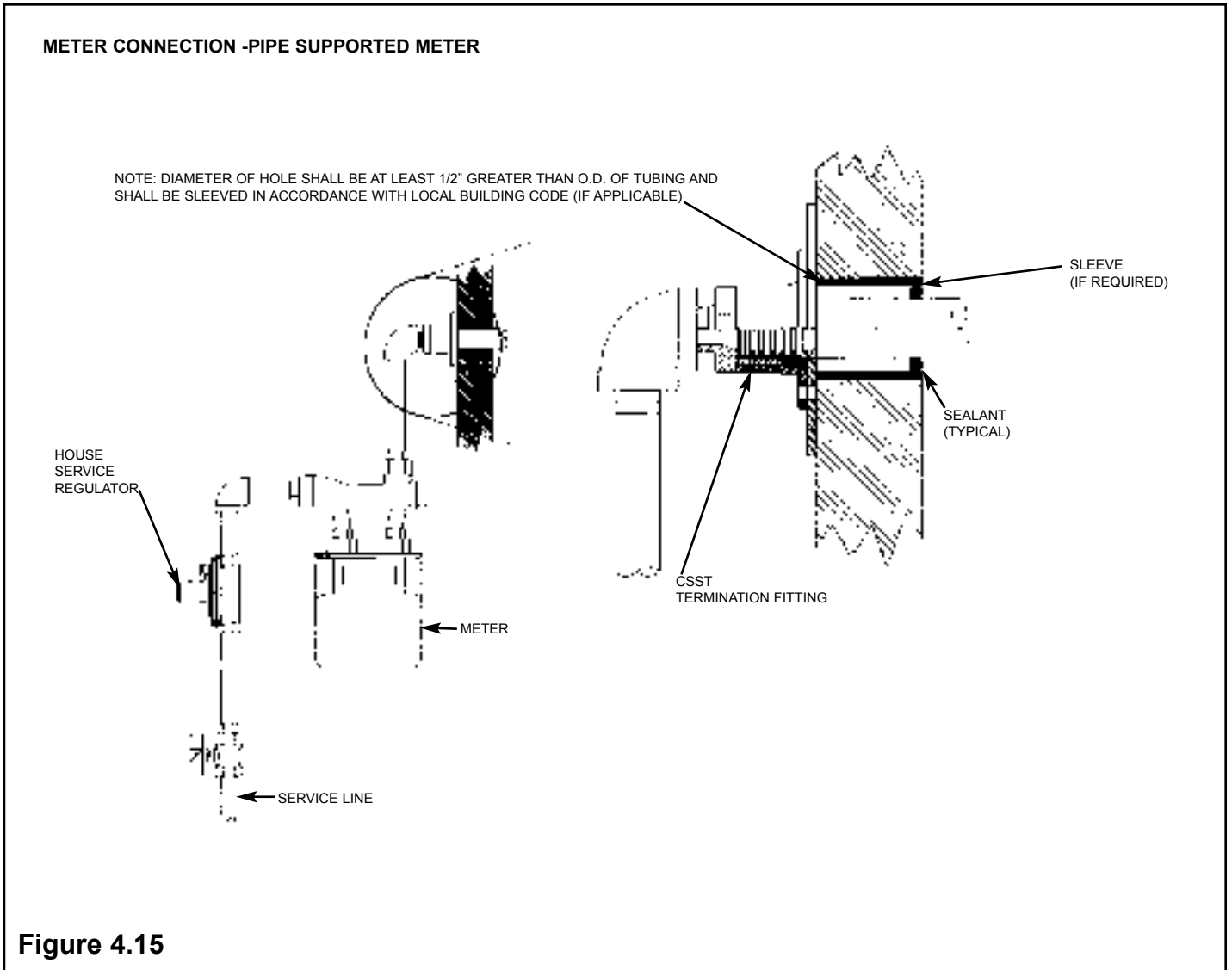


Figure 4.15

**METER CONNECTION -
PIPE SUPPORTED METER**

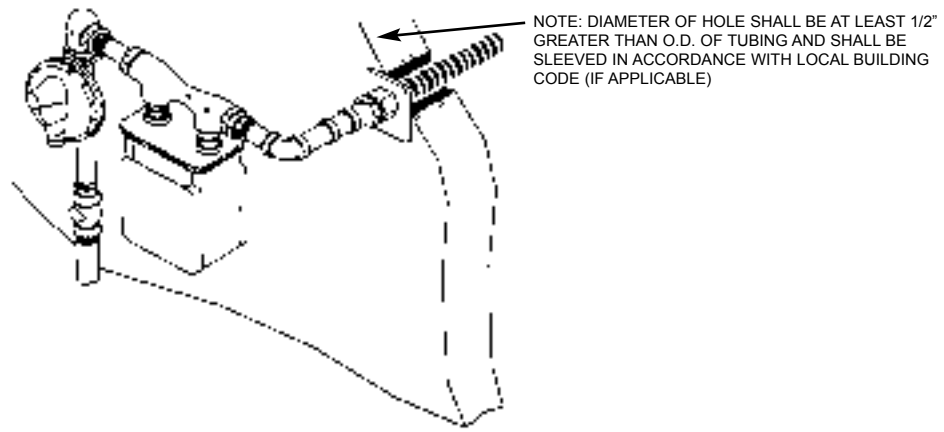


Figure 4.16

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.

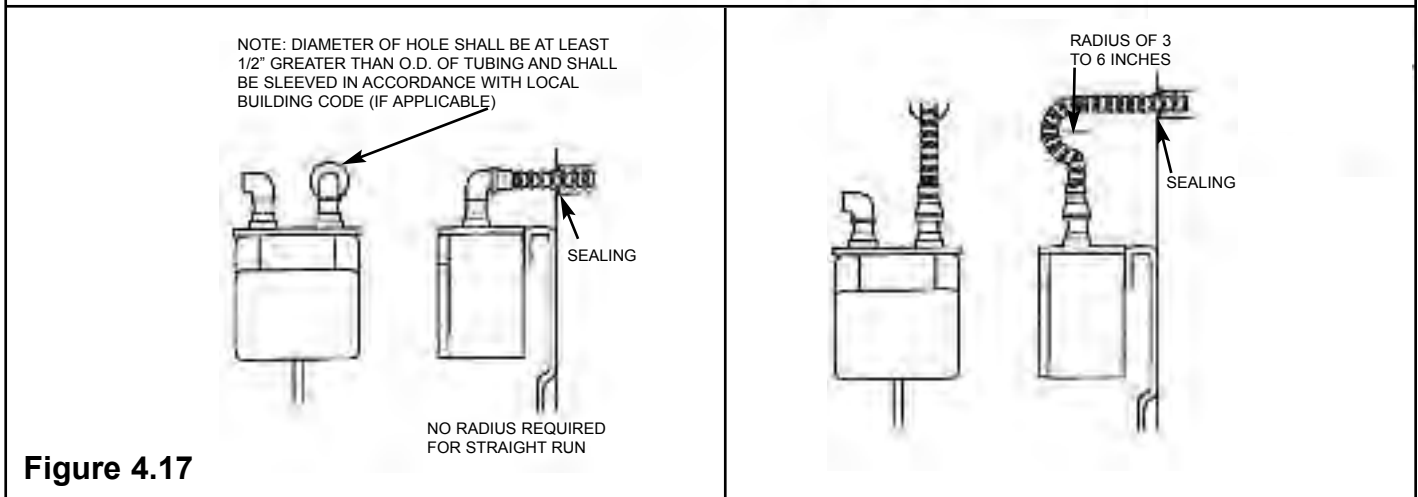
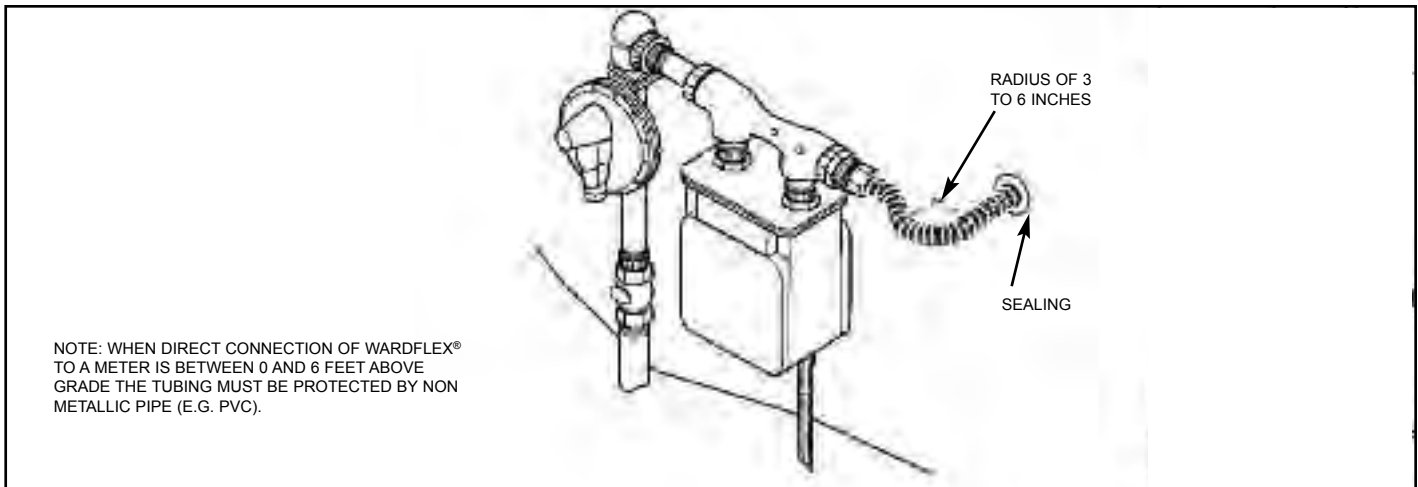


Figure 4.17

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.

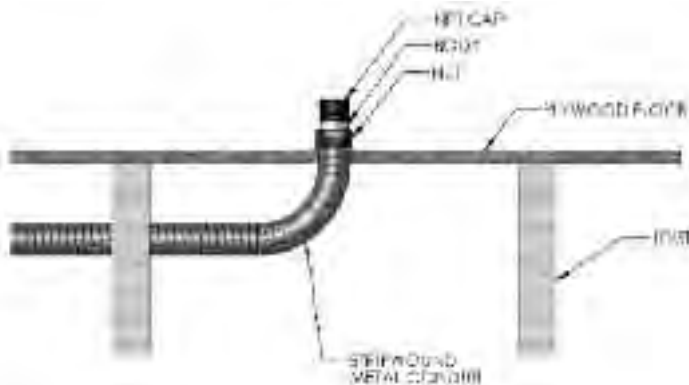


Figure 4.18

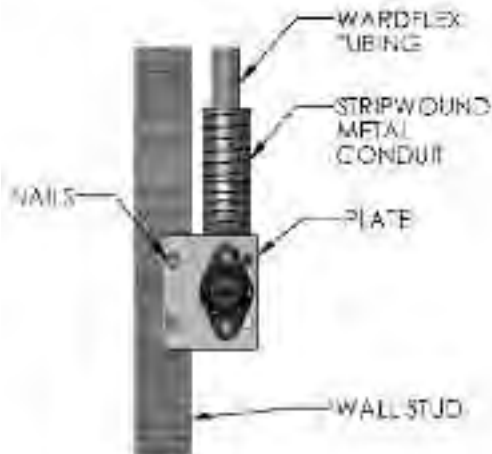


Figure 4.20

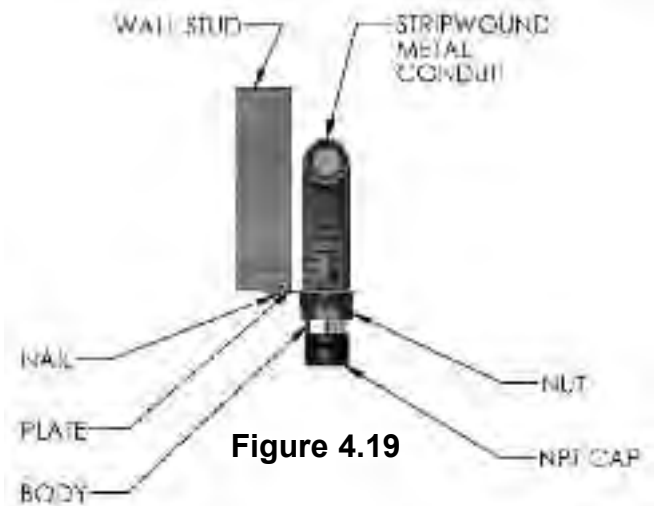


Figure 4.19

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.

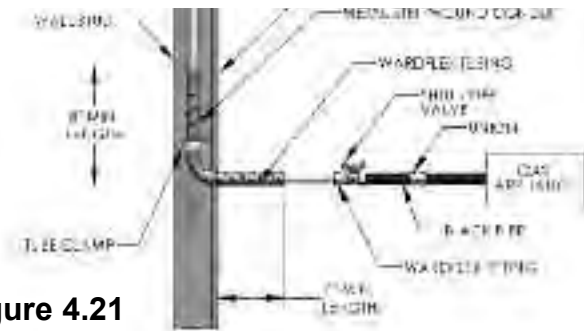


Figure 4.21

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 APPLIANCES-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.

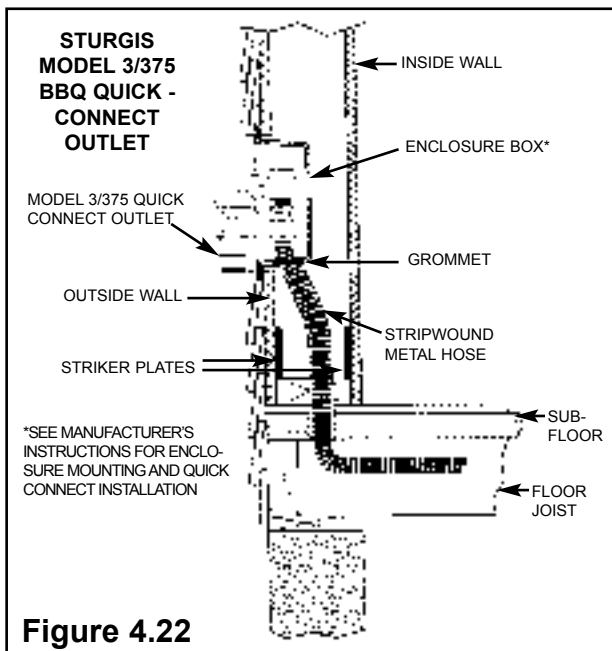


Figure 4.22

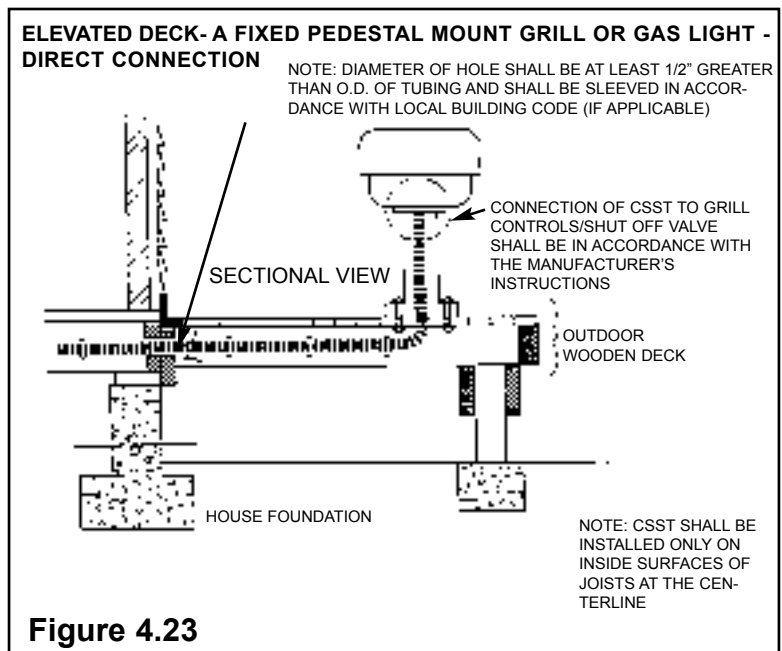


Figure 4.23

**GROUND LEVEL GAS
LIGHT/PEDESTAL
BBQ GRILL - BURIED
CONNECTION**

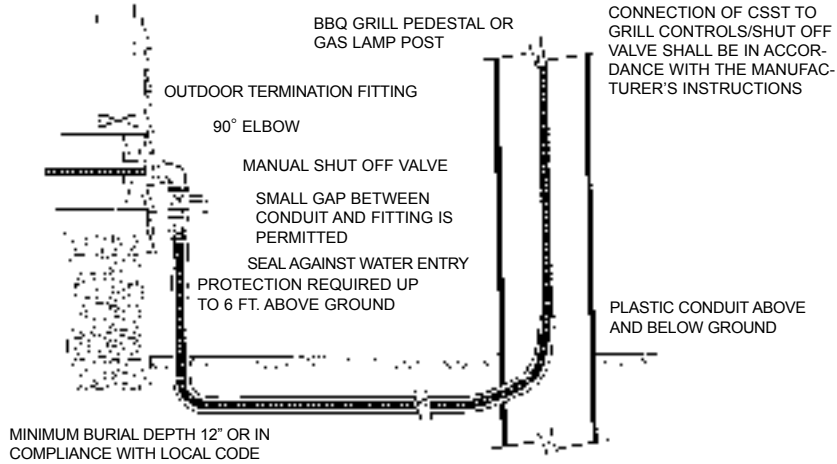


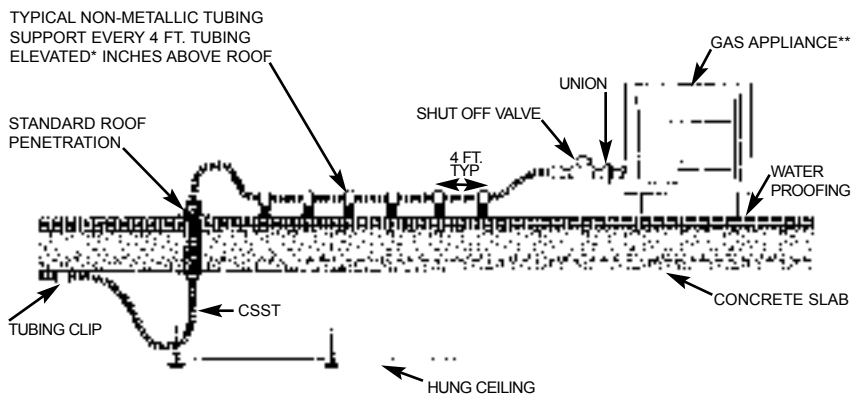
Figure 4.24

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.

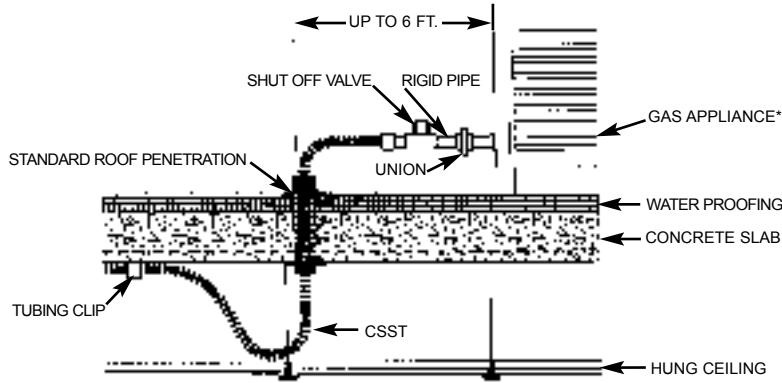
**LONG OUTDOOR
CONNECTION TO
ROOF MOUNTED
EQUIPMENT**



* 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”.

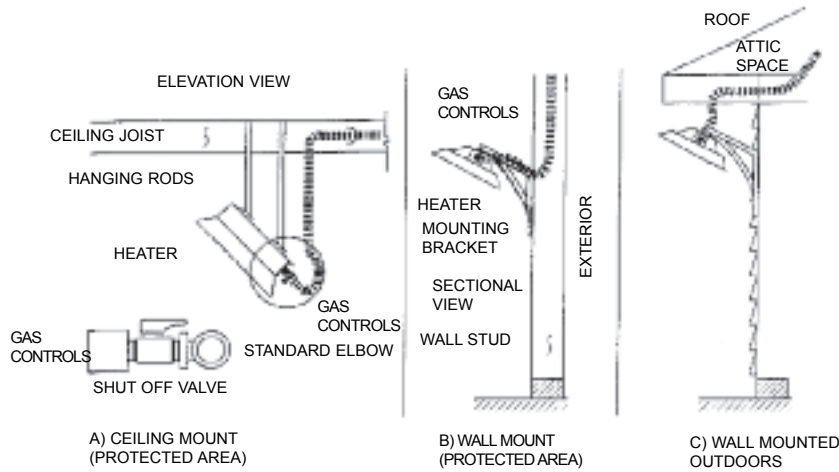
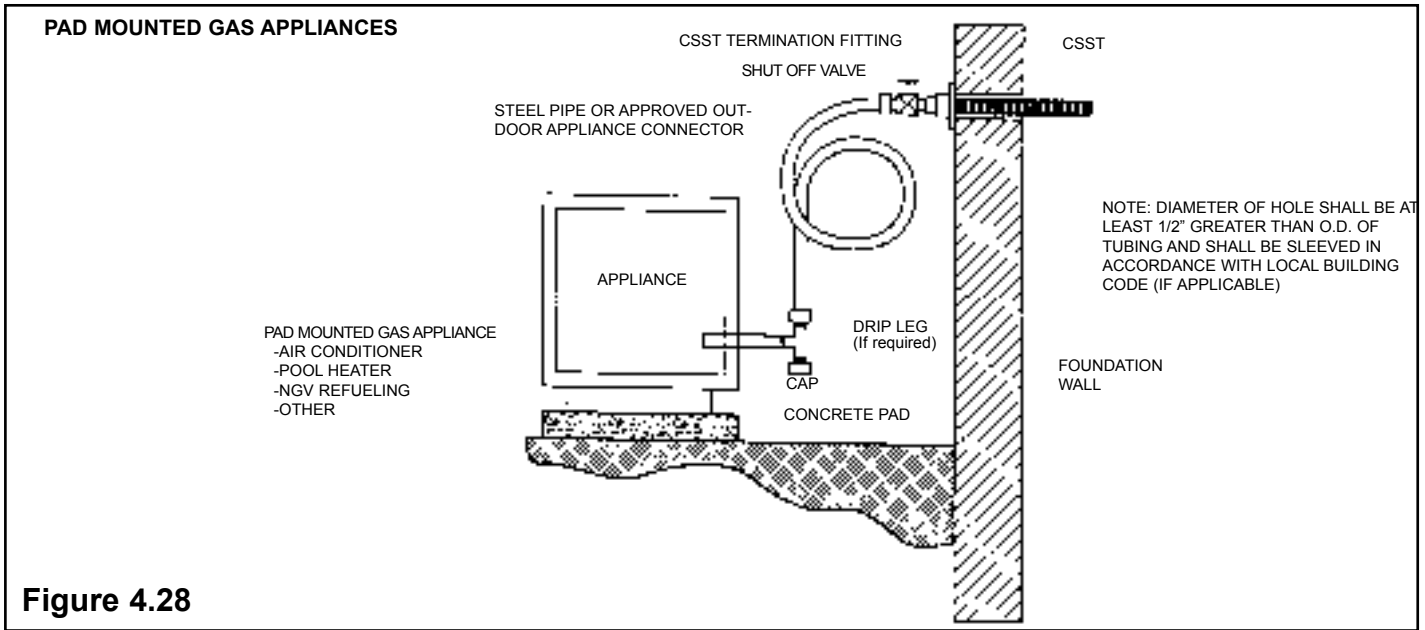


Figure 4.27

C. Pad Mounted Gas Appliances

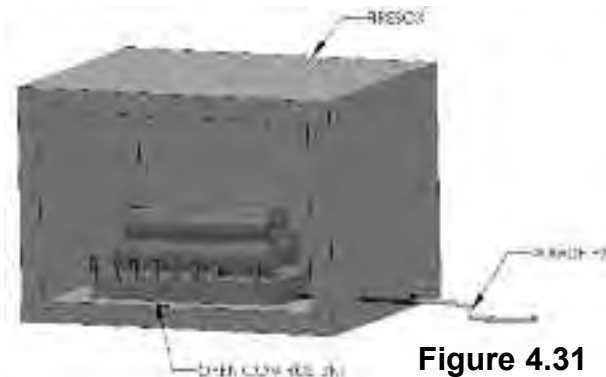
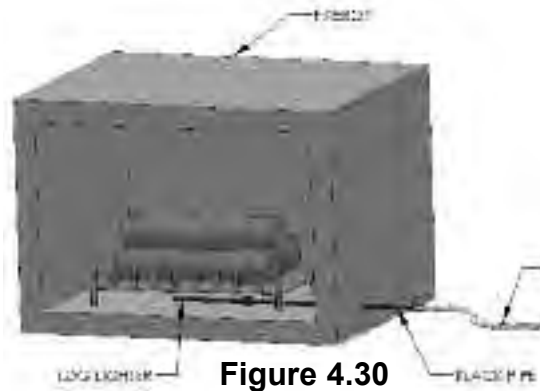
Gas appliances mounted on concrete pads or blocks, such as heat pumps, air conditioners, pool heaters and NGV refueling systems, shall be connected to the WARDFLEX®/WARDFLEX® II system at a termination fitting using either rigid pipe or an approved outdoor appliance connector as shown in Figure 4.28.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



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.

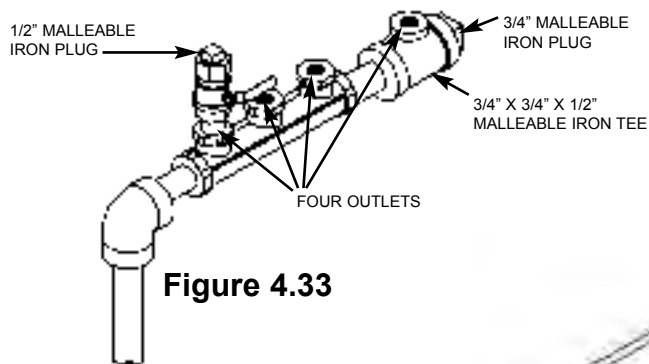
- A. When routing WARDFLEX® and WARDFLEX® II through masonry construction, for connection to gas fireplaces and gas logs CSST is required to be sleeved in a non metallic conduit through the masonry structure. The plastic coating should be left intact, through the sleeved portion of the installation, 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.



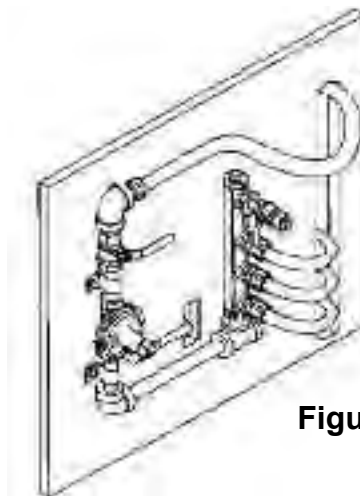
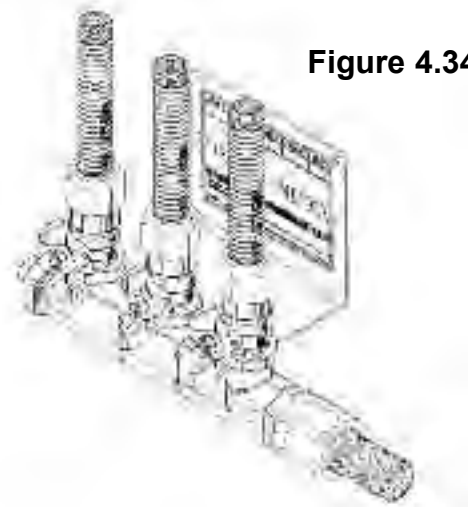
4.7 MANIFOLD STATION

- 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 orientation. 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**



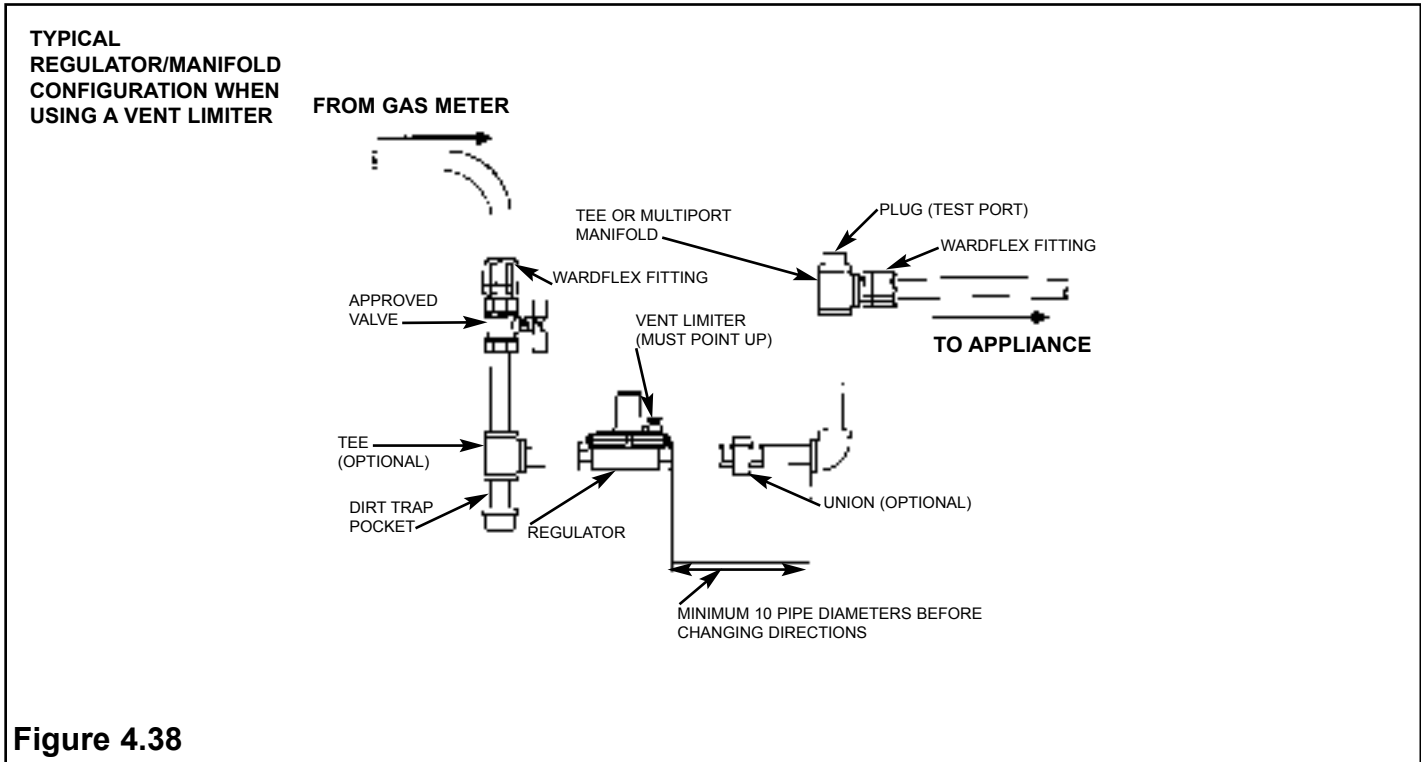
**SINGLE 3 - PORT MANIFOLD WITH MANIFOLD
BRACKET AND WARDFLEX GAS VALVES INSTALLED**



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.



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	1,250,000 BTU/HR	1,250,000 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 environment. Vent protection devices shall be used in outdoor installations.

ACCESSORIES FOR GAS PRESSURE REGULATORS




Vent Limiting Means	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.
 1,2	2-IAS certified for 2PSI (LP) and 5 PSI (natural) with 325-3. Color-green 1/8"NPT
 3	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.

Figure 4.39

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. 1/2" 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.

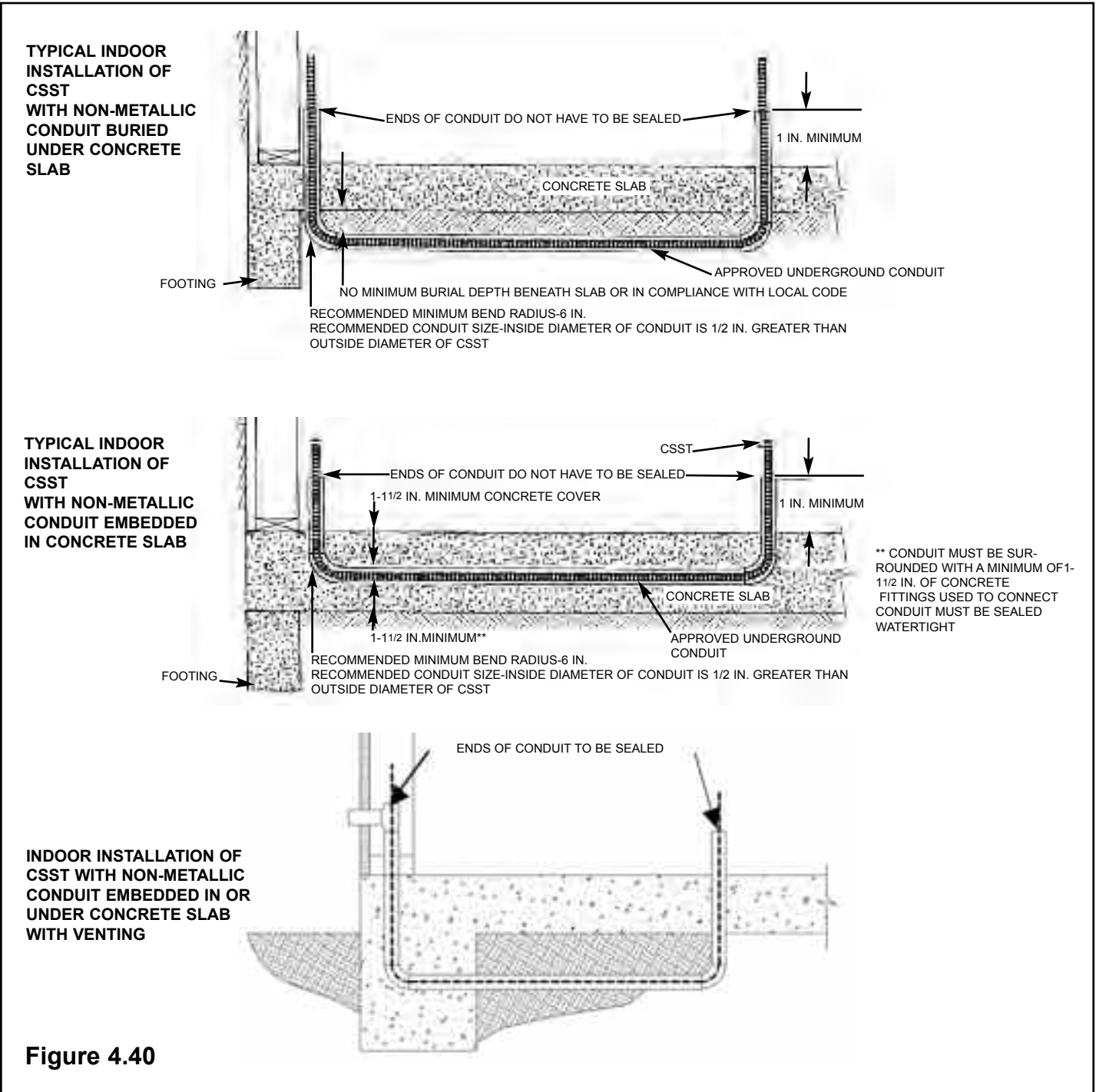
For indoor buried installations, Ward Manufacturing does not require the conduit to be vented to the outside. Due to its continuous construction and availability in long run lengths, no fittings are permitted inside the conduit. This eliminates the possibility of gas build up caused by leaking fittings 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.



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 manufacturer'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 underground 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.

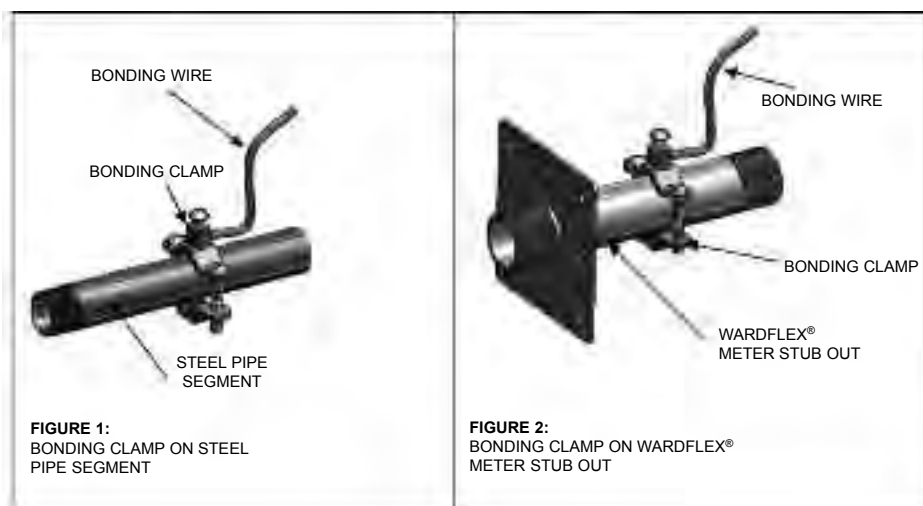


Figure 4.41

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.

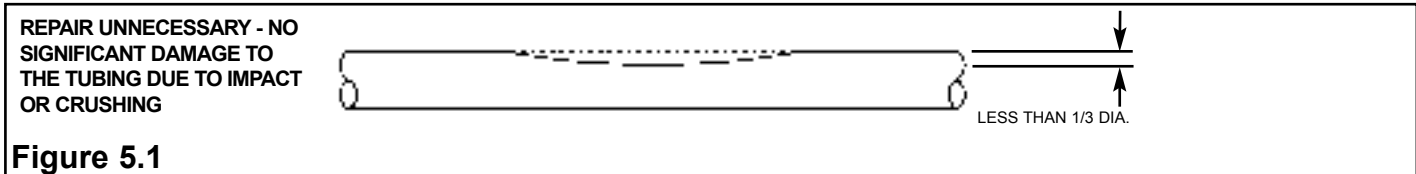
5.0 INSPECTION, REPAIR AND REPLACEMENT

5.1 MINIMUM INSPECTION REQUIREMENTS

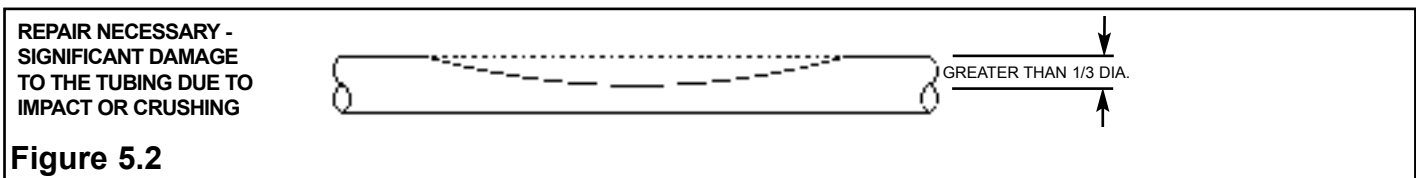
If the tubing is damaged refer to the following subsections to determine the severity of damage and, if necessary the method of repair.

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.

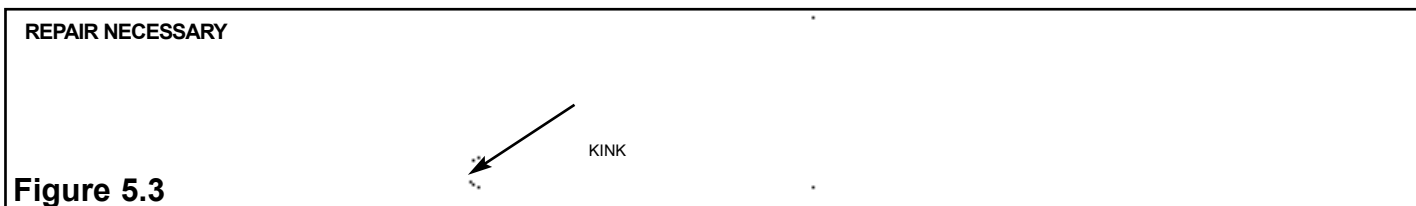


- The tubing must be repaired or replaced under the following circumstances:
- The tubing has been significantly damaged (Figure 5.2).
- The tubing has been punctured.
- The tubing has been bent beyond its minimum bend radius so that a crease or kink appears (Figure 5.3).



5.2 REPAIR/REPLACEMENT OF DAMAGED TUBING

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



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.

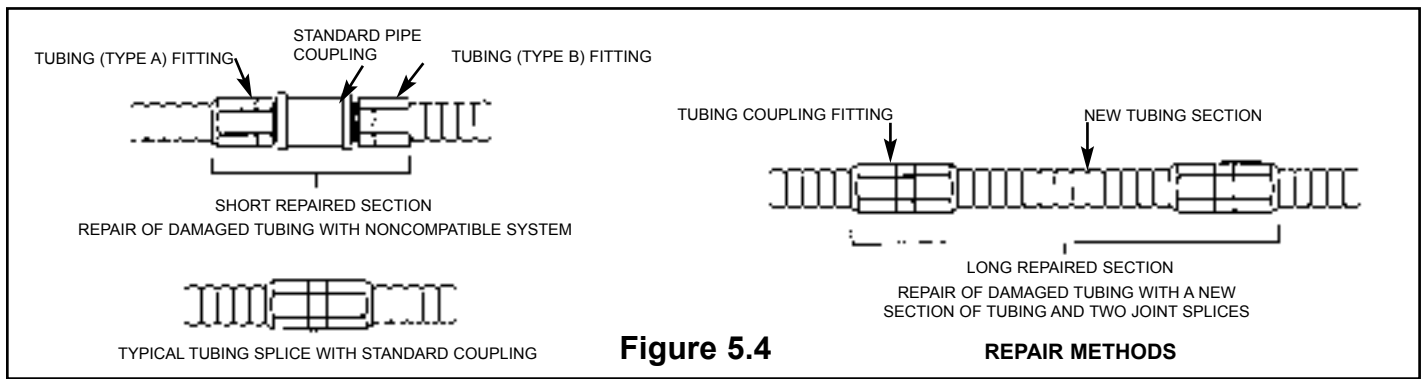


Figure 5.4

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.

6.0 TESTING

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.

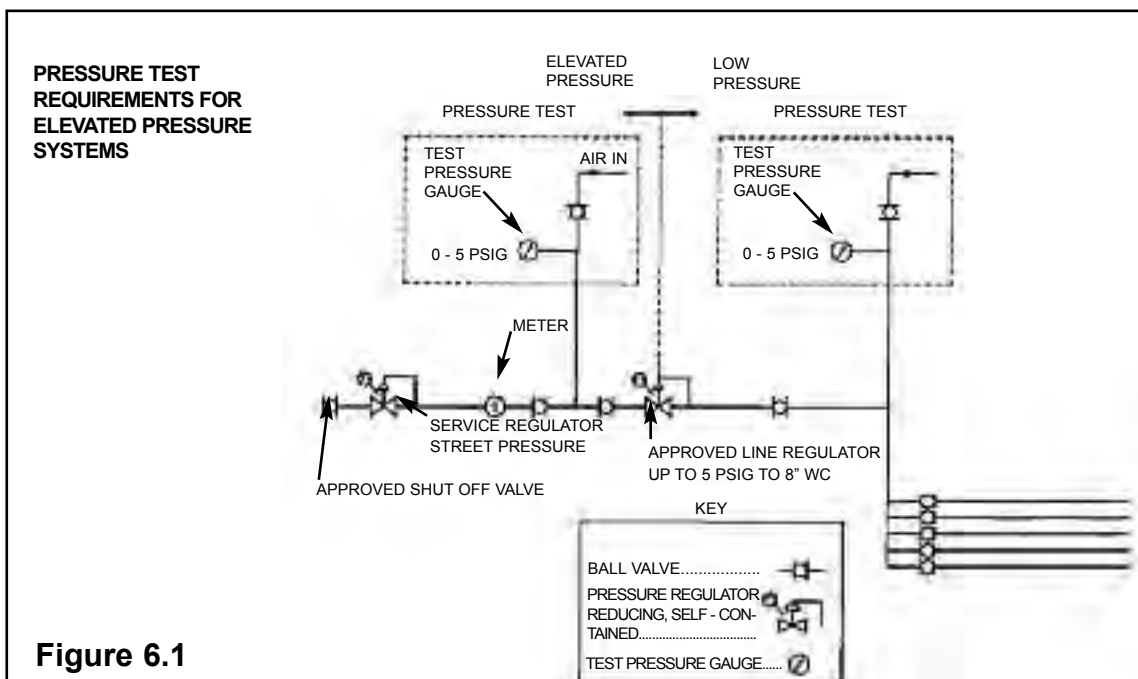


Figure 6.1

7.0 SIZING TABLES (NATURAL AND LP)

Table	Page
A-1 Natural Gas-Low Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) for Gas Pressure of 0.5 PSI or less and Pressure Drop of 0.5 in.WC	60
A-2 Natural Gas-Low Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) for Gas Pressure of 0.5 PSI or less and Pressure Drop of 1.0 in.WC	60
A-3 Natural Gas-Low Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) for Gas Pressure of 0.5 PSI or less and Pressure Drop of 1.5 in.WC	61
A-4 Natural Gas-Low Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) for Gas Pressure of 0.5 PSI or less and Pressure Drop of 2.0 in.WC	61
A-5 Natural Gas-Low Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) for Gas Pressure of 0.5 PSI or less and Pressure Drop of 2.5 in.WC	62
A-6 Natural Gas-Low Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) for Gas Pressure of 0.5 PSI or less and Pressure Drop of 3.0 in.WC	62
A-7 Natural Gas-Low Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) for Gas Pressure of 0.5 PSI or less and Pressure Drop of 4.0 in.WC	63
A-8 Natural Gas-Low Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) for Gas Pressure of 0.5 PSI or less and Pressure Drop of 5.0 in.WC	63
A-9 Natural Gas-Low Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) for Gas Pressure of 0.5 PSI or less and Pressure Drop of 6.0 in.WC	64
A-10 Natural Gas-Elevated Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) for Gas Pressure of 1.0 PSI and Pressure Drop of 13.0 in.WC	65
A-11 Natural Gas-Elevated Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) for Gas Pressure of 2.0 PSI and Pressure Drop of 1.0 PSI	65
A-12 Natural Gas-Elevated Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) for Gas Pressure of 2.0 PSI and Pressure Drop of 1.5 PSI	66
A-13 Natural Gas-Elevated Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) for Gas Pressure of 5.0 PSI and Pressure Drop of 3.5 PSI	66
A-14 Natural Gas-Elevated Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) for Gas Pressure of 10.0 PSI and Pressure Drop of 7.0 PSI	67
A-15 Natural Gas-Elevated Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Cubic Feet per Hour (CFH) for Gas Pressure of 25.0 PSI and Pressure Drop of 10.0 PSI	67
A-16 Propane Gas-Low Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Thousands of BTU (KBTU) for Gas Pressure of 0.5 PSI or less and Pressure Drop of 0.5 in.WC	68
A-17 Propane Gas-Low Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Thousands of BTU (KBTU) for Gas Pressure of 0.5 PSI or less and Pressure Drop of 1.0 in.WC	68
A-18 Propane Gas-Low Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Thousands of BTU (KBTU) for Gas Pressure of 0.5 PSI or less and Pressure Drop of 2.0 in.WC	69
A-19 Propane Gas- Low Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Thousands of BTU (KBTU) for Gas Pressure of 0.5 PSI or less and Pressure Drop of 2.5 in.WC	69
A-20 Propane Gas- Low Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Thousands of BTU (KBTU) for Gas Pressure of 0.5 PSI or less and Pressure Drop of 3.0 in.WC	70
A-21 Propane Gas- Low Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Thousands of BTU (KBTU) for Gas Pressure of 0.5 PSI or less and Pressure Drop of 6.0 in.WC	70
A-22 Propane Gas-Elevated Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Thousands of BTU (KBTU) for Gas Pressure of 2.0 PSI and Pressure Drop of 1.0 PSI	71
A-23 Propane Gas-Elevated Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Thousands of BTU (KBTU) for Gas Pressure of 5.0 PSI and Pressure Drop of 3.5 PSI	71
A-24 Propane Gas-Elevated Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Thousands of BTU (KBTU) for Gas Pressure of 10.0 PSI and Pressure Drop of 7.0 PSI	72
A-25 Propane Gas-Elevated Pressure Maximum Capacity of WARDFLEX®/WARDFLEX® II CSST in Thousands of BTU (KBTU) for Gas Pressure of 25.0 PSI and Pressure Drop of 10.0 PSI	72
A-26 Steel Pipe Capacities Maximum Capacity of Steel Pipe in Cubic Feet per Hour (CFH) for Gas Pressure of 0.5 PSI or less and Pressure Drop of 0.5 in.WC	73
A-27 Steel Pipe Capacities Maximum Capacity of Steel Pipe in Cubic Feet per Hour (CFH) of Natural Gas for Gas Pressure of 0.5 PSI or less and Pressure Drop of 1.0 in.WC	73
A-28 WARDFLEX/WARDFLEX II Pressure Drop per Foot	74-75
A-29 SCHEDULE 40 Black Iron Pipe Pressure Drop per Foot	76-77
A-30 Polyethylene Pipe Pressure Drop per Foot	78-79
A-31 WARDFLEX/WARDFLEX II Pressure Drop per Foot Propane Gas	80-81
A-32 SCHEDULE 40 Black Iron Pipe Pressure Drop per Foot Propane Gas	82-83

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 Capacity 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)

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	31	39	48	62
5	63	155	270	497	1150	2167	3993
10	44	104	192	357	830	1544	2880
15	36	83	157	294	686	1267	2379
20	31	70	137	256	600	1101	2077
25	27	62	122	230	540	987	1870
30	25	56	112	212	496	903	1716
40	21	47	97	185	433	784	1498
50	19	42	87	167	390	703	1348
60	17	39	80	153	358	643	1237
70	16	36	74	143	333	597	1151
80	15	33	69	134	313	559	1080
90	14	31	65	127	296	528	1022
100	13	30	62	121	281	501	972
125	12	27	57	109	253	452	875
150	10	24	53	100	233	419	803
200	9	21	47	88	203	372	701
250	8	19	43	79	183	339	631
300	7	17	40	73	169	314	579
400	6	15	36	63	148	279	506
500	5	13	33	57	134	254	455
600	5	12	31	52	123	236	418
700	4	11	29	49	115	221	388
800	4	10	27	46	108	209	365
900	4	10	26	43	102	199	345
1000	4	9	25	41	97	190	328
1100	3	9	24	40	93	183	314
1200	3	8	23	38	90	177	301
1300	3	8	23	37	86	171	290
1400	3	8	22	35	84	166	280
1500	3	7	21	34	81	161	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)

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	31	39	48	62
5	90	192	379	692	1592	3040	5536
10	63	135	270	497	1150	2167	3993
15	51	110	221	409	951	1777	3298
20	44	95	192	357	830	1544	2880
25	39	85	172	321	748	1385	2592
30	36	77	157	294	686	1267	2379
40	31	67	137	256	600	1101	2077
50	27	60	122	230	540	987	1870
60	25	55	112	211	496	903	1716
70	23	51	104	196	461	837	1595
80	21	47	97	184	433	784	1498
90	20	45	92	174	410	740	1417
100	19	42	87	165	390	703	1348
125	17	38	78	148	351	631	1214
150	15	34	71	136	322	577	1114
200	13	30	62	118	281	501	972
250	12	27	56	106	253	449	875
300	10	24	51	97	233	411	803
400	9	21	44	85	203	357	701
500	8	19	40	76	183	320	631
600	7	17	36	70	168	293	579
700	7	16	34	65	156	272	539
800	6	15	32	61	147	254	506
900	6	14	30	57	139	240	478
1000	5	13	28	55	132	228	455
1100	5	12	27	52	126	218	435
1200	5	12	26	50	121	209	418
1300	5	11	25	48	117	201	402
1400	4	11	24	46	113	193	388
1500	4	11	23	45	109	187	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 Capacity 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	31	39	48	62
5	112	236	462	840	1926	3705	6703	
10	78	166	329	603	1391	2641	4834	
15	63	135	270	497	1150	2167	3993	
20	54	116	234	433	1005	1882	3487	
25	48	104	210	389	905	1688	3139	
30	44	95	192	357	830	1544	2880	
40	38	82	167	311	725	1342	2515	
50	34	73	149	279	653	1203	2264	
60	31	67	137	256	600	1101	2077	
70	28	62	127	238	558	1021	1932	
80	26	58	119	223	524	956	1814	
90	25	55	112	211	496	903	1716	
100	23	52	106	200	472	857	1633	
125	21	46	95	180	425	769	1470	
150	19	42	87	165	390	703	1348	
200	16	37	76	144	341	611	1177	
250	14	33	68	129	307	548	1060	
300	13	30	62	118	281	501	972	
400	11	26	54	103	246	435	849	
500	10	23	48	93	221	390	764	
600	9	21	44	85	203	357	701	
700	8	19	41	79	189	331	652	
800	8	18	38	74	177	310	612	
900	7	17	36	70	168	293	579	
1000	7	16	35	66	160	278	551	
1100	6	15	33	63	153	265	527	
1200	6	15	32	61	147	254	506	
1300	6	14	30	59	141	245	487	
1400	6	14	29	56	136	236	470	
1500	5	13	28	55	132	228	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	31	39	48	62
5	130	273	532	964	2205	4265	7676	
10	90	192	379	692	1592	3040	5536	
15	73	156	311	570	1316	2493	4573	
20	63	135	270	497	1150	2167	3993	
25	56	120	242	447	1036	1943	3594	
30	51	110	221	409	951	1777	3298	
40	44	95	192	357	830	1544	2880	
50	39	85	172	321	748	1385	2592	
60	36	77	157	294	686	1267	2379	
70	33	72	146	273	638	1175	2212	
80	31	67	137	256	600	1101	2077	
90	29	63	129	242	567	1039	1965	
100	27	60	122	230	540	987	1870	
125	24	53	110	207	486	885	1683	
150	22	49	100	189	446	809	1544	
200	19	42	87	165	390	703	1348	
250	17	38	78	148	351	631	1214	
300	15	34	71	136	322	577	1114	
400	13	30	62	118	281	501	972	
500	12	27	56	106	253	449	875	
600	10	24	51	97	233	411	803	
700	10	22	47	91	216	381	747	
800	9	21	44	85	203	357	701	
900	8	20	42	80	192	337	663	
1000	8	19	40	76	183	320	631	
1100	8	18	38	73	175	306	603	
1200	7	17	36	70	168	293	579	
1300	7	16	35	67	162	282	558	
1400	7	16	34	65	156	272	539	
1500	6	15	33	63	151	263	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 Capacity 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)

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	31	39	48	62
5	145	306	593	1076	2449	4756	8527
10	102	215	423	770	1768	3390	6151
15	82	175	346	634	1462	2781	5080
20	71	151	301	553	1277	2416	4436
25	63	135	270	497	1150	2167	3993
30	57	123	247	455	1056	1982	3664
40	49	106	214	397	922	1722	3200
50	44	95	192	357	830	1544	2880
60	40	86	176	327	762	1413	2643
70	37	80	163	304	709	1310	2458
80	34	75	152	285	666	1227	2308
90	32	71	144	269	630	1159	2183
100	31	67	137	256	600	1101	2077
125	27	60	122	230	540	987	1870
150	25	55	112	211	496	903	1716
200	21	47	97	184	433	784	1498
250	19	42	87	165	390	703	1348
300	17	39	80	151	358	643	1237
400	15	33	69	132	313	559	1080
500	13	30	62	118	281	501	972
600	12	27	57	108	258	458	892
700	11	25	53	101	240	425	830
800	10	23	49	94	226	398	779
900	9	22	47	89	213	376	737
1000	9	21	44	85	203	357	701
1100	9	20	42	81	194	341	670
1200	8	19	41	78	186	327	643
1300	8	18	39	75	180	314	620
1400	7	18	38	72	173	303	598
1500	7	17	36	70	168	293	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)

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	31	39	48	62
5	160	336	649	1384	2668	5199	9293
10	112	236	462	957	1926	3705	6703
15	90	192	379	771	1592	3040	5536
20	78	166	329	662	1391	2641	4834
25	69	148	295	588	1253	2368	4352
30	63	135	270	533	1150	2167	3993
40	54	118	234	458	1005	1882	3487
50	48	106	210	406	905	1688	3139
60	44	97	192	369	830	1544	2880
70	41	90	178	340	772	1432	2678
80	38	85	167	316	725	1342	2515
90	36	80	157	297	690	1267	2379
100	34	76	149	281	660	1203	2264
125	30	69	134	251	601	1079	2038
150	27	63	122	230	557	987	1870
200	23	55	106	200	493	857	1633
250	21	50	95	180	449	769	1470
300	19	45	87	165	416	703	1348
400	16	40	76	144	369	615	1177
500	14	36	68	129	336	555	1060
600	13	33	62	118	311	510	972
700	12	30	57	110	291	475	904
800	11	29	54	103	275	446	849
900	10	27	51	97	262	423	803
1000	10	26	48	93	251	403	764
1100	9	25	46	89	241	385	731
1200	9	24	44	85	232	370	701
1300	9	23	43	82	224	357	675
1400	8	22	41	79	218	345	652
1500	8	21	40	76	211	334	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 Capacity 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	31	39	48	62
5	186	389	747	1370	3053	5983	10665
10	130	273	532	964	2205	4265	7676
15	105	222	436	794	1823	3498	6341
20	90	192	379	692	1592	3040	5536
25	81	171	340	622	1434	2726	4984
30	73	156	311	570	1316	2493	4573
40	63	135	270	497	1150	2167	3993
50	56	120	242	447	1036	1943	3594
60	51	110	221	409	951	1777	3298
70	47	101	205	380	884	1648	3067
80	44	95	192	357	830	1544	2880
90	41	89	181	337	786	1458	2724
100	39	85	172	321	748	1385	2592
125	35	76	154	288	673	1242	2334
150	32	69	141	264	618	1136	2141
200	27	60	122	230	540	987	1870
250	24	53	110	207	486	885	1683
300	22	49	100	189	446	809	1544
400	19	42	87	165	390	703	1348
500	17	38	78	148	351	631	1214
600	15	34	71	136	322	577	1114
700	14	32	66	126	300	535	1036
800	13	30	62	118	281	501	972
900	12	28	58	112	266	473	920
1000	12	27	56	106	253	449	875
1100	11	25	53	102	242	429	837
1200	10	24	51	97	233	411	803
1300	10	23	49	94	224	395	773
1400	10	22	47	91	216	381	747
1500	9	22	46	88	209	369	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	31	39	48	62
5	208	436	833	1536	3391	6672	11888
10	145	306	593	1076	2449	4756	8527
15	118	249	486	883	2024	3901	7044
20	102	215	423	770	1768	3390	6151
25	90	192	379	692	1592	3040	5536
30	82	175	346	634	1462	2781	5080
40	71	151	301	553	1277	2416	4436
50	63	135	270	497	1150	2167	3993
60	57	123	247	455	1056	1982	3664
70	53	113	229	423	982	1838	3407
80	49	106	214	397	922	1722	3200
90	46	100	202	375	873	1626	3027
100	44	95	192	357	830	1544	2880
125	39	85	172	321	748	1385	2592
150	36	77	157	294	686	1267	2379
200	31	67	137	256	600	1101	2077
250	27	60	122	230	540	987	1870
300	25	55	112	211	496	903	1716
400	21	47	97	184	433	784	1498
500	19	42	87	165	390	703	1348
600	17	39	80	151	358	643	1237
700	16	36	74	140	333	597	1151
800	15	33	69	132	313	559	1080
900	14	31	65	125	296	528	1022
1000	13	30	62	118	281	501	972
1100	12	28	59	113	269	478	930
1200	12	27	57	108	258	458	892
1300	11	26	55	104	249	441	859
1400	11	25	53	101	240	425	830
1500	10	24	51	97	233	411	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 Capacity 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.							
<i>(based on a 0.60 specific gravity gas)</i>							
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	31	39	48	62
5	229	479	911	1687	3694	7294	12991
10	160	336	649	1182	2668	5199	9293
15	130	273	532	964	2205	4265	7676
20	112	236	462	840	1926	3705	6703
25	99	211	414	755	1735	3323	6033
30	90	192	379	692	1592	3040	5536
40	78	166	329	603	1391	2641	4834
50	69	148	295	542	1253	2368	4352
60	63	135	270	497	1150	2167	3993
70	58	126	250	462	1070	2009	3713
80	54	118	234	433	1005	1898	3487
90	51	111	221	409	951	1811	3298
100	48	106	210	389	905	1736	3139
125	43	95	188	350	821	1588	2825
150	39	87	172	321	763	1476	2592
200	34	75	149	279	680	1316	2264
250	30	68	134	251	622	1203	2038
300	27	62	122	230	578	1119	1870
400	23	54	106	200	515	997	1633
500	21	48	95	180	471	912	1470
600	19	44	87	165	438	848	1348
700	17	41	81	154	412	797	1254
800	16	38	76	144	390	755	1177
900	15	36	71	137	372	721	1114
1000	14	34	68	130	357	691	1060
1100	14	33	65	124	344	665	1013
1200	13	31	62	119	332	642	972
1300	12	30	60	115	321	622	936
1400	12	29	57	111	312	604	904
1500	12	28	56	108	304	587	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 Capacity 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)

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	31	39	48	62
5	342	710	1329	2507	5310	10640	18923
10	239	499	947	1757	3835	7584	13507
15	193	405	776	1427	3170	6222	11089
20	167	350	675	1231	2770	5406	9650
25	148	313	605	1098	2494	4848	8687
30	135	285	553	1001	2290	4435	7971
40	116	246	480	873	2000	3853	6960
50	104	219	431	785	1801	3455	6265
60	94	200	394	719	1653	3161	5749
70	87	185	365	668	1538	2932	5346
80	81	173	342	627	1444	2746	5020
90	76	163	323	592	1367	2593	4749
100	72	154	307	563	1301	2463	4519
125	64	137	275	506	1171	2208	4068
150	59	125	251	464	1075	2020	3733
200	50	108	218	404	939	1755	3259
250	45	97	196	363	846	1574	2934
300	41	88	179	333	776	1440	2692
400	35	76	155	290	678	1251	2351
500	31	68	139	261	611	1122	2116
600	28	62	127	239	561	1026	1942
700	26	58	118	222	521	952	1806
800	24	54	111	208	490	892	1695
900	23	51	104	197	463	842	1604
1000	22	48	99	187	441	799	1526
1100	21	46	95	179	422	763	1459
1200	20	44	91	172	405	731	1400
1300	19	42	87	165	390	703	1348
1400	18	41	84	159	376	678	1302
1500	17	39	81	154	364	656	1260

Table A-11

Gas Pressure of: **2.0 psi**
 Pressure Drop of: **1.0 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	31	39	48	62
5	505	1044	1926	3698	7578	15405	27356
10	353	733	1372	2592	5473	10981	19526
15	286	596	1125	2105	4524	9008	16030
20	247	515	977	1816	3953	7827	13937
25	220	460	876	1620	3560	7019	12503
30	200	419	801	1475	3268	6421	11442
40	172	362	696	1273	2855	5579	9948
50	154	323	624	1135	2571	5003	8954
60	140	294	571	1034	2360	4576	8217
70	129	272	529	959	2195	4244	7641
80	120	254	496	900	2062	3976	7175
90	113	239	468	851	1951	3754	6787
100	107	227	445	809	1857	3566	6459
125	95	202	398	727	1672	3198	5814
150	87	184	364	666	1535	2925	5335
200	75	159	317	581	1341	2542	4658
250	67	142	284	522	1207	2279	4193
300	61	129	260	478	1108	2085	3848
400	52	112	225	417	968	1811	3360
500	46	100	202	375	872	1624	3024
600	42	91	185	343	800	1486	2775
700	39	84	171	319	744	1378	2581
800	36	79	160	299	699	1291	2423
900	34	74	151	283	661	1219	2292
1000	32	70	144	269	630	1158	2181
1100	31	67	137	257	602	1105	2085
1200	29	64	131	247	578	1059	2002
1300	28	62	126	237	557	1018	1927
1400	27	60	122	229	537	982	1861
1500	26	58	118	222	520	950	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 Capacity 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	31	39	48	62
5	623	1283	2348	4553	9172	18779	33322
10	435	902	1673	3191	6621	13386	23784
15	353	733	1372	2592	5473	10981	19526
20	304	633	1192	2236	4782	9541	16976
25	271	565	1068	1994	4306	8556	15229
30	247	515	977	1816	3953	7827	13937
40	213	445	849	1567	3453	6801	12117
50	189	397	761	1398	3110	6098	10870
60	172	362	696	1273	2855	5579	9948
70	159	335	646	1176	2655	5174	9250
80	148	313	605	1098	2494	4847	8686
90	140	294	571	1034	2360	4576	8217
100	132	279	542	982	2246	4347	7819
125	118	249	486	883	2023	3898	7038
150	107	228	445	809	1857	3585	6459
200	92	199	386	705	1644	3156	5639
250	82	179	346	634	1502	2859	5076
300	75	165	317	581	1395	2637	4658
400	64	144	275	506	1241	2322	4067
500	57	129	246	455	1133	2103	3661
600	52	119	225	417	1052	1940	3360
700	48	110	209	387	989	1812	3124
800	45	104	196	363	936	1708	2935
900	42	98	185	343	893	1621	2779
1000	40	93	175	327	855	1547	2647
1100	38	89	167	312	823	1483	2532
1200	36	86	160	299	794	1427	2432
1300	35	82	154	288	769	1377	2344
1400	33	80	149	278	746	1333	2265
1500	32	77	144	269	725	1292	2194

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	31	39	48	62
5	965	1975	3554	7030	13794	28406	50320
10	675	1388	2532	4927	9879	20248	35917
15	547	1129	2076	4002	8147	16610	29487
20	472	975	1804	3453	7118	14432	25636
25	420	870	1617	3080	6410	12942	22999
30	382	793	1479	2805	5884	11839	21046
40	330	685	1285	2420	5201	10287	18298
50	294	611	1152	2158	4728	9225	16426
60	267	557	1054	1966	4374	8439	15199
70	247	515	977	1816	4095	7872	14233
80	230	481	915	1696	3868	7449	13446
90	217	453	864	1597	3679	7094	12787
100	205	430	821	1517	3517	6791	12226
125	183	383	736	1360	3197	6192	11117
150	166	349	673	1244	2958	5742	10287
200	143	303	585	1080	2616	5097	9100
250	128	272	528	969	2378	4647	8275
300	116	249	486	886	2200	4309	7656
400	100	216	426	770	1945	3825	6773
500	89	194	385	690	1769	3488	6159
600	81	178	354	631	1636	3234	5699
700	75	165	330	585	1532	3034	5337
800	70	154	311	548	1447	2871	5041
900	66	146	295	518	1376	2734	4795
1000	62	139	281	492	1315	2618	4584
1100	59	132	269	469	1263	2516	4402
1200	56	127	259	450	1217	2427	4242
1300	54	122	249	432	1176	2348	4099
1400	52	118	241	417	1139	2277	3972
1500	50	114	234	403	1106	2213	3857

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

Table A-14

Gas Pressure of: 10.0 psi
Pressure Drop of: 7.0 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	31	39	48	62
5		2891	4842	10050	19789	38067	59564
10		2047	3552	7165	14648	28295	45392
15		1672	2963	5879	12284	23787	38721
20		1449	2606	5109	10842	21031	34592
25		1297	2358	4582	9842	19115	31695
30		1184	2174	4192	9093	17681	29508
40		1026	1911	3643	8026	15632	26361
50		918	1730	3267	7285	14208	24153
60		838	1594	2989	6730	13142	22487
70		776	1488	2772	6295	12303	21169
80		726	1402	2597	5940	11619	20089
90		685	1330	2452	5644	11048	19183
100		650	1269	2329	5392	10561	18407
125		581	1148	2089	4894	9599	16865
150		531	1058	1911	4522	8878	15702
200		460	931	1660	3991	7850	14027
250		412	842	1489	3623	7135	12852
300		376	776	1362	3347	6599	11966
400		326	683	1184	2954	5834	10690
500		291	618	1062	2681	5303	9794
600		266	569	971	2477	4905	9119
700		246	531	901	2317	4592	8584
800		230	501	844	2187	4337	8146
900		217	475	797	2078	4123	7778
1000		206	453	757	1985	3941	7464
1100		197	434	722	1904	3784	7190
1200		188	417	692	1834	3646	6949
1300		181	403	666	1771	3523	6734
1400		174	390	642	1715	3413	6541
1500		168	378	621	1664	3313	6367

Tubing Length (Ft.)

Table A-15

Gas Pressure of: 25.0 psi
Pressure Drop of: 10.0 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	31	39	48	62
5		4686	9174	15713	31976	43967	74301
10		3290	6154	11195	23456	34615	58742
15		2676	4872	9182	19568	30096	51198
20		2310	4128	7977	17207	27253	46440
25		2062	3630	7152	15573	25233	43057
30		1879	3268	6542	14354	23695	40476
40		1622	2769	5683	12622	21456	36715
50		1448	2435	5096	11424	19866	34040
60		1319	2192	4661	10530	18655	32000
70		1219	2006	4323	9828	17689	30371
80		1139	1857	4049	9259	16893	29026
90		1073	1736	3823	8784	16220	27890
100		1016	1633	3631	8380	15641	26912
125		907	1436	3255	7584	14482	24951
150		826	1293	2978	6991	13599	23456
200		714	1096	2587	6147	12314	21276
250		637	963	2319	5564	11402	19726
300		580	867	2122	5128	10706	18544
400		501	735	1843	4509	9695	16820
500		447	646	1652	4081	8976	15595
600		407	582	1511	3762	8429	14660
700		376	532	1402	3511	7993	13914
800		352	493	1313	3308	7633	13298
900		331	460	1240	3138	7329	12777
1000		314	433	1177	2994	7067	12329
1100		299	410	1124	2869	6839	11937
1200		286	390	1077	2759	6636	11590
1300		274	372	1035	2662	6456	11280
1400		264	357	999	2576	6293	11000
1500		255	343	965	2497	6145	10746

Tubing Length (Ft.)

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 Capacity 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: 0.5 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	31	39	48	62
5	100	245	426	785	1817	3425	6311
10	70	164	303	564	1312	2440	4552
15	57	131	248	464	1084	2002	3760
20	49	110	216	404	948	1740	3283
25	43	98	192	363	853	1560	2956
30	40	88	177	335	784	1427	2712
40	33	74	153	292	684	1239	2367
50	30	66	137	263	616	1111	2130
60	27	61	126	241	565	1016	1955
70	25	56	116	226	526	943	1819
80	24	52	109	211	494	883	1707
90	22	49	102	200	467	834	1615
100	21	47	98	191	444	791	1536
125	19	42	90	172	399	714	1383
150	16	37	83	158	368	662	1269
200	14	33	74	139	320	588	1108
250	13	30	67	124	289	535	997
300	11	26	63	115	267	496	915
400	9	23	56	99	233	441	799
500	8	20	52	90	211	401	719
600	8	18	49	82	194	373	660
700	6	17	45	77	181	349	613
800	6	15	42	72	170	330	576
900	6	15	41	67	161	314	545
1000	6	14	39	64	153	300	518
1100	5	14	37	63	147	289	496
1200	5	12	36	60	142	279	475
1300	5	12	36	58	135	270	458
1400	5	12	34	55	132	262	442
1500	5	11	33	53	128	254	428

Table A-17

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	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	31	39	48	62
5	142	304	599	1094	2518	4805	8752
10	100	213	427	786	1818	3425	6312
15	81	173	350	647	1503	2810	5214
20	70	150	304	564	1313	2441	4553
25	62	134	272	507	1182	2189	4098
30	57	122	249	465	1085	2003	3761
40	49	106	216	405	948	1740	3284
50	43	95	194	364	854	1560	2956
60	40	87	177	334	784	1427	2712
70	36	80	164	310	729	1324	2522
80	33	75	154	291	685	1240	2368
90	32	71	145	275	648	1171	2240
100	30	67	138	261	616	1112	2132
125	27	60	124	235	555	997	1919
150	24	55	113	215	510	912	1761
200	21	47	98	187	445	792	1538
250	19	42	88	168	401	711	1384
300	16	39	81	154	368	650	1270
400	14	33	70	134	321	565	1109
500	13	30	63	121	289	506	998
600	11	27	58	111	266	463	916
700	11	25	54	103	247	430	852
800	9	24	50	96	232	402	800
900	9	22	47	91	219	380	756
1000	8	21	45	87	209	361	720
1100	8	20	43	83	200	344	688
1200	8	19	41	79	192	330	660
1300	8	18	40	76	185	317	636
1400	6	18	38	74	178	306	614
1500	6	17	37	71	173	296	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 Capacity 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: 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	31	39	48	62
5	205	432	841	1524	3486	6742	12134
10	142	304	599	1094	2518	4805	8752
15	115	247	491	901	2081	3942	7229
20	100	213	427	786	1818	3425	6312
25	89	190	382	706	1637	3071	5682
30	81	173	350	647	1503	2810	5214
40	70	150	304	564	1313	2441	4553
50	62	134	272	507	1182	2189	4098
60	57	122	249	465	1085	2003	3761
70	52	113	231	432	1010	1857	3497
80	49	106	216	405	948	1740	3284
90	46	100	204	383	897	1643	3106
100	43	95	194	364	854	1560	2956
125	38	85	174	327	769	1399	2661
150	35	77	159	300	706	1280	2442
200	30	67	138	261	616	1112	2132
250	27	60	124	235	555	997	1919
300	24	55	113	215	510	912	1761
400	21	47	98	187	445	792	1538
500	19	42	88	168	401	711	1384
600	16	39	81	154	368	650	1270
700	16	36	75	143	342	603	1181
800	14	33	70	134	321	565	1109
900	13	31	66	127	304	533	1049
1000	13	30	63	121	289	506	998
1100	13	28	60	115	277	483	954
1200	11	27	58	111	266	463	916
1300	11	26	56	107	256	445	882
1400	11	25	54	103	247	430	852
1500	9	24	52	99	239	415	824

Table A-19

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	31	39	48	62
5	229	485	938	1702	3871	7518	13480
10	161	340	668	1217	2796	5359	9723
15	130	277	548	1003	2311	4396	8031
20	112	239	476	874	2019	3819	7013
25	100	213	427	786	1818	3425	6312
30	90	194	390	720	1669	3133	5793
40	77	168	339	628	1458	2722	5058
50	70	150	304	564	1313	2441	4553
60	63	137	278	517	1205	2233	4178
70	58	127	258	480	1121	2071	3885
80	54	119	241	451	1053	1940	3648
90	51	112	228	426	996	1832	3451
100	49	106	216	405	948	1740	3284
125	43	95	194	364	854	1560	2956
150	40	87	177	334	784	1427	2712
200	33	75	154	291	685	1240	2368
250	30	67	138	261	616	1112	2132
300	27	61	126	239	566	1017	1956
400	24	53	110	209	494	884	1708
500	21	47	98	187	445	792	1538
600	19	43	90	172	409	725	1411
700	17	40	83	160	380	672	1312
800	16	37	78	150	357	630	1232
900	14	35	74	141	338	595	1165
1000	14	33	70	134	321	565	1109
1100	14	32	67	128	307	539	1060
1200	13	30	64	123	295	517	1017
1300	13	29	62	119	284	497	980
1400	11	28	60	114	274	479	946
1500	11	27	58	111	266	463	916

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

Table A-20

Gas Pressure of: 0.5 psi or Less
 Pressure Drop of: 3.0 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	31	39	48	62
5	253	531	1025	2187	4217	8218	14689
10	177	373	730	1512	3044	5856	10595
15	142	303	599	1218	2516	4805	8751
20	123	262	520	1046	2198	4174	7641
25	109	233	466	929	1980	3743	6879
30	100	213	426	842	1817	3425	6311
40	85	186	369	723	1588	2974	5512
50	76	167	331	641	1430	2668	4961
60	70	153	303	583	1312	2440	4552
70	65	142	281	537	1220	2263	4233
80	60	134	263	499	1146	2121	3975
90	57	126	248	469	1090	2002	3760
100	54	120	235	444	1043	1901	3578
125	47	109	211	396	950	1705	3221
150	43	99	192	363	880	1560	2956
200	36	86	167	316	779	1354	2581
250	33	79	150	284	709	1215	2323
300	30	71	137	260	657	1111	2130
400	25	63	120	227	583	972	1860
500	22	56	107	203	531	877	1675
600	21	52	98	186	491	806	1536
700	19	47	90	173	459	750	1429
800	17	45	85	162	434	705	1342
900	16	42	80	153	414	668	1269
1000	16	41	75	147	396	637	1207
1100	14	39	72	140	380	608	1155
1200	14	37	69	134	366	584	1108
1300	14	36	67	129	354	564	1067
1400	13	34	64	124	344	545	1030
1500	13	33	63	120	333	527	997

Table A-21

Gas Pressure of: 0.5 psi or Less
 Pressure Drop of: 6.0 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	31	39	48	62
5	362	757	1440	2666	5839	11530	20535
10	253	531	1025	1868	4217	8218	14689
15	205	431	840	1523	3485	6741	12133
20	177	373	730	1327	3044	5856	10595
25	156	333	654	1193	2742	5252	9536
30	142	303	599	1093	2516	4805	8751
40	123	262	520	953	2198	4174	7641
50	109	233	466	856	1980	3743	6879
60	100	213	426	785	1817	3425	6311
70	92	199	395	730	1691	3175	5869
80	85	186	369	684	1588	3000	5512
90	81	175	349	646	1503	2862	5213
100	76	167	331	614	1430	2744	4961
125	68	150	297	553	1297	2510	4465
150	62	137	271	507	1206	2333	4097
200	54	118	235	441	1074	2080	3578
250	47	107	211	396	983	1901	3221
300	43	98	192	363	913	1768	2956
400	36	85	167	316	814	1576	2581
500	33	75	150	284	744	1441	2323
600	30	69	137	260	692	1340	2130
700	27	64	128	243	651	1259	1982
800	25	60	120	227	616	1193	1860
900	24	56	112	216	588	1139	1760
1000	22	53	107	205	564	1092	1675
1100	22	52	102	196	543	1051	1601
1200	21	49	98	188	524	1014	1536
1300	19	47	94	181	507	983	1479
1400	19	45	90	175	493	954	1429
1500	19	44	88	170	480	927	1383

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

Table A-22

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	31	39	48	62
5	798	1650	3044	5846	11980	24352	43244
10	558	1159	2169	4097	8652	17358	30866
15	452	943	1779	3328	7152	14239	25340
20	390	815	1545	2871	6249	12373	22031
25	348	727	1385	2561	5627	11095	19764
30	316	663	1267	2332	5166	10150	18087
40	272	572	1101	2012	4513	8819	15725
50	243	511	987	1795	4064	7908	14155
60	221	466	903	1634	3731	7234	12989
70	204	430	837	1517	3470	6710	12079
80	190	402	784	1423	3259	6286	11342
90	179	379	740	1345	3084	5935	10729
100	169	359	703	1279	2935	5637	10210
125	150	320	630	1150	2643	5055	9190
150	138	292	576	1054	2426	4624	8433
200	119	252	501	918	2120	4018	7364
250	106	225	449	826	1909	3603	6629
300	96	205	411	757	1752	3296	6083
400	82	177	357	659	1531	2864	5311
500	73	158	320	593	1378	2568	4781
600	66	144	292	543	1265	2349	4387
700	62	133	271	505	1177	2179	4080
800	57	125	254	473	1105	2041	3831
900	54	118	240	448	1046	1927	3624
1000	51	112	228	426	995	1830	3448
1100	49	106	217	407	952	1747	3297
1200	46	102	208	390	914	1674	3164
1300	44	98	200	375	880	1610	3047
1400	43	94	193	362	850	1553	2942
1500	41	91	187	351	823	1501	2848

Table A-23

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	31	39	48	62
5	1525	3121	5618	11112	21804	44902	79543
10	1067	2194	4002	7788	15616	32007	56775
15	865	1784	3281	6326	12878	26256	46611
20	746	1541	2851	5458	11251	22813	40524
25	664	1375	2556	4868	10132	20458	36355
30	604	1253	2337	4434	9301	18714	33268
40	522	1082	2031	3825	8221	16261	28924
50	465	965	1821	3411	7473	14582	25965
60	422	880	1666	3107	6914	13339	24025
70	390	814	1544	2870	6473	12443	22498
80	364	760	1446	2680	6114	11775	21254
90	343	716	1365	2524	5815	11213	20213
100	324	679	1297	2398	5559	10734	19326
125	289	605	1163	2149	5053	9788	17573
150	262	551	1063	1966	4675	9076	16261
200	226	478	924	1707	4135	8057	14384
250	202	429	834	1531	3759	7345	13080
300	183	393	768	1400	3477	6811	12102
400	158	341	673	1217	3074	6046	10706
500	141	306	608	1090	2796	5513	9735
600	128	281	559	997	2586	5112	9008
700	119	260	521	924	2421	4796	8436
800	111	243	491	866	2287	4538	7968
900	104	230	466	818	2175	4321	7579
1000	98	219	444	777	2078	4138	7246
1100	93	208	425	741	1996	3977	6958
1200	89	200	409	711	1923	3836	6705
1300	85	192	393	682	1858	3711	6479
1400	82	186	380	659	1800	3599	6278
1500	79	180	369	637	1748	3498	6096

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

Table A-24

Gas Pressure of: 10.0 psi
Pressure Drop of: 7.0 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	31	39	48	62
5		4569	7655	15886	31282	60175	94157
10		3235	5615	11327	23155	44728	71754
15		2644	4684	9293	19419	37602	61209
20		2291	4119	8076	17140	33245	54682
25		2050	3728	7243	15558	30217	50102
30		1872	3436	6626	14374	27949	46646
40		1622	3021	5758	12687	24711	41671
50		1451	2735	5164	11516	22460	38181
60		1325	2521	4724	10640	20774	35547
70		1227	2353	4382	9951	19448	33463
80		1148	2216	4106	9391	18367	31756
90		1083	2103	3876	8923	17464	30324
100		1028	2006	3682	8524	16694	29097
125		919	1815	3302	7737	15174	26660
150		840	1673	3021	7148	14035	24821
200		727	1471	2625	6309	12409	22174
250		651	1332	2354	5727	11278	20316
300		594	1227	2154	5291	10432	18915
400		515	1079	1872	4670	9223	16898
500		461	977	1678	4239	8383	15482
600		421	900	1536	3916	7754	14414
700		390	840	1424	3663	7259	13569
800		364	792	1334	3457	6855	12877
900		344	751	1260	3284	6518	12296
1000		326	716	1197	3138	6231	11799
1100		311	686	1142	3010	5982	11366
1200		298	660	1095	2899	5763	10985
1300		286	637	1053	2800	5569	10645
1400		276	616	1015	2711	5395	10341
1500		266	597	982	2631	5238	10065

Table A-25

Gas Pressure of: 25.0 psi
Pressure Drop of: 10.0 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	31	39	48	62
5		7407	14503	24838	50546	69501	117452
10		5202	9729	17697	37079	54719	92856
15		4230	7702	14514	30932	47575	80931
20		3652	6526	12610	27200	43080	73411
25		3260	5739	11306	24618	39888	68063
30		2970	5167	10342	22691	37456	63983
40		2565	4378	8984	19953	33917	58038
50		2289	3850	8056	18058	31404	53809
60		2086	3466	7368	16645	29490	50584
70		1928	3171	6833	15537	27962	48009
80		1801	2936	6401	14636	26703	45884
90		1696	2744	6043	13886	25640	44088
100		1607	2582	5740	13247	24725	42541
125		1434	2271	5146	11989	22893	39442
150		1307	2044	4707	11051	21497	37078
200		1128	1732	4089	9717	19466	33632
250		1007	1523	3667	8795	18023	31182
300		917	1371	3354	8106	16925	29313
400		792	1162	2914	7128	15325	26589
500		707	1022	2612	6451	14190	24652
600		644	920	2390	5947	13325	23175
700		595	841	2216	5551	12635	21995
800		556	779	2076	5229	12066	21021
900		524	728	1960	4961	11585	20198
1000		496	685	1861	4732	11172	19490
1100		473	648	1776	4535	10810	18870
1200		452	617	1702	4362	10491	18321
1300		434	589	1637	4209	10205	17831
1400		418	564	1579	4072	9947	17389
1500		403	542	1526	3948	9713	16987

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

Table A-26											
		Gas Pressure of: 0.5		psi or Less							
		Pressure Drop of: 0.5		inches W.C.							
<i>(based on a 0.60 specific gravity gas)</i>											
	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-27											
		Gas Pressure of: 0.5		psi or Less							
		Pressure Drop of: 1.0		inches W.C.							
<i>(based on a 1.52 specific gravity gas)</i>											
	Size	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	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

8.0 DEFINITIONS

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-33 Multipliers to be Used with Tables A-1 through A-27 and Table A-34

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-34 Natural Gas Flow in CFH

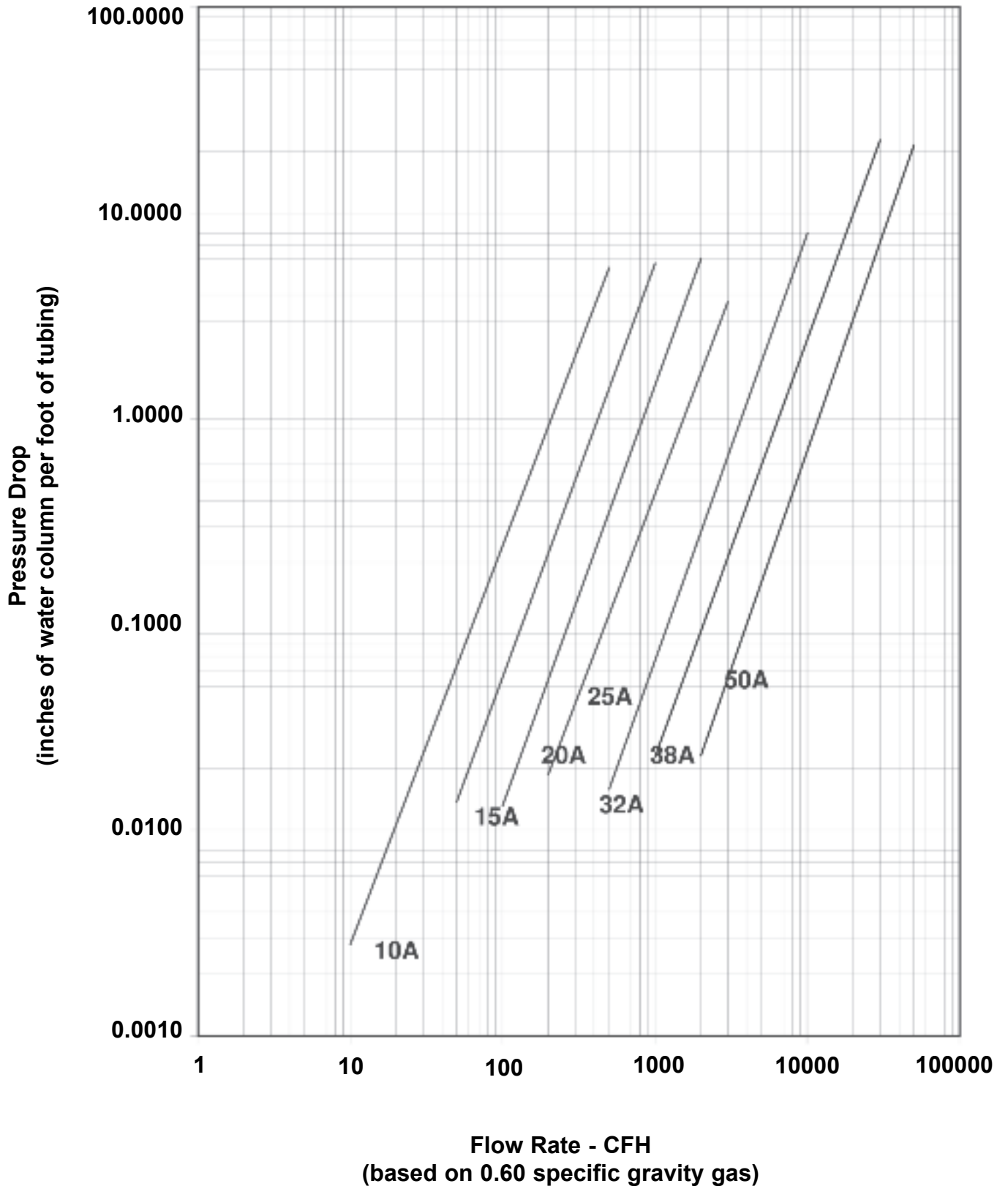
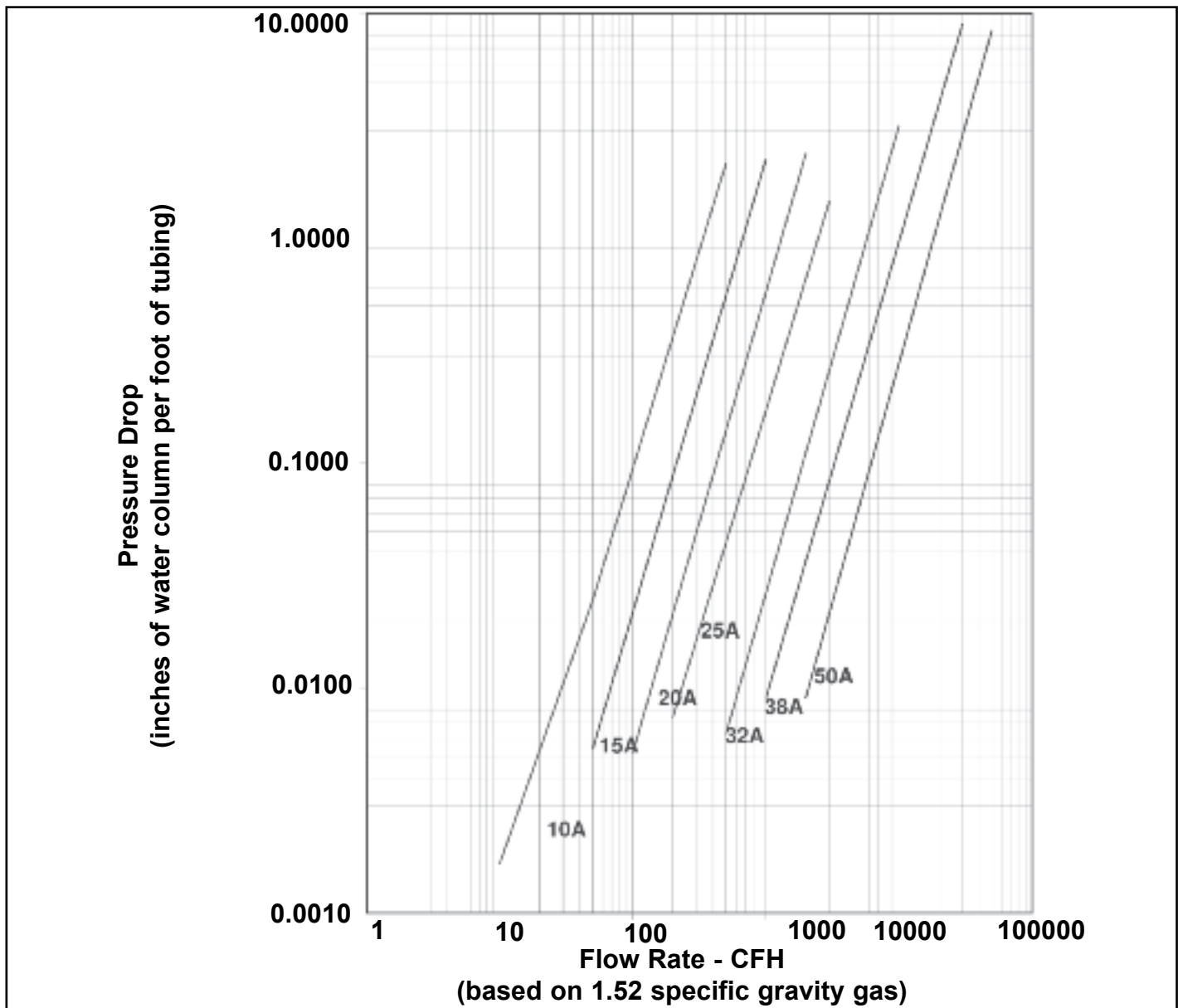


Table A-35 Propane Flow in CFH



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-35 Equivalent Lengths Factor for Fittings and Valves	
10A Tubing $L_2^1 = L_1^2 (0.08)n^3$	
15A Tubing $L_2 = L_1 (0.4)n$	
25A, 32A, 38A, 50A Tubing $L_2 = L_1 (6.0)n$	
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.	

APPENDIX B

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 m³) of pipe volume or fraction thereof. When testing a system having a volume less than 10 cubic feet (0.28m³) 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 m³), 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.

WARD Flex

WARD Flex 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.

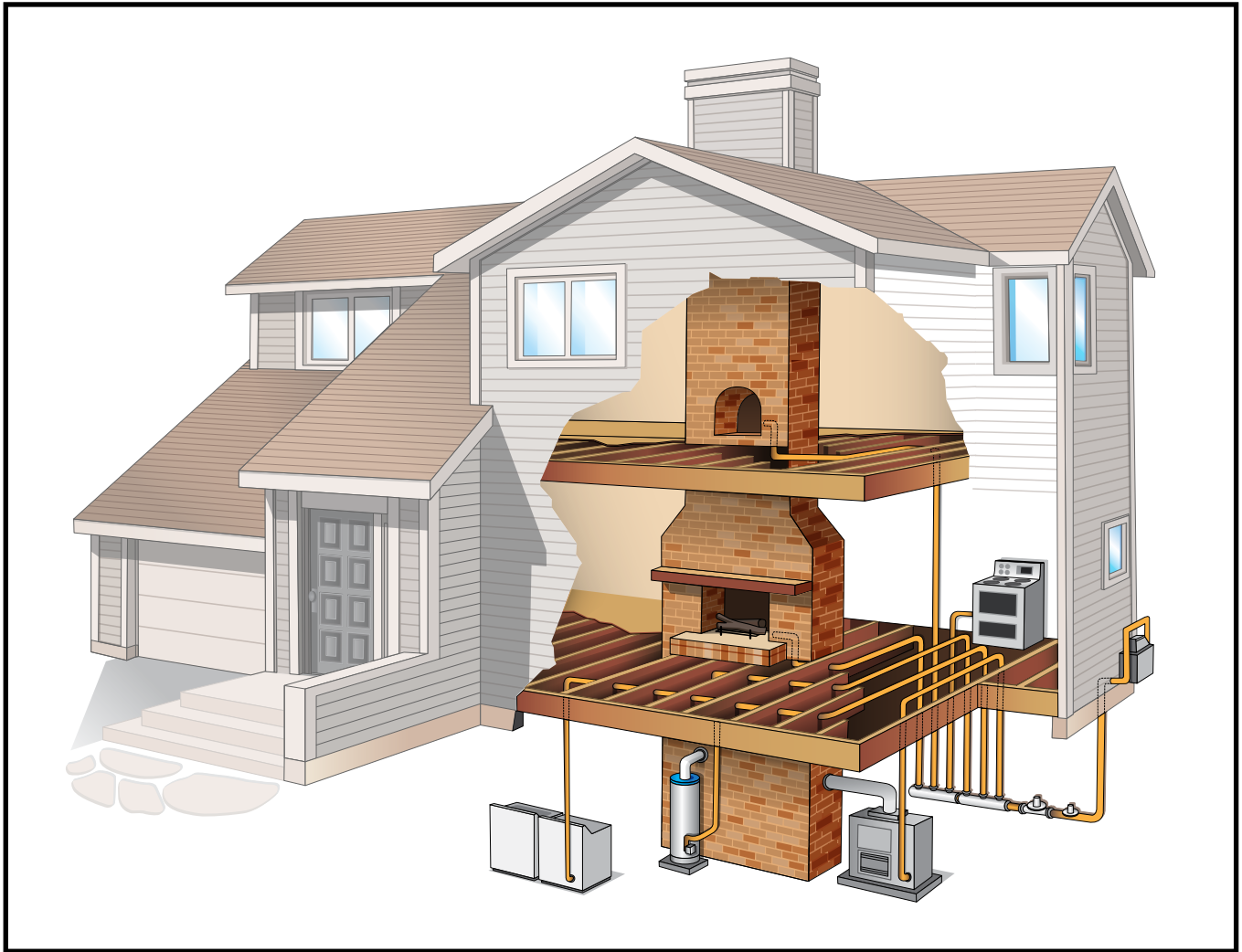
This warranty shall not apply to any products that are not installed in accordance with the applicable WARDFLEX®/WARDFLEX® II Design and Installation Guide, or that are altered, repaired or misused, through negligence or otherwise, in a manner that, in the reasonable opinion of SELLER, adversely affects 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.

WARD MFG



WARDMFG

117 GULICK STREET | BLOSSBURG, PA 16912 | PH: 800-248-1027 | FAX: 570-241-0100

WWW.WARDMFG.COM



MADE IN THE USA

WDFLXINSTALL

WARDFLEX is a registered trademark of Ward Manufacturing, LLC © 2014