VOLUME VII: XIRTEC® CPVC POTABLE WATER PIPING SYSTEM

MECHANICAL TECHNICAL MANUAL SERIES

MECHANICAL SYSTEMS

Xirtec® CPVC

- Hot and Cold Potable Water Distribution

IPEX by aliaxis

We build tough products for tough environments®

Xirtec® CPVC Potable Water Piping System

Mechanical Technical Manual Series, Vol. VII

IPEX USA LLC hereinafter referred to as "IPEX".

LITERATURE & WEBSITE DISCLAIMER

The information contained here within is based on current information and product design at the time of publication and is subject to change without notification. IPEX does not guarantee or warranty the accuracy, suitability for particular applications, or results to be obtained therefrom. Always consult a licensed piping-design engineering firm for engineering recommendations during the design and installation of a project.

ABOUT IPEX

At IPEX, we have been manufacturing nonmetallic pipe and fittings since 1951. Our products are made available for customers thanks to a network of regional stocking locations throughout North America. We offer a wide variety of systems including complete lines of piping, fittings, valves and custom-fabricated items.

More importantly, we are committed to meeting our customers' needs. As a leader in the plastic piping industry, IPEX continually develops new products, modernizes manufacturing facilities and acquires innovative process technology. In addition, our staff take pride in their work, making available to customers their extensive thermoplastic knowledge and field experience. IPEX personnel are committed to improving the safety, reliability and performance of thermoplastic materials. We are involved in several standards committees and are members of and/or comply with the organizations listed on this page.

If you need additional copies of any instructions, or if you have questions about the safe and proper installation of IPEX products, contact IPEX Toll Free 1-800-463-9572.

For the most up-to-date information on IPEX products, visit: ipexna.com

Always adhere to local jobsite and workplace safety regulations.

UNDERSTANDING SAFETY ALERT MESSAGES

It is important to read and understand this manual. It contains information to help maintain safety and prevent problems. Improper installation or use of Xirtec® CPVC can result in personal injury and/or property damage. It is important to be aware of and recognize safety alert messages as they appear in this manual.

The types of safety alert messages are described below.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid personal injury or death.

WARNING

"**WARNING**" Indicates a hazardous situation which, if not avoided, could result in severe injury or death.

CAUTION

"**CAUTION**" Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

"**NOTICE**" Indicates a hazardous situation which, if not avoided, may result in system failure and property damage.

The use of the word "**NOTE**" signifies special instructions which are important but are not related to hazards.

XIRTEC CPVC SAFETY ALERTS

WARNING

- **NEVER** use or test Xirtec CPVC pipe, fittings and valves with compressed air or other gases.
- **DO NOT** use air-over-water boosters.

Use of compressed air or gas in Xirtec CPVC pipe, fittings, and valves can result in explosive failures and cause severe injury or death.

WARNING

Follow all preparation and installation procedures.

WARNING

MAINTENANCE, AGING AND REPAIRS

ALWAYS refer to SECTION 4 of this Technical Manual before commencing any maintenance or repairs on any Xirtec CPVC products. Failure to follow instructions may cause cracks or fractures to develop in Xirtec CPVC products resulting in property damage and personal injury.

NOTICE

Xirtec CPVC (1/2" - 6") may be used in hot and cold potable water distribution systems. All installation guidelines and recommendations found in this manual are for potable water applications. Volume 1 *Vinyl Process Piping Systems* of Industrial Technical Manual Series should be referenced for all other applications.

NOTICE

AGING OF CORZAN® TECHNOLOGY

Corzan®* Technology aging can result in changes to physical characteristics such as increased brittleness and the reduction in impact resistance. This is precipitated by prolonged elevated operating temperatures or prolonged exposure to UV light. Refer to SECTION 4 of this Technical Manual for further details.

CAUTION

Xirtec CPVC must be installed at least 6" away from any external heat source with a surface temperature greater than 160°F.

CAUTION

Do not connect Xirtec CPVC products directly to a hot water heater or boiler. When Xirtec CPVC piping is connected to a gas-fired or electric water heater, use a metal nipple to ensure Xirtec CPVC piping is a minimum 12" away from the appliance.

NOTE: Verify Code requirements prior to installation.

SUPPLEMENTAL INFORMATION - DO'S AND DON'TS

CAUTION

Refer to the contents of this Technical Manual for complete instructions and guidelines.

DO'S

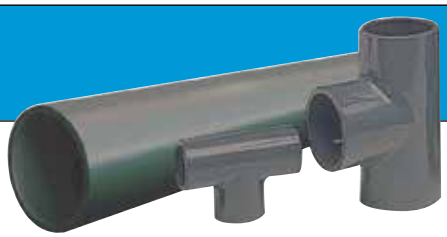
- Read the manufacturer's installation instructions and install product accordingly
- Follow recommended safe work practices
- Use only PTFE (Teflon™) tape to seal threaded connections
- Make certain that gasket lubricants or fire-stop materials are compatible with Xirtec CPVC product
- Keep pipe and fittings in original packaging until needed
- If pipe and fittings are stored outdoors, cover with a well-ventilated white tarp
- Follow handling and storage procedures
- Only use tools on Xirtec CPVC pipe and fittings as described in this manual
- Cut the pipe ends squarely
- Deburr and bevel the pipe end with a chamfering tool before solvent welding
- Avoid puddling of solvent cement in fittings and pipe
- Make certain no solvent cement is on the mating faces of flanges, valves or unions, as well as the threaded portion of adapter fittings
- Ensure excess primer and solvent cement does not run inside pipe, fittings and valves
- Follow Xirtec CPVC recommended cure times before pressure testing
- Slowly fill piping system with water and bleed the air from the system before pressure testing
- Use water hammer arrestors
- Allow for movement due to expansion and contraction
- Install Xirtec CPVC at least 6" away from any external heat source with a surface temperature greater than 160°F.

DON'TS

- Don't use petroleum or solvent-based paints, sealants or lubricants
- Don't install adhesive tape, insulated wire, or cable in direct contact with Xirtec CPVC product
- Don't use solvent cement that has exceeded its shelf life or has become discolored or jelled
- Don't thread or drill Xirtec CPVC pipe
- Don't allow the primer and/or the solvent cement to run inside an Xirtec CPVC valve
- Don't use solvent cement near sources of heat or open flame, or when smoking
- Don't pressure test until recommended cure times have elapsed
- Don't pressure test with air
- Don't cut pipe with dull or broken cutting-tool blades
- Don't use ratchet cutters
- Don't use Xirtec CPVC product that's been stored unprotected outdoors and is faded in color
- Don't allow threaded rod to come in contact with the pipe, for example, threaded rods used to connect pipe hangers
- Don't connect Xirtec CPVC products directly to a hot water heater or boiler.

THE FOLLOWING NOTICE SHOULD BE PRINTED AND POSTED AT THE JOBSITE.

NOTICE



Xirtec® CPVC Potable Water Piping System

Please read the following notice before beginning any activity which could come in contact with this system:

Xirtec CPVC piping components may become damaged by certain substances and construction practices.

DO NOT stack, support, hang equipment, or hang flexible wire/cable, especially communications cable, or other material on the Xirtec CPVC piping system.

ONLY system compatible materials including, but not limited to, solvent cements, caulks and sealants, as noted in the Xirtec CPVC Technical Manual, should be used in contact with the Xirtec CPVC piping system.

DO NOT expose Xirtec CPVC products to incompatible substances, such as cutting oils, non-water based paints, packing oils (commonly found in pumps), traditional pipe thread paste and dope, fungicides, termiticides, insecticides, detergents, building caulks, adhesives tape, solder flux, flexible wire/cable (with special consideration for communications cabling), and non-approved spray foam insulation materials.

DO NOT expose Xirtec CPVC products to open flame, solder, or soldering flux.

DO NOT drop, distort, or impact Xirtec CPVC products or allow objects to be dropped on them.

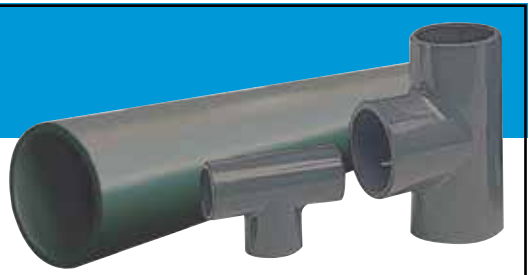
DO NOT handle Xirtec CPVC products with gloves contaminated with oils (hydrocarbons) or other incompatible materials.

Failure to follow this notice may cause cracks or fractures to develop in Xirtec CPVC products resulting in personal injury and property damage due to leaks or flooding. The presence of any visible cracks may require partial or full system replacement. For additional information contact the general contractor or system installer.

REFER TO THE XIRTEC CPVC POTABLE WATER TECHNICAL MANUAL AND FOR ADDITIONAL XIRTEC CPVC PRODUCT INFORMATION, CONTACT IPEX AT 800-463-9572 OR VISIT IPEXNA.COM

NOTICE

Xirtec® CPVC Potable Water Piping System



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For your convenience, there are additional jobsite notice copies located within the last pages of this manual.

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For the most up-to-date information on Xirtec CPVC products, visit: ipexna.com

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CONTENTS

OVERVIEW

Xirtec® CPVC is a thermoplastic piping system that may be used for the distribution of potable water in the United States and where approved by authorities having jurisdiction (AHJ). Xirtec® CPVC is a registered trademark used under license. Pipe and fittings are manufactured using Corzan®* CPVC compound designed for the distribution of hot and cold potable water.

This manual provides installers, designers and engineers with guidance to help ensure the proper usage and installation of Xirtec CPVC for hot and cold potable water distribution systems. Readers are encouraged to contact an IPEX representative for any further consultation or clarification before using Xirtec CPVC for hot and cold potable water distribution systems to ensure a successful installation.

FEATURES AND BENEFITS

COMPLETE LINE – a dimensionally matched system that ensures an ideal fit between pipe, fittings and valves all offered from a single source.

FULLY CERTIFIED – Xirtec CPVC pipe, fittings and valves are certified to applicable ASTM standards. All components are listed to NSF61 for potable water applications.

SIZE RANGE – offered in IPS nominal pipe sizes 1/2" through 6".

LIGHTWEIGHT – when compared to traditional materials, Xirtec CPVC is relatively lightweight offering efficiency in transport, handling and installation.

FLOW CAPACITY – Xirtec CPVC scaling resistance results in long term increased flow capacity over copper.

CORROSION RESISTANCE – Xirtec CPVC material is resistant to metallic corrosion.

BURNING CHARACTERISTICS – Xirtec CPVC pipe and fittings are listed and labeled as having a Flame Spread and Smoke-Developed Rating of not more than 25 and 50, respectively, when tested in general accordance with ASTM E84 or UL 723. Always check with local authorities for approval.

MATERIAL – The Xirtec CPVC system has added impact strength resistance and heat deflection temperature (HDT) from being manufactured with Corzan CPVC compounds.

BIM – full suite of Xirtec CPVC Building Information Modeling (BIM) design models are available in Revit and many other popular formats at ipexna.com.

TRAINING AND SUPPORT – local application engineers and sales representation provide support where and when you need it. On-site training is also available prior to installation to ensure systems are installed without issue.

For additional information please contact an IPEX representative at ipexna.com.

*Xirtec® CPVC piping system is made with Corzan® CPVC compound. Corzan® is a registered trademark of the Lubrizol Corporation. Distributed in USA by IPEX USA LLC, Pineville, North Carolina.

APPLICATIONS

Xirtec CPVC may be used for hot and cold potable water distribution systems in the United States and where approved by AHJ's. If using Xirtec CPVC for any application other than hot and cold potable water distribution, refer to Volume 1 ***Vinyl Process Piping Systems*** **of Industrial Technical Manual Series.**

Common types of buildings where Xirtec CPVC may be used include:

- Apartments / condos / multi-family
- Hotels
- Long-term care facilities
- Retail stores
- Office buildings
- Schools
- Dormitories
- Health care facilities
- Restaurants
- Indoor sports facilities

MATERIAL DESCRIPTION

Xirtec® CPVC pipe, fittings and valves are manufactured with Corzan® CPVC Compound (Cell Classification 24448 and 23447) conforming to ASTM D1784, and are grey in color. These quality CPVC compounds are renowned for chemical resistance, durability and elevated temperature and pressure ratings. They feature outstanding resistance to photodegradation, creep stress and immunity to oxidation. Corzan CPVC compounds provide extended service and low maintenance versus common and strong resistance. They are not immune metals traditionally used in plumbing systems.

Xirtec CPVC pipe, fittings and valves are all designed within standard tolerances to work together as a system and must be installed as such. Only products approved by IPEX as part of the Xirtec CPVC system must be used. Mixing pipe, fittings, valves, sealants or joining methods not approved by IPEX can result in unsafe conditions and will void the warranty of the affected system.

PIPE

Xirtec CPVC pipe is manufactured to Iron Pipe Size Outside Diameter (IPSOD) dimensions. Pipe is made in 10 ft. and 20 ft. lengths and are available in nominal sizes 1/2" – 6".

Physical Dimensions and Weights of Xirtec CPVC Sch 80 pipe: Psi @ 73°F

Nom Size (in.)	OD (in.)	Min. Wall Thickness (in.)	Avg. ID (in)	Wgt of CPVC Pipe (lb/ft)
1/2	0.840	0.147	0.526	0.22
3/4	1.050	0.154	0.722	0.31
1	1.315	0.179	0.936	0.45
1-1/4	1.660	0.191	1.255	0.62
1-1/2	1.900	0.200	1.476	0.75
2	2.375	0.218	1.913	1.04
2-1/2	2.875	0.276	2.290	1.58
3	3.500	0.300	2.864	2.12
4	4.500	0.337	3.786	3.10
6	6.625	0.432	5.709	5.91

FITTINGS

The Xirtec CPVC system offers a wide variety of fittings including Tees, Reducer Tees, Elbows, Couplings, Reducer Bushings, and Flanges.

For additional information on potable water specific fittings, contact an IPEX representative at ipexna.com.

VALVES

Xirtec CPVC True Union Ball Valves (VXE Model) are available in sizes 1/2" through 4". True union connections allow for easy valve removal and replacement without having to cut the pipe. This valve uses specially selected EPDM O-ring seals for performance in potable water where a variety of treatment chemicals may be used.

Xirtec CPVC One-Piece Ball Valves are available in sizes 1/2" - 1". The one-piece valves can withstand 400 psi at 73°F. These valves feature a spin-welded design, making the valves light and compact. They are the smarter valve option for applications that do not require a serviceable connection.

For sizes 2-1/2" and above, consideration may also be given towards using IPEX FK Butterfly Valves. For additional information on Xirtec CPVC valves, contact an IPEX representative at ipexna.com.

Xirtec CPVC Pipe Physical Properties

PROPERTIES	CORZAN CPVC
Cell classification	24448
Specific gravity	1.51
Tensile strength, psi at 73°F	7,320
Modulus of elasticity tensile, psi at 73°F	423.000
Flexural strength, psi	13,200
Izod impact, ft.lbs./in. at 73°F, notched	10.0
Compressive strength, psi	10,100
Poisson's ratio	0.33
Working stress, psi at 73°F	2,000
Coefficient of thermal expansion in./in./°F ($\times 10^{-5}$)	3.4
Linear expansion, in./10°F per 100' of pipe	0.41
Maximum operating temperature under pressure	200°F
Deflection temperature under load, °F at 66 psi	n/a
Deflection temperature under load, °F at 264 psi	239
Thermal conductivity, BTU.in./hr.ft^2.°F	0.95
Burning rate	Self extinguish
Burning class	V-0
Flash ignition, °F	900
Limited oxygen index (%)	60
Water absorption, %, (24 hrs. at 73°F)	0.03

SYSTEM PRESSURE AND TEMPERATURE RATINGS

NOTICE

Maximum operating temperature of Xirtec CPVC used in Potable Water Piping System must not exceed 160°F.

Xirtec CPVC
Maximum Working Pressures

Nom. Size (in.)	Max Working Pressure (psi)
1/2	850
3/4	690
1	630
1-1/4	520
1-1/2	470
2	400
2-1/2	420
3	370
4	320
6	280

Xirtec CPVC
Temperature Correction Factors

Operating Temperature °F	Correction Factors CPVC
73	1.00
80	0.96
90	0.91
100	0.82
110	0.74
120	0.65
130	0.58
140	0.50
150	0.45
160	0.40

Example:

What is the Pressure Rating of 3" Schedule 80 CPVC at 100°F?

Step 1: Determine Maximum Working Pressure for 3" Schedule 80 CPVC from the table above = 370 psi

Step 2: Determine Correction Factor at 100°F for CPVC = 0.82

Step 3: Maximum Working Pressure x Correction Factor will give the pressure rating at the elevated system temperature

370 psi x 0.82 = 303.4 psi @ 100°F

SPECIAL PRESSURE AND TEMPERATURE CONSIDERATIONS FOR ACCESSORIES

For individual accessory pressure and temperature capabilities, refer to the Accessories Maximum Operating Pressure Vs. Temperature chart below.

BRONZE THREADED ADAPTER FITTINGS

CPVC Threaded Adapter Fittings provide a transition from Xirtec CPVC to metallic threaded accessories such as valves, pumps or alternative materials. The adapter fittings are rated at 400 psi at 73°F and 150 psi at 160°F.

FULL PRESSURE (FP) FLANGE KITS

The Xirtec CPVC FP Flange Kits are specifically designed to increase the pressure capability of a Xirtec CPVC one-piece flange. The Full Pressure Flange Kits have a pressure rating equal to that of Xirtec CPVC pipe in each of the 4 sizes offered (2-1/2", 3", 4" and 6"). The pressure rating is valid for connections to solid flat face metal flanges or to a second Xirtec CPVC FP Flange Kit.

MAINTENANCE COUPLINGS

Maintenance Couplings provide a fast 'pipe to pipe' alternative connection for Xirtec CPVC. They are ideal for quick repairs of Xirtec CPVC pipe in need of maintenance without delays due to necessary cure times associated with solvent cement.

Available sizes are 1" through 4". The couplings are rated at 400 psi at 73°F and 150 psi at 160°F.

XIRTEC CPVC ONE-PIECE BALL VALVE

Xirtec CPVC One-Piece Ball Valves have a pressure rating of 400 psi at 73°F and 150 psi at 160°F.

XIRTEC CPVC TRUE UNION BALL VALVE

Xirtec CPVC True Union Ball Valves (VXE model) have a pressure rating of 232 psi at 73°F.

For pressures at elevated temperatures, refer to the Accessories Maximum Operating Pressure Vs. Temperature chart below.

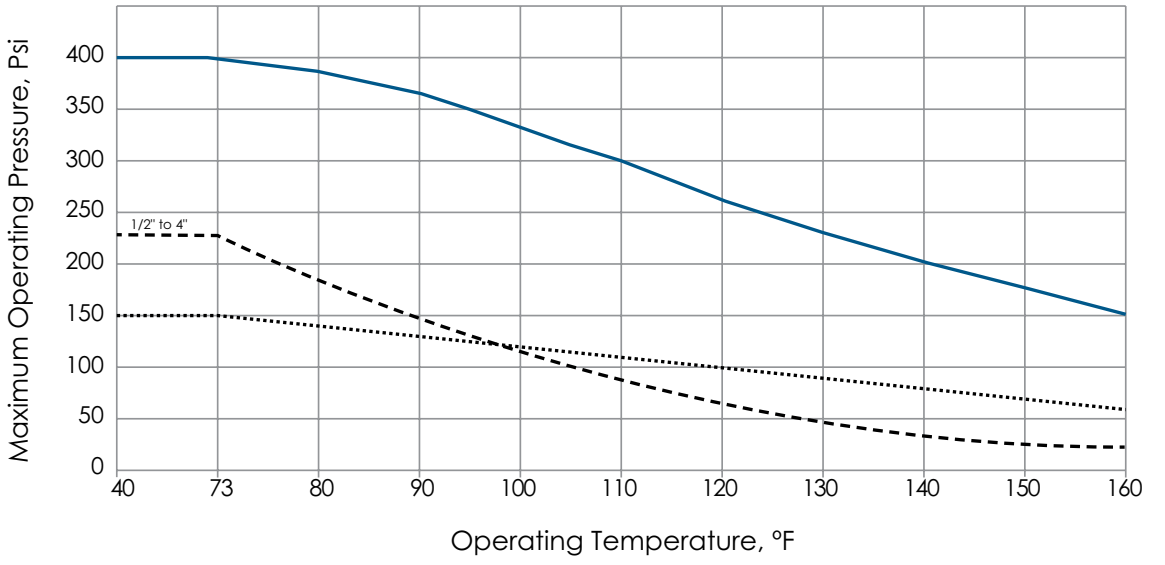
FLANGES AND UNION FITTINGS

Due to the presence of mechanical seals, Xirtec CPVC unions and flanges have a cold water pressure rating of 150 psi at 73°F. This rating is reduced at higher temperatures. Refer to the Accessories Maximum Operating Pressure Vs. Temperature chart below.

NOTICE

Maximum operating temperatures and pressures of the lowest rated component in the piping system must not be exceeded during pressure testing or system operation. Always design to limit and accommodate all surge pressures in an Xirtec CPVC system.

Accessories Maximum Operating Pressure Vs. Temperature



HYDRAULIC DESIGN

SIZING XIRTEC CPVC PIPE

Proper sizing design is necessary to create a balance between flow velocity, flow volume and pressure head losses. Due to similar inside diameter dimensions, Xirtec CPVC may use design sizes similar to copper.

INSIDE DIAMETER COMPARISON

A Xirtec CPVC water distribution system offers increased flow capacity when compared to alternative piping materials. Xirtec CPVC and Type L copper have similar inside diameters while PEX and CTS CPVC are considerably smaller. Most of the time during pipe sizing of a water distribution system, Xirtec CPVC can be used as a direct substitute for Type L copper for new designs and system replacements while one nominal size larger of PEX or CTS CPVC may be required to maintain equivalent flow and velocity.

Inside Diameter Comparison

Nom. Pipe Size (in)	Xirtec CPVC (in)	Copper Type L (in)	PEX SDR 9 (in)	CTS CPVC (in)
1/2	0.526	0.545	0.475	0.479
3/4	0.722	0.785	0.670	0.695
1	0.936	1.025	0.861	0.903
1-1/4	1.255	1.265	1.054	1.104
1-1/2	1.476	1.505	1.245	1.310
2	1.913	1.985	1.629	1.717
2-1/2	2.290	2.465	2.011	-
3	2.864	2.945	2.400	-
4	3.786	3.905	-	-
6	5.709	5.845	-	-

FLOW CAPACITY AND FRICTION LOSS THROUGH PIPING

The flow capacity of a pipe is related to its inside diameter. As fluid flows through a piping system, it will experience friction resistance between the fluid and the pipe wall resulting in a pressure loss. This pressure loss is a result of fluid density, viscosity, velocity, temperature, type of flow, and smoothness of the pipe wall.

Friction loss for Xirtec CPVC pipe can be determined using the following equations.

DARCY-WEISBACH EQUATION

The most widely used equation to calculate friction loss in water distribution system is the Darcy-Weisbach equation. This equation takes into account the density of water at a given temperature, the pipe roughness, the water velocity, and the length of the pipe run.

$$H_L = f\left(\frac{L}{d_i}\right)\left(\frac{V^2}{2g}\right)$$

Where:

H_L = Frictional head loss (ft. water)
(One ft. of water = 0.4335 psi)

f = friction factor (dimensionless)

L = length of pipe (ft)

d_i = inside diameter of pipe (ft)

V = flow velocity (ft/s)

g = gravitational acceleration (32.2 ft/s^2)

First, designers are reminded of the velocity and flow rate relationship.

Velocity = Volumetric Flow / Pipe Area, or V = Q/A.

To allow the use of the formula with commonly used units of measure, it can be rearranged as follows:

$$V = \frac{(0.4085)Q}{d_i^2}$$

Where:

V = flow velocity (ft/s)

Q = volumetric flow (US gpm)

d_i = inside diameter of pipe (in)

Next, the dimensionless friction factor (f) must be determined. Water distribution systems generally operate in the turbulent flow regime. Therefore, the friction factor is derived using the Colebrook equation, where f is solved implicitly.

$$\frac{1}{\sqrt{f}} = -2\log\left(\frac{\varepsilon}{3.7d_i} + \frac{2.51}{Re\sqrt{f}}\right)$$

Where:

f = friction factor (dimensionless)

ε = absolute pipe roughness (5 x 10^{-6} ft for Xirtec CPVC pipe)

d_i = inside diameter of pipe (ft)

Re = Reynolds number ($Re = \rho VD/\mu$)

Where:

ρ = density of water (lb_m/ft^3)

V = flow velocity (ft/s)

d_i = inside diameter of pipe (ft)

μ = dynamic viscosity ($lb_m/ft \cdot s$)

For turbulent flow, the Reynolds number is greater than > 4000.

The friction factor (f) can also be determined using a standard Moody chart. The Moody chart shows the relationship between the friction factor, the Reynolds number, the relative pipe roughness (the ratio between the absolute pipe roughness (ε) and inside diameter of the pipe (d_i), $\varepsilon / (d_i)$)

Once the friction factor has been determined, it can then be used in the Darcy-Weisbach equation to calculate the frictional head loss.

The friction loss tables on the pages that follow use the Darcy-Weisbach equation to determine head loss for Xirtec CPVC pipe.

Contact IPEX for further assistance at ipexna.com.

HAZEN-WILLIAMS EQUATION

A commonly used equation to calculate friction loss in water distribution systems is the Hazen-Williams equation. This equation is generally valid for water flowing in pipe sizes larger than 2" and temperatures between 40°F and 75°F. Using this equation, designers can calculate the friction losses, also known as Head Loss (H_L), for a given pipe size and the flow rate, Q.

First, designers are reminded of the velocity and flow rate relationship.

Velocity = Volumetric Flow / Pipe Area, or V = Q/A.

To allow the use of the formula with commonly used units of measure, it can be rearranged as follows:

$$V = \frac{(0.4085)Q}{d_i^2}$$

Where:

V = flow velocity (ft/s)

Q = volumetric flow (US gpm)

d_i = inside diameter of pipe (in.)

The Hazen-Williams empirical formula for calculating head loss is as follows,

$$H_L = \frac{0.2083(100/C)^{1.852}(Q)^{1.852}}{(d_i)^{4.8655}}$$

Where:

H_L = Frictional head loss (ft. water/100ft)
(One foot of water = 0.4335 psi)

C = Hazen-William factor (150 for Xirtec CPVC)

d_i = Inside diameter of pipe (in)

This formula can be simplified for use with Xirtec CPVC by substituting C =150 and by converting units for H_L to read as,

$$H_L = \frac{0.0983(Q)^{1.852}}{(d_i)^{4.8655}}$$

DESIGN VELOCITY

The maximum design velocity for Xirtec CPVC Potable Water System is 8 ft/s (2.44 m/s). This limit is considered a good balance between maximizing flow capacity while minimizing frictional head losses and water hammer potential.

Thermoplastic pipe is not subject to erosion caused by high velocities and turbulent flow in commercial water applications. The design velocity for Xirtec CPVC does not account, however, for possible erosion of metallic system component and fixtures. The system must be designed and installed utilizing good engineering practices.

For fluid velocities greater than 5ft/s, additional design considerations are required. Examples of these considerations are listed below.

ACTUATED VALVES - Using actuated valves with a specific closing time will reduce the possibility of inadvertent opening or closing of a valve too quickly. With pneumatic and air-spring actuators, it may be necessary to place a valve in the air line to slow down the valve operation cycle.

PUMP STARTUP - Evaluate flow at pump start-up and during spin-down. Also determine how much air, if any, is introduced during pump start-up. Any entrapped air should be evacuated by venting from the high point.

If possible, when starting a pump, partially close the valve in the discharge line to minimize the volume of water that is rapidly accelerated through the system. Once the pump is up to speed and the line completely full, the valve may be opened.

SURGE CONTROL - Use surge control devices and standpipes to give flow storage during surge and to minimize column separation. Check valves can be used near pumps to help keep lines full.

VACUUM BREAKER-AIR-RELIEF VALVES - Use properly sized vacuum breaker-air-relief valves to control the amount of air that is admitted or exhausted through the system.

XIRTEC CPVC FLOW CAPACITY AND FRICTION LOSSES – PIPE

Note: These tables summarize the velocity and head loss of Xirtec CPVC pipe for all sizes and for various volumetric flow rates. The upper velocity limit of 8 ft/s is used for all sizes.

Flow Rate		Velocity	40°F		60°F		80°F		100°F		120°F		140°F		160°F	
			Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)
US gpm	L/sec	ft/s	1/2"		1/2"		1/2"		1/2"		1/2"		1/2"		1/2"	
0.5	0.03	0.74	0.97	0.42	0.87	0.38	0.81	0.35	0.75	0.33	0.71	0.31	0.68	0.29	0.65	0.28
1	0.06	1.48	3.12	1.35	2.85	1.23	2.64	1.14	2.49	1.08	2.36	1.02	2.26	0.98	2.18	0.94
2	0.13	2.95	10.27	4.45	9.44	4.09	8.82	3.82	8.34	3.61	7.96	3.45	7.64	3.31	7.38	3.20
3	0.19	4.43	20.77	8.99	19.17	8.30	17.98	7.78	17.06	7.38	16.31	7.06	15.70	6.80	15.20	6.58
4	0.25	5.91	34.35	14.87	31.81	13.77	29.90	12.95	28.42	12.31	27.24	11.79	26.26	11.37	25.46	11.02
5	0.32	7.38	50.84	22.01	47.19	20.43	44.44	19.24	42.31	18.32	40.61	17.58	39.21	16.98	38.05	16.48

Flow Rate		Velocity	40°F		60°F		80°F		100°F		120°F		140°F		160°F	
			Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)
US gpm	L/sec	ft/s	3/4"		3/4"		3/4"		3/4"		3/4"		3/4"		3/4"	
1	0.06	0.78	0.70	0.30	0.64	0.28	0.59	0.26	0.56	0.24	0.53	0.23	0.50	0.22	0.48	0.21
2	0.13	1.57	2.30	0.99	2.10	0.91	1.96	0.85	1.85	0.80	1.76	0.76	1.69	0.73	1.63	0.70
3	0.19	2.35	4.62	2.00	4.25	1.84	3.97	1.72	3.76	1.63	3.59	1.55	3.45	1.49	3.33	1.44
4	0.25	3.13	7.62	3.30	7.03	3.04	6.59	2.85	6.25	2.70	5.97	2.59	5.74	2.49	5.56	2.41
5	0.32	3.92	11.25	4.87	10.40	4.50	9.77	4.23	9.27	4.01	8.88	3.84	8.55	3.70	8.28	3.58
6	0.38	4.70	15.49	6.71	14.34	6.21	13.49	5.84	12.82	5.55	12.28	5.32	11.84	5.13	11.48	4.97
7	0.44	5.49	20.31	8.79	18.84	8.16	17.73	7.68	16.87	7.31	16.18	7.01	15.61	6.76	15.14	6.56
8	0.50	6.27	25.69	11.12	23.86	10.33	22.49	9.74	21.42	9.27	20.55	8.90	19.84	8.59	19.26	8.34
9	0.57	7.05	31.62	13.69	29.41	12.73	27.74	12.01	26.44	11.45	25.40	11.00	24.54	10.62	23.83	10.32
10	0.63	7.84	38.12	16.51	35.48	15.36	33.49	14.50	31.95	13.83	30.71	13.30	29.68	12.85	28.84	12.49

Flow Rate		Velocity	40°F		60°F		80°F		100°F		120°F		140°F		160°F	
			Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)
US gpm	L/sec	ft/s	1"		1"		1"		1"		1"		1"		1"	
4	0.25	1.87	2.23	0.96	2.05	0.89	1.91	0.83	1.81	0.78	1.73	0.75	1.66	0.72	1.60	0.69
5	0.32	2.33	3.28	1.42	3.02	1.31	2.83	1.23	2.68	1.16	2.56	1.11	2.46	1.07	2.38	1.03
6	0.38	2.80	4.51	1.95	4.16	1.80	3.90	1.69	3.70	1.60	3.54	1.53	3.41	1.48	3.30	1.43
7	0.44	3.26	5.90	2.55	5.46	2.36	5.12	2.22	4.87	2.11	4.66	2.02	4.49	1.94	4.34	1.88
8	0.50	3.73	7.46	3.23	6.91	2.99	6.49	2.81	6.17	2.67	5.91	2.56	5.70	2.47	5.52	2.39
9	0.57	4.20	9.17	3.97	8.50	3.68	8.00	3.46	7.61	3.29	7.29	3.16	7.03	3.04	6.82	2.95
10	0.63	4.66	11.04	4.78	10.24	4.44	9.64	4.18	9.18	3.97	8.80	3.81	8.49	3.68	8.24	3.57
15	0.95	6.99	22.60	9.79	21.05	9.12	19.89	8.61	18.98	8.22	18.24	7.90	17.64	7.64	17.14	7.42

XIRTEC CPVC FLOW CAPACITY AND FRICTION LOSSES – PIPE

Note: These tables summarize the velocity and head loss of Xirtec CPVC pipe for all sizes and for various volumetric flow rates. The upper velocity limit of 8 ft/s is used for all sizes.

Flow Rate		Velocity	40°F		60°F		80°F		100°F		120°F		140°F		160°F	
			Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)
US gpm	L/sec	ft/s	1-1/4″		1-1/4″		1-1/4″		1-1/4″		1-1/4″		1-1/4″		1-1/4″	
8	0.50	2.07	1.85	0.80	1.71	0.74	1.60	0.69	1.52	0.66	1.45	0.63	1.40	0.60	1.35	0.58
9	0.57	2.33	2.27	0.98	2.10	0.91	1.97	0.85	1.87	0.81	1.79	0.77	1.72	0.75	1.67	0.72
10	0.63	2.59	2.73	1.18	2.53	1.09	2.37	1.03	2.25	0.98	2.16	0.93	2.08	0.90	2.01	0.87
15	0.95	3.89	5.57	2.41	5.17	2.24	4.87	2.11	4.64	2.01	4.45	1.93	4.30	1.86	4.17	1.80
20	1.26	5.19	9.26	4.01	8.63	3.73	8.14	3.53	7.76	3.36	7.46	3.23	7.21	3.12	7.00	3.03
25	1.58	6.48	13.77	5.96	12.84	5.56	12.14	5.26	11.59	5.02	11.15	4.83	10.79	4.67	10.49	4.54
30	1.89	7.78	19.05	8.25	17.79	7.70	16.85	7.29	16.11	6.97	15.51	6.72	15.02	6.50	14.61	6.32

Flow Rate		Velocity	40°F		60°F		80°F		100°F		120°F		140°F		160°F	
			Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)
US gpm	L/sec	ft/s	1-1/2″		1-1/2″		1-1/2″		1-1/2″		1-1/2″		1-1/2″		1-1/2″	
10	0.63	1.88	1.26	0.55	1.17	0.51	1.10	0.47	1.04	0.45	0.99	0.43	0.96	0.41	0.92	0.40
15	0.95	2.81	2.57	1.11	2.38	1.03	2.24	0.97	2.13	0.92	2.04	0.89	1.97	0.85	1.91	0.83
20	1.26	3.75	4.27	1.85	3.97	1.72	3.74	1.62	3.56	1.54	3.42	1.48	3.30	1.43	3.20	1.39
25	1.58	4.69	6.34	2.74	5.90	2.56	5.57	2.41	5.32	2.30	5.11	2.21	4.94	2.14	4.79	2.08
30	1.89	5.63	8.76	3.79	8.17	3.54	7.72	3.34	7.38	3.19	7.09	3.07	6.86	2.97	6.67	2.89
35	2.21	6.56	11.53	4.99	10.76	4.66	10.19	4.41	9.74	4.22	9.37	4.06	9.07	3.93	8.82	3.82
40	2.52	7.50	14.63	6.33	13.68	5.92	12.95	5.61	12.39	5.36	11.94	5.17	11.56	5.00	11.25	4.87

Flow Rate		Velocity	40°F		60°F		80°F		100°F		120°F		140°F		160°F	
			Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)
US gpm	L/sec	ft/s	2″		2″		2″		2″		2″		2″		2″	
20	1.26	2.23	1.24	0.54	1.15	0.50	1.08	0.47	1.03	0.45	0.99	0.43	0.95	0.41	0.92	0.40
25	1.58	2.79	1.84	0.80	1.71	0.74	1.61	0.70	1.53	0.66	1.47	0.64	1.42	0.61	1.37	0.60
30	1.89	3.35	2.54	1.10	2.36	1.02	2.23	0.96	2.12	0.92	2.04	0.88	1.97	0.85	1.91	0.83
35	2.21	3.91	3.33	1.44	3.11	1.34	2.93	1.27	2.80	1.21	2.69	1.16	2.60	1.12	2.52	1.09
40	2.52	4.46	4.23	1.83	3.94	1.71	3.72	1.61	3.55	1.54	3.42	1.48	3.30	1.43	3.21	1.39
45	2.84	5.02	5.21	2.26	4.86	2.11	4.60	1.99	4.39	1.90	4.23	1.83	4.09	1.77	3.98	1.72
50	3.15	5.58	6.29	2.72	5.87	2.54	5.56	2.41	5.31	2.30	5.11	2.21	4.95	2.14	4.81	2.08
55	3.47	6.14	7.45	3.23	6.97	3.02	6.60	2.86	6.31	2.73	6.08	2.63	5.88	2.55	5.72	2.48
60	3.79	6.70	8.70	3.77	8.14	3.53	7.72	3.34	7.39	3.20	7.12	3.08	6.89	2.98	6.71	2.90
65	4.10	7.26	10.04	4.35	9.40	4.07	8.92	3.86	8.54	3.70	8.23	3.56	7.97	3.45	7.76	3.36
70	4.42	7.81	11.47	4.97	10.75	4.65	10.19	4.41	9.76	4.23	9.42	4.08	9.13	3.95	8.89	3.85

XIRTEC CPVC FLOW CAPACITY AND FRICTION LOSSES – PIPE

Note: These tables summarize the velocity and head loss of Xirtec CPVC pipe for all sizes and for various volumetric flow rates. The upper velocity limit of 8 ft/s is used for all sizes.

Flow Rate		Velocity	40°F		60°F		80°F		100°F		120°F		140°F		160°F	
			Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)
US gpm	L/sec	ft/s	2-1/2"		2-1/2"		2-1/2"		2-1/2"		2-1/2"		2-1/2"		2-1/2"	
30	1.89	2.34	1.08	0.47	1.00	0.43	0.94	0.41	0.90	0.39	0.86	0.37	0.83	0.36	0.80	0.35
35	2.21	2.73	1.41	0.61	1.31	0.57	1.24	0.54	1.18	0.51	1.13	0.49	1.09	0.47	1.06	0.46
40	2.52	3.12	1.79	0.77	1.67	0.72	1.57	0.68	1.50	0.65	1.44	0.62	1.39	0.60	1.35	0.58
45	2.84	3.51	2.20	0.95	2.05	0.89	1.94	0.84	1.85	0.80	1.78	0.77	1.72	0.74	1.67	0.72
50	3.15	3.89	2.66	1.15	2.48	1.07	2.34	1.01	2.24	0.97	2.15	0.93	2.08	0.90	2.02	0.87
55	3.47	4.28	3.15	1.36	2.94	1.27	2.78	1.20	2.66	1.15	2.55	1.11	2.47	1.07	2.40	1.04
60	3.79	4.67	3.68	1.59	3.43	1.49	3.25	1.41	3.11	1.34	2.99	1.29	2.89	1.25	2.81	1.22
65	4.10	5.06	4.24	1.84	3.96	1.72	3.75	1.63	3.59	1.55	3.45	1.50	3.34	1.45	3.25	1.41
70	4.42	5.45	4.84	2.10	4.53	1.96	4.29	1.86	4.10	1.78	3.95	1.71	3.82	1.66	3.72	1.61
75	4.73	5.84	5.48	2.37	5.12	2.22	4.86	2.10	4.65	2.01	4.48	1.94	4.33	1.88	4.22	1.83
80	5.05	6.23	6.15	2.66	5.75	2.49	5.46	2.36	5.22	2.26	5.03	2.18	4.87	2.11	4.74	2.05
85	5.36	6.62	6.85	2.97	6.42	2.78	6.09	2.64	5.83	2.52	5.62	2.43	5.44	2.36	5.30	2.29
90	5.68	7.01	7.59	3.29	7.11	3.08	6.75	2.92	6.46	2.80	6.23	2.70	6.04	2.62	5.88	2.55
95	5.99	7.40	8.36	3.62	7.84	3.39	7.44	3.22	7.13	3.09	6.88	2.98	6.67	2.89	6.49	2.81
100	6.31	7.79	9.17	3.97	8.60	3.72	8.16	3.53	7.82	3.39	7.55	3.27	7.32	3.17	7.13	3.09

Flow Rate		Velocity	40°F		60°F		80°F		100°F		120°F		140°F		160°F	
			Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)
US gpm	L/sec	ft/s	3"		3"		3"		3"		3"		3"		3"	
40	2.52	1.99	0.62	0.27	0.57	0.25	0.54	0.23	0.51	0.22	0.49	0.21	0.47	0.21	0.46	0.20
45	2.84	2.24	0.76	0.33	0.70	0.31	0.66	0.29	0.63	0.27	0.61	0.26	0.59	0.25	0.57	0.25
50	3.15	2.49	0.91	0.40	0.85	0.37	0.80	0.35	0.76	0.33	0.73	0.32	0.71	0.31	0.69	0.30
55	3.47	2.74	1.08	0.47	1.01	0.44	0.95	0.41	0.91	0.39	0.87	0.38	0.84	0.36	0.82	0.35
60	3.79	2.99	1.26	0.55	1.18	0.51	1.11	0.48	1.06	0.46	1.02	0.44	0.98	0.43	0.96	0.41
65	4.10	3.24	1.45	0.63	1.36	0.59	1.28	0.56	1.22	0.53	1.18	0.51	1.14	0.49	1.10	0.48
70	4.42	3.49	1.66	0.72	1.55	0.67	1.46	0.63	1.40	0.61	1.35	0.58	1.30	0.56	1.26	0.55
75	4.73	3.74	1.88	0.81	1.75	0.76	1.66	0.72	1.58	0.69	1.52	0.66	1.47	0.64	1.43	0.62
80	5.05	3.98	2.11	0.91	1.97	0.85	1.86	0.81	1.78	0.77	1.71	0.74	1.66	0.72	1.61	0.70
85	5.36	4.23	2.35	1.02	2.19	0.95	2.08	0.90	1.98	0.86	1.91	0.83	1.85	0.80	1.80	0.78
90	5.68	4.48	2.60	1.12	2.43	1.05	2.30	1.00	2.20	0.95	2.12	0.92	2.05	0.89	1.99	0.86
95	5.99	4.73	2.86	1.24	2.68	1.16	2.54	1.10	2.43	1.05	2.34	1.01	2.26	0.98	2.20	0.95
100	6.31	4.98	3.14	1.36	2.93	1.27	2.78	1.20	2.66	1.15	2.56	1.11	2.48	1.07	2.41	1.05
120	7.57	5.98	4.35	1.88	4.07	1.76	3.86	1.67	3.70	1.60	3.57	1.54	3.46	1.50	3.37	1.46
140	8.83	6.97	5.73	2.48	5.38	2.33	5.11	2.21	4.89	2.12	4.72	2.04	4.58	1.98	4.46	1.93
160	10.09	7.97	7.29	3.15	6.84	2.96	6.50	2.82	6.24	2.70	6.02	2.61	5.84	2.53	5.70	2.47

SYSTEM DESIGN

XIRTEC CPVC FLOW CAPACITY AND FRICTION LOSSES – PIPE

Note: These tables summarize the velocity and head loss of Xirtec CPVC pipe for all sizes and for various volumetric flow rates. The upper velocity limit of 8 ft/s is used for all sizes.

Flow Rate		Velocity	40°F		60°F		80°F		100°F		120°F		140°F		160°F	
			Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)
US gpm	L/sec	ft/s	4"		4"		4"		4"		4"		4"		4"	
70	4.42	1.99	0.44	0.19	0.41	0.18	0.38	0.17	0.37	0.16	0.35	0.15	0.34	0.15	0.33	0.14
75	4.73	2.14	0.49	0.21	0.46	0.20	0.43	0.19	0.41	0.18	0.40	0.17	0.38	0.17	0.37	0.16
80	5.05	2.28	0.55	0.24	0.52	0.22	0.49	0.21	0.47	0.20	0.45	0.19	0.43	0.19	0.42	0.18
85	5.36	2.42	0.62	0.27	0.58	0.25	0.54	0.24	0.52	0.22	0.50	0.22	0.48	0.21	0.47	0.20
90	5.68	2.56	0.68	0.30	0.64	0.28	0.60	0.26	0.57	0.25	0.55	0.24	0.53	0.23	0.52	0.22
95	5.99	2.71	0.75	0.33	0.70	0.30	0.66	0.29	0.63	0.27	0.61	0.26	0.59	0.26	0.57	0.25
100	6.31	2.85	0.82	0.36	0.77	0.33	0.73	0.32	0.69	0.30	0.67	0.29	0.65	0.28	0.63	0.27
120	7.57	3.42	1.14	0.49	1.07	0.46	1.01	0.44	0.97	0.42	0.93	0.40	0.90	0.39	0.87	0.38
140	8.83	3.99	1.50	0.65	1.41	0.61	1.33	0.58	1.27	0.55	1.23	0.53	1.19	0.51	1.16	0.50
160	10.09	4.56	1.91	0.83	1.79	0.77	1.69	0.73	1.62	0.70	1.56	0.68	1.52	0.66	1.47	0.64
180	11.36	5.13	2.36	1.02	2.21	0.96	2.10	0.91	2.01	0.87	1.94	0.84	1.88	0.81	1.83	0.79
200	12.62	5.70	2.85	1.23	2.67	1.16	2.54	1.10	2.43	1.05	2.35	1.02	2.27	0.98	2.22	0.96
220	13.88	6.27	3.38	1.46	3.17	1.37	3.02	1.31	2.89	1.25	2.79	1.21	2.71	1.17	2.64	1.14
240	15.14	6.84	3.95	1.71	3.71	1.61	3.53	1.53	3.39	1.47	3.27	1.42	3.17	1.37	3.09	1.34
260	16.40	7.41	4.57	1.98	4.29	1.86	4.08	1.77	3.92	1.70	3.78	1.64	3.67	1.59	3.58	1.55
280	17.67	7.98	5.22	2.26	4.91	2.13	4.67	2.02	4.48	1.94	4.33	1.88	4.21	1.82	4.10	1.78

Flow Rate		Velocity	40°F		60°F		80°F		100°F		120°F		140°F		160°F	
			Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)	Friction Head Loss (ft water/100 ft)	Friction Pressure (psi/100 ft)
US gpm	L/sec	ft/s	6"		6"		6"		6"		6"		6"		6"	
160	10.09	2.01	0.27	0.12	0.25	0.11	0.24	0.10	0.23	0.10	0.22	0.09	0.21	0.09	0.20	0.09
180	11.36	2.26	0.33	0.14	0.31	0.13	0.29	0.13	0.28	0.12	0.27	0.12	0.26	0.11	0.25	0.11
200	12.62	2.51	0.40	0.17	0.37	0.16	0.35	0.15	0.34	0.15	0.32	0.14	0.31	0.14	0.30	0.13
220	13.88	2.76	0.47	0.20	0.44	0.19	0.42	0.18	0.40	0.17	0.38	0.17	0.37	0.16	0.36	0.16
240	15.14	3.01	0.55	0.24	0.52	0.22	0.49	0.21	0.47	0.20	0.45	0.20	0.44	0.19	0.42	0.18
260	16.40	3.26	0.64	0.28	0.60	0.26	0.56	0.24	0.54	0.23	0.52	0.23	0.50	0.22	0.49	0.21
280	17.67	3.51	0.73	0.31	0.68	0.29	0.65	0.28	0.62	0.27	0.60	0.26	0.58	0.25	0.56	0.24
300	18.93	3.76	0.82	0.36	0.77	0.33	0.73	0.32	0.70	0.30	0.68	0.29	0.65	0.28	0.64	0.28
350	22.08	4.39	1.08	0.47	1.02	0.44	0.97	0.42	0.93	0.40	0.89	0.39	0.87	0.38	0.84	0.37
400	25.24	5.01	1.38	0.60	1.29	0.56	1.23	0.53	1.18	0.51	1.14	0.49	1.11	0.48	1.08	0.47
450	28.39	5.64	1.70	0.74	1.60	0.69	1.52	0.66	1.46	0.63	1.41	0.61	1.37	0.59	1.34	0.58
500	31.55	6.27	2.06	0.89	1.94	0.84	1.85	0.80	1.77	0.77	1.71	0.74	1.66	0.72	1.62	0.70
550	34.70	6.89	2.45	1.06	2.30	1.00	2.20	0.95	2.11	0.91	2.04	0.88	1.98	0.86	1.93	0.84
600	37.85	7.52	2.86	1.24	2.70	1.17	2.57	1.11	2.47	1.07	2.39	1.04	2.32	1.01	2.27	0.98
640	40.38	8.02	3.22	1.39	3.04	1.31	2.89	1.25	2.78	1.20	2.69	1.17	2.62	1.13	2.55	1.11

SIZING PIPE BY FIXTURE UNIT

A common design aid for sizing distribution water pipe is a Fixture Unit Table. More details on this method including the values assigned for various fixtures can be found in all model plumbing codes. However, work is beginning in some jurisdictions to recognize that a single one-size-fits-all table may not be adequate to properly size water lines given the wide variety of inside diameters available. To help address this, IPEX has derived an alternative table using the actual pipe inside diameters of various commonly available water pipe materials. The Maximum Fixture Unit values are presented for each type and nominal size of water pipe based on a maximum recommended velocity and using the Average Pressure Loss Method. Note that Type L Copper is shown for two different maximum velocity values with the higher one being a cold water limit and the lower one being a limit for hot water not greater than 140°F.

As can be seen below, there are significant differences amongst pipe materials in terms of maximum fixture units permitted to be served. Designers are cautioned that the use of a single fixture unit table as presented in many Codes may not be appropriate or applicable for piping with inside diameters smaller than the nominal pipe size.

Water Pipe Sizing - Maximum Number of Fixture Units Served Using Average Pressure Loss Method

Nominal Pipe Size (In.)	WATER VELOCITY																	
	Xirtec CPVC Sch. 80			Xirtec CPVC Sch. 80			Type L Copper (Cold)			Type L Copper (Hot)			PEX SDR 9			CPVC SDR11 (CTS)		
	5 ft/s			8 ft/s			8 ft/s			5 ft/s			8 ft/s			8 ft/s		
	FLOW AND FIXTURE UNITS SERVED (SYSTEM WITH FLUSH TANKS)																	
	L/s	GPM	Fixture Units	L/s	GPM	Fixture Units	L/s	GPM	Fixture Units	L/s	GPM	Fixture Units	L/s	GPM	Fixture Units	L/s	GPM	Fixture Units
1/2	0.19	3.0	3	0.32	5.0	6	0.37	5.8	7	0.23	3.6	3.5	0.28	4.4	4.5	0.28	4.5	5
3/4	0.38	6.0	7	0.63	10.0	13	0.76	12.1	16	0.48	7.6	9	0.55	8.8	11.5	0.60	9.5	12.5
1	0.66	10.5	14	1.06	16.8	24	1.30	20.6	31	0.81	12.9	18	0.92	14.5	20.5	1.01	16.0	23
1-1/4	1.20	19.0	28	1.94	30.8	55	1.98	31.3	56	1.24	19.6	29	1.37	21.8	34	1.51	23.9	39
1-1/2	1.67	26.5	45	2.69	42.6	97	2.80	44.4	105	1.75	27.7	48	1.91	30.3	55	2.12	33.6	62
2	2.84	45.0	107	4.54	71.9	235	4.87	77.1	260	3.04	48.2	121	3.28	51.9	138	3.64	57.8	164
2-1/2	4.10	65.0	199	6.51	103.2	391	7.51	119.0	473	4.69	74.4	246						
3	6.40	101.4	382	10.19	161.5	704	10.7	169.8	750	6.70	106.1	405						
4	11.17	177.1	797	17.82	282.4	1620	18.8	298.7	1765	11.8	186.7	860						
6	25.41	402.8	2715	37.41	593.0	5000	-	-	-	-	-	-						

Note: This table should be used as a general guide only. Refer to the local plumbing code for water distribution pipe sizing rules.

HEAD LOSS CHARACTERISTICS – FITTINGS AND VALVES

In addition to head losses that result from frictional forces in the pipe, losses also occur when water flows through fittings and valves in the system. These losses are difficult to calculate due to the complex internal geometry of the various fittings. Generally, loss values are determined for each fitting configuration by experimental tests and are expressed in equivalent length of straight pipe. Typical equivalent length values or pressure drops for fittings can be found below.

Pressure drops through valves also contribute to the overall friction loss of fluid through a piping system.

Flow rate coefficients (Cv) are defined as the flow rate in gallons per minute (US gpm) through an open valve resulting in a pressure drop of 1 psi. Flow rate coefficients are listed below:

Friction Loss through Fittings (Equivalent pipe length in feet)

Size (in.)	Tee Run	Tee Branch	90° Bend	45° Bend
1/2	1.0	3.8	1.5	0.8
3/4	1.4	4.9	2.0	1.1
1	1.7	6.0	2.5	1.4
1-1/4	2.3	7.3	3.8	1.8
1-1/2	2.7	8.4	4.0	2.1
2	4.0	12.0	5.7	2.6
2-1/2	4.9	14.7	6.9	3.1
3	6.1	16.4	7.9	4.0
4	7.9	22.0	11.4	5.1
6	12.3	32.7	16.7	8.0

Flow Coefficients Cv for Xirtec CPVC Ball Valves

Size (in.)	VXE True Union Ball Valve	One-Piece Ball Valve
1/2	14	12
3/4	27	19
1	54	41
1-1/4	77	-
1-1/2	123	-
2	238	-
2-1/2	348	-
3	487	-
4	654	-

The following formula can be used to calculate the pressure loss across a valve under a given flow rate:

$f = sg\,(Q/Cv)^2$

Where:

f = pressure drop (friction loss) across the valve (psi)

sg = specific gravity of fluid (water = 1.0)

Q = flow through the valve (US gpm)

Cv = flow rate coefficient

Example:

What is the pressure loss across a 2" Xirtec CPVC True Union Ball Valve (VXE Model) in a Xirtec CPVC system having a flow rate of 50 US gpm?

Calculate the answer in equivalent feet of pipe and psi.

$f = sg\,(Q/Cv)^2$

Q = 50 US gpm

Cv = 238

$f = 1 \times (50/238)^2 = 0.044$ psi

From the Xirtec CPVC Flow Capacity and Friction Losses - Pipe chart: 50 US gpm through a 2" pipe generates a loss of 2.5 psi/100ft.

Therefore:

$$\frac{0.044}{(2.5/100)} = 1.76 \text{ ft of pipe}$$

SURGE PRESSURE CALCULATIONS

POTENTIAL SURGE PRESSURE GIVEN FLOW CONDITIONS

Never exceed a maximum pressure rating for Xirtec CPVC components.

The following formulae can be used to predict the potential surge pressure in Xirtec CPVC for given flow conditions.

$$a = \frac{4660}{\sqrt{1 + \left[\frac{k(DR-2)}{E}\right]}} \qquad P = \frac{(a)\,(dV)}{2.31g}$$

where:

a = wave velocity (ft/s)

k = fluid bulk modulus (= 300,000 psi for water)

DR = pipe dimension ratio (see table - pg 3)

E = Modulus of elasticity for pipe (See Modulus of Elasticity table)

g = acceleration due to gravity (= 32.2 ft/s^2)

P = pressure surge (psi)

dV = velocity change (ft/s)

Modulus of Elasticity and Working Stress for Xirtec CPVC

Temperature °F	Modulus, E psi	Stress, S psi
73	423,000	2,000
90	403,000	1,800
110	371,000	1,500
120	355,000	1,300
140	323,000	1,000
160	291,000	800

To prevent rapid closing creating high surge pressures, the minimum closure time of a valve can be calculated using the following equation:

$$T = \frac{2 \times L}{a}$$

Where:

T = Minimum closure time of a valve (with linear characteristics) seconds

L = Length of a pipe run upstream of the valve ft

a = wave velocity of the fluid ft/s

It is not possible to apply firm rules to the time period for actuation of a valve since this depends on pressure and flow conditions specific to the installation. These times should wherever possible be determined by computer modeling software. Controlling transient surges is a complex task. It is one of the more important phases of piping design. A design engineer should assess if surge pressures will occur and provide recommendations to manage these surge events. It is not always reasonable to assume the rate of change in velocity is uniform. Most types of valves have non-linear characteristics that result in most of the effect occurring in the last 10-20% of closure. Therefore, the effective closure times are considerably less than nominal times.

Example: A cold water flow of 35 US gpm in 2" Xirtec CPVC is suddenly stopped due to a rapid valve closure. The run is 250 ft long. The system pressure is 100 psi at 73°F. What potential water hammer (surge pressure) could be generated?

Solution: First calculate the system velocity using velocity formula presented earlier,

$$V = \frac{(0.4085)Q}{d_i^2}$$

$$= \frac{(0.4085)\ (35)}{1.917^2} = 3.89 \text{ ft/s}$$

Next, we must determine the value of E for cold water flow. By referring to table above, select the lowest temperature value (T= 73°F) where E = 423,000 psi.

Now wave velocity 'a' can be calculated:

$$a = \frac{4660}{\sqrt{1+\left[\frac{300{,}000\ (11-2)}{423{,}000}\right]}} = 1{,}715 \text{ ft/s}$$

Now calculate surge pressure,

$$P = \frac{(1715) \times (3.89)}{2.31\ (32.2)} = \textbf{89.7 psi}$$

Thus, the potential surge pressure for this piping system would be 89.7 psi.

Therefore, the total line pressure that the piping system could see would be 100 psi (static pressure) + 89.7 psi (surge pressure) = 189.7 psi.

It is also interesting to note that a similar calculation for 2" Type L copper at 35 US gpm would yield a potential surge pressure of 285 psi (100 static pressure + 185 surge pressure) due to the higher rigidity of the copper pipe.

What is the minimum valve closure time required to prevent an instantaneous pressure surge?

Solution:

From the previous example, the total line pressure that the piping could see would be 100 psi + 89.7 psi = 189.7 psi. of

$$T = \frac{2 \times 250 \text{ ft}}{1715 \text{ ft/s}} \qquad T = 0.29 \text{ seconds}$$

THRUST FORCES

Thrust forces can occur at any point in a piping system where the directional or cross-sectional area of the waterway changes or where additional structure loads, such as valves, are installed. These forces must be accommodated by means of reinforcement using anchors, riser clamps, or restraining hangers.

The size of or need for reinforcements should be based on the design engineer's evaluation of flow velocities and pressure increases due to the fluid's momentum.

Note: the thrust created at unrestrained fittings can be considerable (as shown in table below) and must be addressed during installation.

Thrust at Fittings in Pounds per 100 psi of Internal Pressure

Size	Blank Ends and Junctions	90° Bends	45° Bends
1/2	60	85	50
3/4	90	130	70
1	140	200	110
1-1/4	220	320	170
1-1/2	300	420	230
2	450	630	345
2-1/2	650	910	500
3	970	1,360	745
4	1,600	2,240	1,225

EXPANSION AND CONTRACTION DESIGN

As with all construction materials, Xirtec CPVC piping undergoes expansion and contraction when subjected to changes in temperature. The coefficient of linear expansion for Xirtec CPVC is 3.8 x 10^{-5} in/in/°F which corresponds to a change in length of 0.456 in per 10°F temperature change per 100 ft. of pipe length.

NOTICE

Designers and installers must anticipate and account for the total change in temperature (ΔT) between the date of installation and the peak temperature the Xirtec CPVC system will see. As an example, for installations at 40°F, in combination with usage at the maximum operating system temperature of 160°F, the Xirtec CPVC systems would see a ΔT as high as 120°F.

NOTICE

Failure to properly design and accommodate for expansion and contraction due to temperature changes can lead to system failure.

Follow all IPEX recommendations for accommodating expansion and contraction.

CALCULATING EXPANSION AND CONTRACTION

Determine the total amount of expansion that any particular straight section of piping will undergo. To do this, the formula below should be used:

$$\Delta L = Y \times \frac{(T - F)}{10} \times \frac{L}{100}$$

Where,

ΔL = change in length due to temp. variance (in.)

Y = expansion coefficient for Xirtec CPVC (0.456 in / 10°F / 100 ft.)

T = initial system installation temperature (°F)

F = final system operating temperature (°F)

L = length of straight section (ft.)

For reference, a table of expansion values is presented on the following page for various temperature changes and pipe section (run) lengths. Note that these expansion length values are independent of pipe size.

When total temperature change is less than 30°F (17°C), provisions for thermal expansion are not generally required, especially when the line includes several directional changes as there is considerable inherent flexibility in the piping system.

Xirtec CPVC Linear Thermal Expansion or Contraction (ΔL in inches)

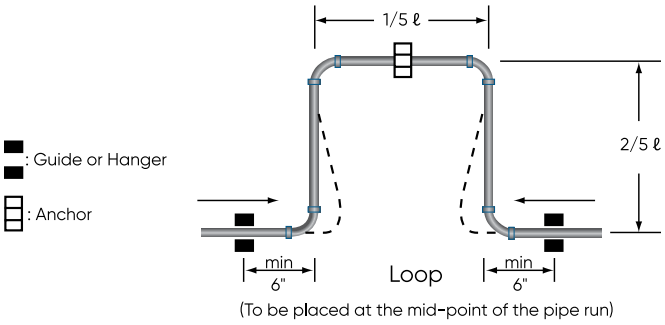
Temp. (°F) Change ΔT (°F)	Length of Run (feet)									
	10	20	30	40	50	60	70	80	90	100
10	0.05	0.09	0.14	0.18	0.23	0.27	0.32	0.36	0.41	0.46
20	0.09	0.18	0.27	0.36	0.46	0.55	0.64	0.73	0.82	0.91
30	0.14	0.27	0.41	0.55	0.68	0.82	0.96	1.09	1.23	1.37
40	0.18	0.36	0.55	0.73	0.91	1.09	1.28	1.46	1.64	1.82
50	0.23	0.46	0.68	0.91	1.14	1.37	1.60	1.82	2.05	2.28
60	0.27	0.55	0.82	1.09	1.37	1.64	1.92	2.19	2.46	2.74
70	0.32	0.64	0.96	1.28	1.60	1.92	2.23	2.55	2.87	3.19
80	0.36	0.73	1.09	1.46	1.82	2.19	2.55	2.92	3.28	3.65
90	0.41	0.82	1.23	1.64	2.05	2.46	2.87	3.28	3.69	4.10
100	0.46	0.91	1.37	1.82	2.28	2.74	3.19	3.65	4.10	4.56
110	0.50	1.00	1.50	2.01	2.51	3.01	3.51	4.01	4.51	5.02
120	0.55	1.09	1.64	2.19	2.74	3.28	3.83	4.38	4.92	5.47
130	0.59	1.19	1.78	2.37	2.96	3.56	4.15	4.74	5.34	5.93
140	0.64	1.28	1.92	2.56	3.19	3.83	4.47	5.11	5.75	6.38

ACCOMMODATING EXPANSION AND CONTRACTION

After determining the amount of expansion or contraction to be expected in the Xirtec CPVC piping system, designers and installers must choose a method to accommodate the movement. Below are the acceptable methods for accommodating expansion and contraction.

1. EXPANSION LOOPS

It is very important to properly size expansion loops. Under-sizing a loop in any of its critical dimensions will actually increase stresses in the system. Diagrams for an expansion loop, sample loop calculations, and reference charts are shown below:



(To be placed at the mid-point of the pipe run)

The critical length "ℓ" must be calculated in order to design the expansion loop.

To calculate "ℓ" manually, the following formula can be used:

$$\ell = \sqrt{\frac{3ED(\Delta L)}{S}}$$

Where,

ℓ = critical length (in.)

E = Modulus of Elasticity for Xirtec CPVC at maximum operating temperature (psi)

D = outside diameter of pipe (in.)

ΔL = change in length due to expansion (in.)

S = working stress at maximum operating temperature (psi)

Example: For a run of 90 ft. of 3" nominal size Xirtec CPVC pipe, installed at 65°F and operating at 140°F, how long should the loop legs be for an expansion loop in order to compensate for the system expansion?

Step 1: Calculate the amount of expansion to be expected.

$$\Delta L = Y \times \frac{(T - F)}{10} \times \frac{L}{100}$$

Known:

L = 90 ft

T = 140°F

F = 65°F

Y = 0.456 in/10°F/100 ft

(Coefficient of Thermal Expansion)

$$\Delta L = 0.456 \times \frac{(140 - 65)}{10} \times \frac{90}{100}$$

$$\Delta L = 3.08 \text{ in.}$$

Step 2: Calculate the critical expansion loop length

$$\ell = \sqrt{\frac{3ED(\Delta L)}{S}}$$

Known:

ΔL = 3.08 in.

E = 323,000 psi

S = 1000 psi

(from Surge Pressure Section – Modulus of Elasticity & Working Stress for Xirtec CPVC), D = 3.5 in (OD, from physical dimension and weights section)

$$\ell = \sqrt{\frac{3 \times 323{,}000 \times 3.5 \times 3.08}{1000}}$$

ℓ = 102.2 inches

Therefore: 2/5 ℓ = 40.9 in. and 1/5 ℓ = 20.4 in.

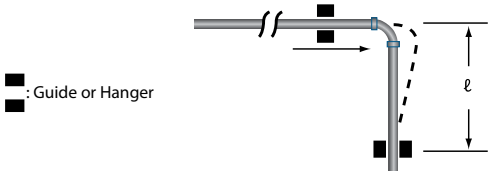
Placement of Expansion Loops

Expansion loops for Xirtec CPVC shall be centered along the pipe run in which they are installed. For example, if 2 loops are required in a section, they should be placed as close as possible to be 1/3 and 2/3 along the pipe section.

2. CHANGE OF DIRECTION

A simple change of direction can also effectively relieve stress caused by thermal expansion/contraction, but as with expansion loops, the 'ℓ' dimension is just as critical. Too short a distance to a guide will reduce the flexibility in the system. 'ℓ' can be calculated as was shown in the previous loops section.

Using the previous example, the critical dimension ℓ = 102.2 in

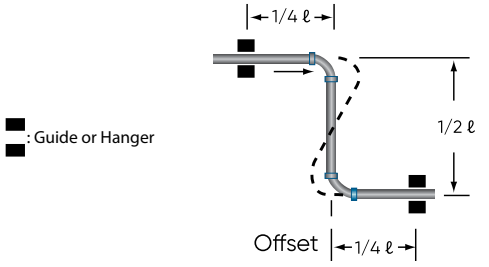


Change of direction

3. OFFSETS

Offsets are similar to loops and changes of directions, and the critical ℓ dimension is calculated in the same way. Unlike a loop, no restraint should be placed between the guides.

Using the previous example, the critical dimension 1/4 ℓ = 25.6 in. and 1/2 ℓ = 51.1 in



THERMAL EXPANSION OF VERTICAL PIPING (RISERS)

The effects of thermal expansion on water filled vertical piping are typically minimized due to the weight of the water column, in combination with supports utilized at horizontal take-offs. The amount of thermal expansion of the vertical piping must be calculated based on the anticipated temperature change.

Vertical piping and horizontal take-offs must be properly supported, as specified by the design engineer, to allow for thermal expansion and contraction movement of the piping. Acceptable methods for accommodating expansion and contraction can be found in this section.

EXPANSION JOINTS

Expansion joints are available for large diameter pipe or where space for offset lines is limited. An expansion joint consists of two cylinders, one telescoping inside the other. The outer cylinder is firmly anchored while the inner cylinder is allowed to move with a piston-like action as the attached pipe expands or contracts. IPEX manufactures the Telescopic Expansion Device (T.E.D.), a cost-effective solution designed to relieve stress in a piping system.

NOTICE

The IPEX T.E.D. must only be installed in exposed spaces where it can be visually inspected and replaced if required because of wear and tear or other causes.

Alignment of expansion joints is most important. Binding can result if the pipe is canted or cocked and does not move in the same plane as the expansion joint. Guide loops should be installed approximately one foot from the end of each expansion joint. Pipe should be restrained at each change of direction so its movement can be directed squarely into the expansion joint.

Beyond the required system guides, the IPEX T.E.D. incorporates a special self-aligning property. A wide piston guide is fitted inside the device to prevent skewing and consequent binding. To further enhance the self-aligning property of the T.E.D., a triple o-ring seal is added, reducing the chances of leaks and/or premature failure due to misalignment, thus effectively increasing the life expectancy of your entire system.

PISTON TRAVEL POSITION CALCULATIONS

Common sense will dictate that if the piston is expected to travel both in (pipe expansion) and out (pipe contraction) of its cylinder, there must be travel available in both directions as shown in the figure below. This requires that T.E.D. units must be installed with the piston partially extended. The piston should be extended based on the ambient temperature at the time of installation and can be accurately calculated by the following formula:

$$P = \frac{T_M - T_A}{T_M - T_L} \times E$$

where:

P = piston travel position at installation (in.)

T_M = maximum operational temperature, °F (°C)

T_A = ambient air installation temperature, °F (°C)

T_L = minimum operational temperature, °F (°C)

E = piston full extension length (in.)

EXPANSION JOINT

Example

For a straight run of pipe, the ambient air temperature at time of installation is 68°F and the temperature of system operation varies from 40°F to 90°F. How much piston travel should a 6" expansion joint be installed with?

Known:

T_M = 90°F

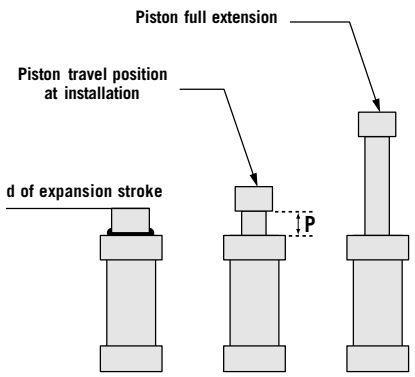
T_A = 68°F

T_L = 40°F

L = 6 in

$$P = \frac{90 - 68}{90 - 40} \times 6, \quad P = 2.64 \text{ in}$$

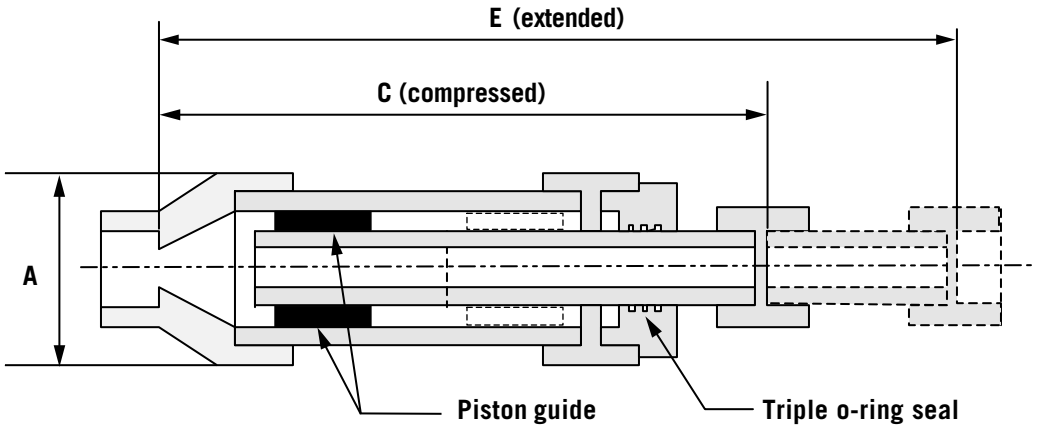
Therefore, the piston travel position should be set during installation by compressing the piston fully, then extending it 2.64".



TELESCOPIC EXPANSION DEVICE (T.E.D.) SPECIFICATIONS AND DIMENSIONS

The T.E.D. is available in CPVC featuring EPDM O-rings to meet potable water application requirements.

TELESCOPIC EXPANSION JOINT



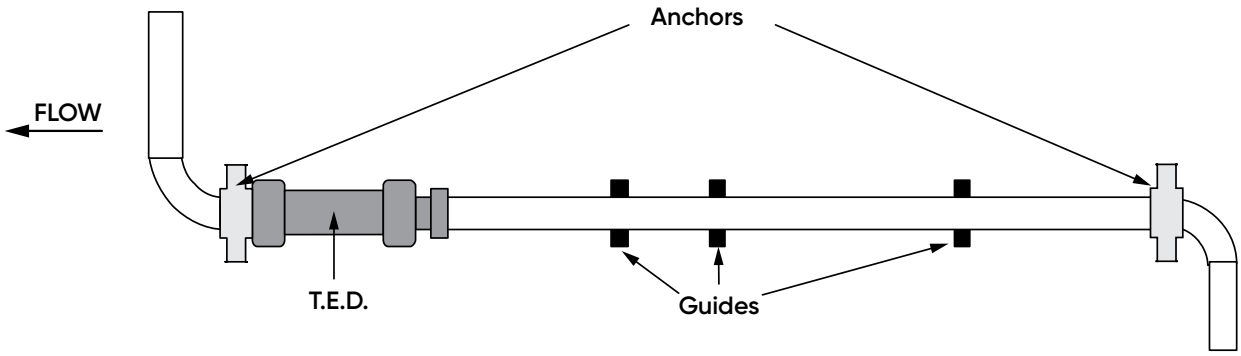
Size (in.)	A (in.)	6" Travel (L = 6)		12" Travel (L = 12) Maximum		Pressure Rating at 73°F psi
		C (in.)	E (in.)	C (in.)	E (in.)	
1/2	2.80	12.75	18.75	18.75	30.75	235
3/4	2.80	12.75	18.75	18.75	30.75	235
1	2.80	11.75	17.75	17.75	29.75	235
1-1/2	4.20	12.75	18.75	18.75	30.75	235
2	4.20	12.00	18.00	18.00	30.00	235
3	5.20	16.25	22.25	22.25	34.25	150
4	7.80	15.25	21.25	21.25	33.25	150

Note: For system fluid temperatures greater than 73°F (23°C), the appropriate temperature correction factor must be used. See the Xirtec CPVC Temperature Correction Factors table in the System Pressure and Temperature Ratings Section of this Manual.

CONFIGURATIONS USING EXPANSION JOINTS

EXAMPLE CONFIGURATION WITH ONE T.E.D.

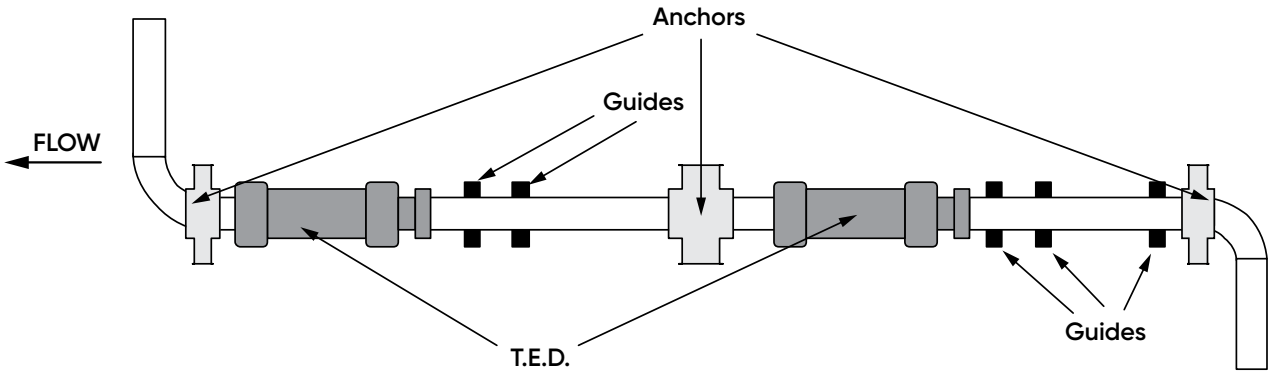
The chart below illustrates a long pipe run, restrained at each change of direction, which requires absorption of thermal expansion. Calculations have determined that a single device can be used with intermediate pipe guides. It is recommended that the device be located as close as possible to the anchor at the end of the run (based on flow direction). The first guide should be installed in the proximity of the connection between the pipe and the receiver on the moving arm of the T.E.D. unit. This will ensure that the deflection is limited to the expected axial direction. The second guide is located relatively close to the first to avoid bowing of the pipe. Additional guides should be installed to ensure that the long run of pipe does not bind the T.E.D.



EXAMPLE CONFIGURATION WITH TWO T.E.D.s

The chart below illustrates an even longer pipe run. Calculations have determined that two devices must be employed. As a result, the run has been divided into two equal segments by a median anchoring point and has been anchored at each change of direction. A T.E.D. unit is positioned at each end of the previously separated runs. Additional guides should be installed to ensure that the long run of pipe does not bind the T.E.D.

If a larger diameter pipe is reduced to a smaller diameter near the middle of the run and should it be determined that two separate devices are needed, it is good practice to subdivide the run with an anchor at the transition point and employ one device for each dimension.



THERMAL CONDUCTIVITY

The rate of thermal conductivity for Xirtec CPVC is 0.95 BTU/hr•ft^2•°F•in. This value compares very favorably to those of metal pipe being 380 times lower than steel and 2,800 times lower than copper.

CONDENSATION POTENTIAL

The high thermal resistance of Xirtec CPVC greatly reduces the potential of condensation forming on the outside of the pipe.

However, to accurately assess individual installations, IPEX can assist designers in calculating condensation potential. To calculate condensation potential, the following parameters must be known by the designer: pipe diameter of Xirtec CPVC, cold water temperature, indoor air temperature, design relative humidity and insulation thickness (if any). Using these input variables, both the pipe surface temperature and the Dew Point temperature can be calculated. Should the pipe surface temperature exceed the Dew Point temperature, condensation will not occur. IPEX can also assist in assessing condensation potential in other pipe materials including copper.

To assist designers, IPEX has prepared the following tables of pipe surface temperatures for Xirtec CPVC for a given set of relative humidities, water temperature, ambient air temperature and the resulting Dew Point temperature. Should the pipe surface temperature be at or below the Dew Point temperature, condensation will occur.

Condensation Potential for Xirtec CPVC (°F)

Condensation will occur.

Water Temp. (°F)	45								
Relative Humidity	45%			50%			55%		
Air Temp. (°F)	65	70	75	65	70	75	65	70	75
Dew Point (°F)	43.1	47.7	52.2	45.9	50.5	55.1	49	53	58

Pipe Size (in)	Pipe Surface Temp (°F)								
1/2	52.3	54.2	56.1	52.3	54.2	56.1	52.3	54.2	56.1
3/4	52.3	54.2	56.1	52.3	54.2	56.1	52.3	54.2	56.1
1	53.0	55.1	57.2	53.0	55.1	57.2	53.0	55.1	57.2
1 1/4	53.3	55.4	57.6	53.3	55.4	57.6	53.3	55.4	57.6
1 1/2	53.5	55.7	57.9	53.5	55.7	57.9	53.5	55.7	57.9
2	53.9	56.2	58.5	53.9	56.2	58.5	53.9	56.2	58.5
2 1/2	55.6	58.3	61.1	55.6	58.3	61.1	55.6	58.3	61.1
3	56.1	58.9	61.8	56.1	58.9	61.8	56.1	58.9	61.8
4	56.8	59.9	63.0	56.8	59.9	63.0	56.8	59.9	63.0
6	58.7	62.2	65.8	58.7	62.2	65.8	58.7	62.2	65.8

Condensation Potential for Xirtec CPVC (°F)

Water Temp. (°F)	50								
Relative Humidity	45%			50%			55%		
Air Temp. (°F)	65	70	75	65	70	75	65	70	75
Dew Point (°F)	43.1	47.7	52.2	45.9	50.5	55.1	49	53	58
Pipe Size (in)	Pipe Surface Temp (°F)								
1/2	55.5	57.4	59.3	55.5	57.4	59.3	55.5	57.4	59.3
3/4	55.5	57.4	59.3	55.5	57.4	59.3	55.5	57.4	59.3
1	56.0	58.1	60.2	56.0	58.1	60.2	56.0	58.1	60.2
1 1/4	56.2	58.4	60.5	56.2	58.4	60.5	56.2	58.4	60.5
1 1/2	56.4	58.6	60.8	56.4	58.6	60.8	56.4	58.6	60.8
2	56.7	59.0	61.3	56.7	59.0	61.3	56.7	59.0	61.3
2 1/2	57.9	60.7	63.4	57.9	60.7	63.4	57.9	60.7	63.4
3	58.3	61.2	64.1	58.3	61.2	64.1	58.3	61.2	64.1
4	58.9	62.0	65.1	58.9	62.0	65.1	58.9	62.0	65.1
6	60.3	63.8	67.4	60.3	63.8	67.4	60.3	63.8	67.4

Some general conclusions can be seen from these tables which follow sound engineering judgment. These are: (a) there is less potential for condensation as pipe sizes (and thus wall thicknesses) increase; (b) lower relative humidity reduces condensation potential; and (c) warmer water temperature inside the piping system reduces condensation potential.

Hot Water Piping

Designers may wish to use external pipe insulation on Xirtec CPVC hot water lines for possible energy savings. This is more of an economic analysis rather than performance assessment. Typically, designers will perform a cost/benefit analysis of pipe insulation versus no insulation in terms of energy consumption costs. Consideration should be given to Local Code Requirements on this topic. Performance of Xirtec CPVC pipe will be unaffected with or without insulation on hot water lines. **External pipe insulation must always be chemically compatible with Xirtec CPVC. Refer to the Chemical Resistance section of this manual.**

CHEMICAL RESISTANCE

The Corzan CPVC compound used to make Xirtec CPVC pipe, valves and fittings can be damaged by contact with chemicals found in some construction products. Care must be taken to ensure that products contacting Xirtec CPVC are chemically compatible.

Confirm chemical compatibility of Xirtec CPVC products made with Corzan CPVC compound by checking with the FBC System Compatible Program[1] or the manufacturers of such common piping systems components as:

- fire stop materials
- pipe insulation and adhesives
- heat trace cables
- wear pads or other rubber components
- thread sealants

Contact an IPEX representative for any further consultation or clarification before using Xirtec CPVC with another component.

The general information below gives an overview of chemical compatibility concerns for Xirtec CPVC potable water piping. Please refer to the FBC System Compatible program at https://www.lubrizol.com/CPVC/FBC-System-Compatible-Program for the most up to date list of compatibility.

Solvent Cements and Primers - These products are designed for use in joining Xirtec CPVC by way of solvent welding. The application of these products should be limited to the spigot-socket connection surfaces of a particular joint. Widespread or careless application of cement or primer to other parts of the piping system must be avoided. This may cause softening and weakening of structural areas of the piping system.

Flexible Wire and Cables - These products may contain plasticizers (also called softeners) which if in contact with Xirtec CPVC may impose harm in the form of environmental stress cracking.

Rubber and Flexible Materials - For the same reasons as with flexible wires and cables, care must be taken when Xirtec CPVC is installed in direct contact with gaskets, electrical tape, hanger padding, vinyl dipped metal parts and flexible hoses or tubes. Plasticizers contained in these substances may impose harm to Xirtec CPVC when in direct contact.

Fungicides and Mold Inhibitors - If ever applying these products in close proximity to Xirtec CPVC piping during water damage or mold cleanup, isolate the piping from these products by use of an external wrap or sleeve. Avoid direct contact of these products with Xirtec CPVC.

Grease and Cooking Oils - If pipe is installed in a kitchen environment, avoid direct or airborne contact with grease or cooking oils.

Leak Detection Substances - Products such as dishwashing liquids with synthetic detergents along with odor emitting products such as colognes, perfumes or scented oils all must not come into contact with Xirtec CPVC due to their high content of solvents which are potentially harmful to Xirtec CPVC.

Proximity to Metal Piping - Some potentially harmful effects to Xirtec CPVC from nearby installation of metallic piping include burning from contact with torches or molten material and solder flux, and incompatible thread sealants, residual oils, lubricants or leak detectors all of which may be commonly used on metal piping.

Paint - Only water-based latex paint may be used on Xirtec CPVC should the piping ever need to be painted. DO NOT USE oil-based paints with Xirtec CPVC.

Polyurethane Spray-On Foams - Some of these products have been tested to be compatible for direct contact with Xirtec CPVC piping. However, the manner in which they are applied is important. To minimize heat applied to Xirtec CPVC due to exothermic heat released by the foam, it is strongly recommended that foam be applied in a maximum layer thickness of 2 inches (50 mm) and that a time lapse of 10 minutes between application of layers is observed. Further information on these products may be obtained from the Spray Polyurethane Foam Alliance (SPFA).

If there are chemical compatibility uncertainties with Xirtec CPVC, IPEX recommends isolating the suspected product from contact with Xirtec CPVC pipe, valves or fittings.

Packing Oils and Pump Grease - Equipment containing packing oil and pump grease must be thoroughly flushed with water before connecting to an Xirtec CPVC piping system.

[1] The FBC System Compatible Program is published and updated by Lubrizol Advanced Materials, Inc.

NOTICE

Always follow the complete Xirtec CPVC System installation instructions provided in this manual.

Failure to comply with handling, storage and installation instructions may cause piping system failure resulting in damage to property.

SAFE HANDLING AND STORAGE OF PIPE, FITTINGS & VALVES

Care must be taken when handling Xirtec CPVC products to ensure that pipe, fittings, valves and accessories are not damaged prior to installation. Take the following precautions to ensure Xirtec CPVC products remain in top condition prior to installation.

- Store pipe indoors if possible
- Pipe stored outside must be covered with a well-ventilated white tarp
- Always keep pipe clean and covered in its original packaging
- Always store pipe on a flat surface and never store other products on top of pipe
- Do not drop or drag pipe
- Always store fittings and valves indoors in original packaging or repackage to protect from damage, dirt and debris
- Inspect all Xirtec CPVC products for shipping damage prior to installation
- Never install Xirtec CPVC products that are damaged

SOLVENT WELDING

INTRODUCTION

Creating optimal solvent welded connections requires attention to detail, proper preparation of components and an understanding of all instructions provided in this manual.

WARNING

DANGER: Highly flammable liquid and vapor may form explosive peroxide. Follow guidelines carefully.

WARNING

During the curing of the solvent welded joints, vapors may accumulate inside the piping system, especially should one end of the line be capped. Nearby sparks from welders or torches may inadvertently ignite these vapors and create a hazardous incident. Attention must be given to removing all vapors using air-blowers or water flushing prior to capping one end of an empty piping system.

SAFE HANDLING AND STORAGE OF PRIMERS AND SOLVENT CEMENTS

Primer and solvent cement are made from flammable liquids and must be kept away from all sources of ignition. Good ventilation must be maintained to reduce fire hazard and to minimize the breathing of solvent vapors. Refer to ASTM F402, Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings. Always adhere to local jobsite and workplace safety regulations.

- Always provide proper ventilation when applying primers and cements
- Avoid skin or eye contact with primers and cements
- Wash immediately if contact occurs to avoid prolonged exposure
- Do not solvent weld joints near open flames or soldering torches
- Use Personal Protection Equipment (PPE) when handling primers and solvent cements
- Always store primer and cement indoors
- For cold weather installation, store primer and cement in a warm location above 40°F
- For hot weather installation, store primer and cement in a cool, shaded location
- Always check bottom of primer and cement cans for date of manufacture and expiry date
- Consult the primer and cement manufacturer directly if unsure that the primer and cement has expired
- Properly discard primer and cement that exceeds its recommended shelf life or expiry date
- Properly discard solvent cement that has hardened or jelled
- Tightly close partially used primer and cement containers
- Always thoroughly shake cement before use

NOTICE

Cement products are formulated for specific material types. To avoid potential joint failure, DO NOT USE PVC cement on CPVC components.

SOLVENT WELDING BASICS

To make consistently tight joints, the following points should be followed:

- Dry fit all joints prior to solvent welding to confirm proper interference fit
- Discard fitting joints without proper interference fit
- Do not solvent weld joints that are too loose or too tight
- Always use beveling tools to prepare pipe ends before cementing
- Do not solvent weld joints without first beveling pipe ends
- Use only primers and solvent cements that meet or exceed the requirements of ASTM F656 and ASTM F493 respectively
- Follow all solvent welding instructions provided in this manual
- The joining surfaces must be softened and made semi-fluid with the use of a primer
- Sufficient cement must be applied to fill the gap between pipe and fittings
- Assembly of pipe and fittings must be made while the cement coatings on the surfaces are still wet and fluid
- Joint strength will develop as the cement cures. If the joint is made properly, the dissolved surfaces in the tight part of the joint will fuse together

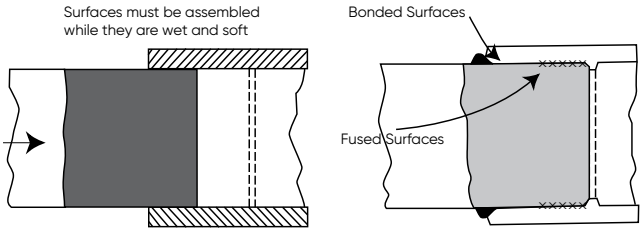
NOTICE

Do not use excessive amounts of primers or solvent cement as it can lead to puddling. Puddling of primer and cement in the pipe and fittings can result in product failures and property damage. Always follow the instructions provided with each can of CPVC primer and/or solvent cement.

CEMENT TYPES

Joints for the Xirtec CPVC Potable System should be made using primers and CPVC heavy-bodied, medium-setting cements that meet or exceed the requirements of ASTM F656 and ASTM F493 respectively.

Sufficient cement must be applied to fill the gap in the loose part of the joint. Besides filling the gap, adequate solvent cement layers will penetrate the surfaces. If the solvent cement coatings on the pipe and fittings are wet and fluid when assembly takes place, they will tend to flow together and become one solvent cement layer. Also, if the solvent cement is wet, the surfaces beneath them will still be soft, and these dissolved surfaces in the tight part of the joint will fuse together.



As the solvent dissipates, the solvent cement layer and the dissolved surfaces will dry and harden with a corresponding increase in joint strength. Completed joints must not be disturbed until they have properly set. See the Joint Set Schedule table for details.

Joint strength continues to develop as the solvent cement dries. To determine when solvent cement joints can be pressure tested, see the table in the Joint Cure Schedule Section.

Before beginning, assemble proper materials for the job appropriate applicator for the size of pipe and fittings to be assembled, tape measure, pencil and beveling tool).

Assemble proper Personal Protective Equipment (PPE) for the job (respirator, safety glasses, gloves and protective clothing).

WARNING: Do not use or test Xirtec® CPVC with compressed air or other gases. Do not use air-over-water boosters.

SOLVENT WELDING INSTRUCTIONS

Step 1 Preparation

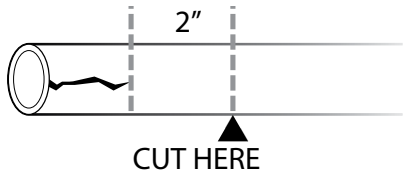
Assemble proper materials for the job. This includes the appropriate cement, primer and applicator for the size of piping system to be assembled, tape measure, contrasting color marker and beveling tool. See Tables for guidelines to estimate the amount of cement required.

CAUTION: Use proper Personal Protective Equipment (PPE) for the job: respirator, safety glasses, gloves and protective clothing.

Step 2 Cutting the Pipe

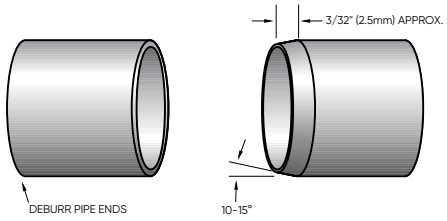
It is important to cut the pipe squarely. A square cut provides the surface of the pipe with the maximum bonding area. Pipe can be easily cut with a wheel-type plastic tubing cutter, chop saw or fine toothed saw. Do not use reciprocating saws.

Tools used to cut pipe must be designed for use with CPVC piping and must be in good condition in accordance with the tool manufacturer's recommendations. If there is any indication of pipe damage or evidence of pipe end cracking, cut off at least 2 inches beyond any visible crack. Use of ratchet cutters is not recommended as they may split the pipe if not properly used and maintained.



Step 3 Preparing Pipe Ends

After cutting, always remove all burrs and filings from both the inside and outside of the pipe and bevel the pipe end using a beveling tool. Remove burrs and filings from the inside of the pipe using a knife edge or file. Failure to remove burrs can scrape channels into pre-softened surfaces, create obstructions inside surface walls, or inadvertently plow cement out of the joint during assembly.



Step 4 Cleaning

Using a clean dry cloth, wipe any dirt and moisture from the fitting socket and the pipe end. Moisture will increase cure times and dirt and grease can prevent adhesion.

WARNING: Do not use or test Xirtec® CPVC with compressed air or other gases. Do not use air-over-water boosters.

Step 5 Dry Fitting

Before applying primer or solvent cement, test all connections (pipe, fittings and accessories) to confirm a proper interference fit exists. Dry-fit contact between properly beveled pipe and fitting sockets is essential in making a good joint. The beveled pipe should easily enter the fitting socket and make contact with the inner fitting socket wall before bottoming out. A proper interference fit is present when the beveled pipe can only be inserted 1/3 to 2/3 of the way into the fitting socket

⚠ **CAUTION: DO NOT SOLVENT WELD PIPE, FITTINGS OR ACCESSORIES THAT FIT LOOSELY TOGETHER OR WHERE PIPE BOTTOMS OUT IN A DRY FIT.** Proper joint strength cannot be developed. Do not solvent weld pipe, fittings or accessories if a beveled pipe cannot easily be inserted at least 1/3 of the way into the fitting socket. This may cause excessive stresses during assembly leading to joint failure.

Step 6 Marking the Pipe

Measure the fitting socket depth and mark the outside of the pipe with this dimension, followed by a second mark 1 inch further back. The first line will provide a guide for ensuring enough solvent cement is applied on the pipe. Maintaining a 1 inch distance to the second line once the pipe is inserted into the fitting socket will indicate full and proper insertion of the pipe inside the fitting socket.

Step 7 Select Applicator

Ensure that the right applicator is being used for the size of pipe or fittings being joined. The applicator size should be equal to half the pipe diameter. It is important that a proper size applicator be used to help ensure that sufficient layers of cement and primer are applied.

Step 8 Primer Application

Using the correct applicator, aggressively work the primer into the fitting socket, keeping the surface and applicator wet until the surface has been softened. More applications may be needed for hard surfaces and cold weather conditions. Re-dip the applicator in primer as required. When the surface is primed, remove any puddles of primer from the socket.

WARNING: Do not use or test Xirtec® CPVC with compressed air or other gases. Do not use air-over-water boosters.

Step 9 Primer Application

Aggressively work the primer on to the end of the pipe to a point 1/2" beyond the depth of the fitting socket.

Step 10 Primer Application

A second application of primer in the fitting socket is required, keeping the surface and applicator wet until the surface has been softened. When the surface is primed, remove any puddles of primer from the socket.

Step 11 Cement Application

Throughly stir the cement or shake can before each use. Immediately and while the surfaces are still wet, using the correct size applicator, aggressively work a heavy, even layer of cement on to the pipe end equal to the depth of the fitting socket. Do not brush it out to a thin paint type layer, as this will dry too quickly.

Step 12 Cement Application

Aggressively work a medium layer of cement into the fitting socket. Avoid puddling cement in the socket by holding the fitting on an angle. If primer has dried, repeat the two Primer Application steps above.

NOTICE: Avoid pulling the cement in the socket. Excessive cement may cause the fitting to weaken due to softening by the trapped solvents.

Step 13 Cement Application

Apply a second heavy, even layer of cement on the pipe. Apply enough solvent cement to completely fill all the gaps between the pipe and fitting at socket entrance.

WARNING: Do not use or test Xirtec® CPVC with compressed air or other gases. Do not use air-over-water boosters.

Step 14 Assembly

Without delay, while the cement is still wet, assemble the pipe and fittings. Use sufficient force to ensure that the pipe bottoms in the fitting socket.

If cement has dried before assembly, discard pipe end and fitting.

Step 15 Assembly

Hold the pipe and fitting together for approximately 30 seconds to avoid push out. If push out does occur, the joint will need to be replaced.

Step 16 Assembly

After assembly, a joint should have a ring or bead of cement completely around the juncture of the pipe and fitting. If voids in this ring are present, sufficient cement was not applied and the joint may be defective.

Step 17 Removing Excess

With a clean, dry cloth, remove the excess solvent cement from the pipe and fitting socket entrance. This will allow the solvent to evaporate from within the joint and prevent weakening of the pipe.

Step 18 Joint Setting & Curing

Handle newly assembled joints carefully until initial set has taken place. **(Note: in humid weather, allow for at least 50% more curing time.)** For initial set and cure times, refer to tables in the Average Joint Set and Cure Time Schedules section of this manual.

AVERAGE JOINT SET SCHEDULE FOR CPVC SOLVENT CEMENT**

Temperature Range	Pipe Sizes 1/2" to 1-1/4"	Pipe Sizes 1-1/2" to 2"	Pipe Sizes 2-1/2" to 6"
60° – 100 °F	2 minutes	5 minutes	30 minutes
40° – 60 °F	5 minutes	10 minutes	2 hours

Note: Initial set schedule is the necessary time to allow before the joint can be carefully handled.

** Due to the many variables in the field, these figures are to be used as a general guide only. Refer to primer and cement manufacturer for actual cure times.

AVERAGE JOINT CURE SCHEDULE FOR CPVC SOLVENT CEMENT**[1]

Relative Humidity 60% or Less	Cure Time Pipe Sizes 1/2" to 1-1/4"		Cure Time Pipe Sizes 1-1/2" to 2"		Cure Time Pipe Sizes 2-1/2" to 6"	
Temperature range during assembly and cure periods	Up to 160 psi	Above 160 psi	Up to 160 psi	Above 160 psi	Up to 160 psi	Above 160 psi
60° – 100 °F	15 min	6 hrs	30 min	12 hrs	1-1/2 hrs	24 hrs
40° – 60 °F	20 min	12 hrs	45 min	24 hrs	4 hrs	48 hrs

Note: Joint cure schedule is the necessary time to allow before pressurizing the system. In damp or humid weather allow at least 50% more cure time.

** Due to the many variables in the field, these figures are to be used as a general guide only. Refer to primer and cement manufacturer for actual cure times.

[1] Pressure values shown in this table indicate the maximum test pressure of the piping system. The system should not be pressurized at all until this cure time has elapsed.

NOTICE

The values provided in these tables are for guidance only and do not necessarily reflect the actual return to service time required for every situation. Installers must allow for additional time where possible when returning Xirtec CPVC system to hot water service.

COLD WEATHER SOLVENT WELDING

- AVOID solvent weld joints when pipe, fitting, valve or installation temperatures are less than 40°F
- Prefabricate as much of the system as possible in a heated area
- Store primer and solvent cement in a warm location when not in use and make certain cement remains fluid
- Take special care to remove moisture such as snow and ice from the surfaces being joined, including pipe ends and fitting and valve sockets
- Ensure that the pipe, fittings and valves are at the same temperature prior to solvent welding
- Ensure the surfaces are softened before joining. Check for proper softening of surfaces and correct amount of cement on a sample pipe. Surfaces are sufficiently softened when scraping a blade on the treated part results in the effortless removal of a thin layer of the base material
- Colder weather requires longer set and cure times. Refer to the Average Joint Set and Cure Time Tables for required set and cure schedules before moving or pressure testing joints. A heating blanket may be used to speed up the set and cure times

HOT WEATHER SOLVENT WELDING

- Store Xirtec CPVC primer and solvent cement in a cool or shaded area prior to use
- Store pipe and fittings in a shaded area prior to solvent welding
- Cool surfaces to be joined with a clean, damp rag. Be sure the surface is dry prior to solvent welding
- Consider solvent welding joints in the cooler morning hours
- Make sure both surfaces to be joined are still wet with solvent cement when joining them together
- Vigorously stir or shake the solvent cement before use

WARNING: Do not use or test Xirtec® CPVC with compressed air or other gases. Do not use air-over-water boosters.

SOLVENT WELDING BALL VALVES

Solvent weld Xirtec CPVC valves using the standard solvent welding procedure outlined in this manual. To avoid damage to Xirtec CPVC valves, follow these important steps:

INSTALLING THE XIRTEC CPVC ONE-PIECE BALL VALVE

(a) Always ensure the valve handle is in the open position. Never install valves with the handle in the closed position as this exposes the ball to dirt, solvent cement, and possible damage.

(b) Always ensure Xirtec CPVC valves are properly supported during the solvent welding procedure. The weight of an unsupported valve may cause unwanted stress on new solvent cement joints.

(c) Solvent weld pipe to valve ends.

- IPEX recommends that the valve be solvent welded horizontally before installing the assembly in the final vertical or horizontal position to avoid solvent cement from contacting the ball and interfering with the valve function.

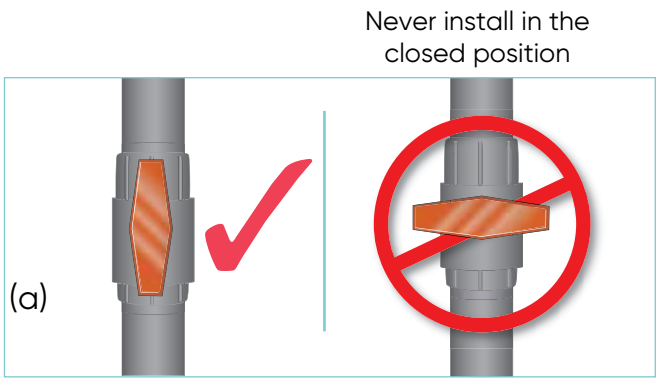
NOTE:

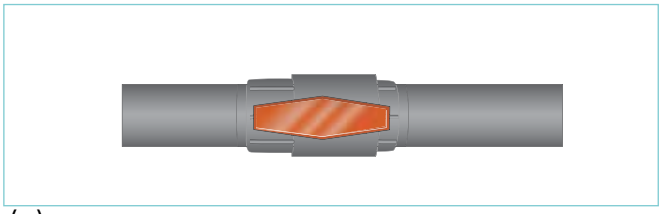
Solvent cement shall only be in contact with the fitting socket and pipe. DO NOT use excessive cement as it may puddle inside the valve and interfere with the sealing surface of the end connectors, the O-ring, or ball inside the valve. Solvent cement will damage these components and prevent proper sealing. Discard any valve that has solvent cement on these components.

NOTE:

For vertical installations, take extra care not to use excessive solvent cement.

DISMANTLING: The Xirtec CPVC One-Piece Ball Valve cannot be serviced and must be replaced as required.





(c)

WARNING: Do not use or test Xirtec® CPVC with compressed air or other gases. Do not use air-over-water boosters.

VERTICAL INSTALLATION FOR XIRTEC CPVC TRUE UNION BALL VALVE (VXE MODEL)

(a) Always ensure the valve handle is in the open position. Never install valves with the handle in the closed position as this exposes the ball to dirt, solvent cement, and damage.

(b) Completely unscrew the union nuts and end connectors.

(c) Slide union nut onto end of pipe section.

(d) Always ensure Xirtec CPVC valves are properly supported during the solvent welding procedure. The weight of an unsupported valve may cause unwanted stress on new solvent cement joints.

(e) Solvent weld the end connectors on the end of the pipes.

- IPEX recommends that the (bidirectional) valve be solvent welded horizontally before installing the assembly in the final vertical or horizontal position to avoid solvent cement from contacting the ball and interfering with the valve function.
- Solvent cement shall only be in contact with the inside of the end connector and pipe. Never allow solvent cement to contact the sealing surface of the end connector or the O-ring on the valve end.
- DO NOT use excessive cement as it may puddle inside the valve and interfere with the sealing surface of the end connectors, the O-ring, or ball inside the valve. Solvent cement will damage these components and prevent proper sealing. Discard any valve that has solvent cement on these components.

Note: For vertical installations, take extra care not to use excessive solvent cement.

(f) Insert the body between the end connectors and if necessary, fix it with the anchoring system. Place the "adjust" end upstream with respect to the direction of flow.

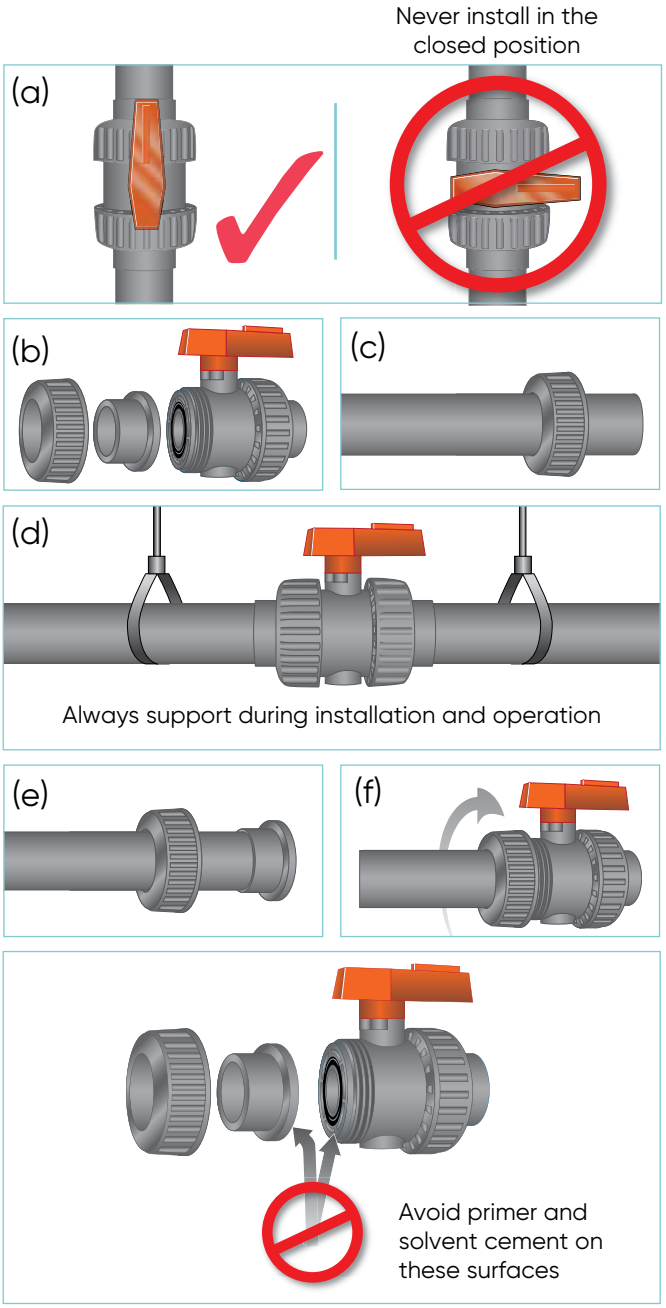
(g) Tighten the downstream union nut.

(h) Tighten the opposite union nut (with the wording "adjust") until a complete seal is achieved. Hand tightening is typically sufficient to maintain a seal for the maximum working pressure.

Note: Over-tightening may damage the threads on the valve body and/or the union nut, and may even cause the union nut to crack.

DISMANTLING PROCEDURES:

- Put the valve in the closed position
- Completely loosen the union nuts
- Remove the body from between the union nuts
- Remove the handle
- Insert the lugs placed under the handle in the corresponding notches of the ball seat support and unscrew the ball seat support by turning the handle counter clockwise
- Take the ball out
- Push down the stem and remove from the body
- Remove the PTFE seats from the ball seat support and from the body
- If necessary, change the EPDM O-rings
- Follow the above steps in reverse to reassemble. Cycle the valve during the first test and tighten the union nuts if necessary



FLANGE CONNECTIONS

Flanges are used where periodic dismantling is required and for convenient transition to metallic piping or components such as pumps and metal valves. Xirtec CPVC flanges have solvent cement socket ends and the same bolt hole dimensions as Class 150 metal flanges per ANSI B16.5. All flanges meet the requirements of ASTM F1970 and are listed to NSF Standard 61 for potable water.

Three types of Xirtec CPVC flanges are offered; solid (one-piece) flanges, blind flanges and Vanstone (two-piece) flanges which assist with bolt hole alignment. All flange styles are pressure rated for 150 psi at 73°F.

Full-face flange gaskets must be installed between the Xirtec CPVC flange and its mating surface. Gaskets must be approved for potable water and must be chemically compatible with Xirtec CPVC. Flange gaskets (1/8" thick) must be made of an elastomeric material with a Durometer A hardness of 50 to 70.

Full-Pressure (FP) Flange Kits are offered and will serve to assist in increasing the operating pressure of solid Xirtec CPVC flanges to the same level of Xirtec CPVC pipe and fittings – see system pressure and temperature section of the manual. These kits consist of a one-piece flange, split metal backing ring, connecting hardware and a NSF-61 listed elastomeric gasket, specifically designed to increase the flange kits operating pressure to that of the corresponding pipe.

FLANGE INSTALLATION GUIDELINES

SOLVENT WELDING FLANGES

In all cases, avoid excessive force on the solvent welded end of Xirtec CPVC flanges. Failure to properly support the flanged connection can lead to excessive stress and failure of the solvent weld flange connection.

If possible, complete the flange bolt connections first and ensure the bolts are fully tightened in accordance with the instructions outlined in this manual. Once this is completed and the flange is fully supported, the solvent weld connection can be performed on the socket end of the flange. Follow all solvent welding procedures in this manual. Ensure the solvent welded joint is fully cured before modifying the bolted flange connection or pressure testing the system. See the tables in the Average Joint Set and Cure Schedules Section of this Manual.

If the solvent welded connection of the flange must be completed first, ensure that the solvent welded joint is fully cured and properly supported before assembling the bolted portion of the flange. See the tables in the Average Joint Set and Cure Schedules Section of this Manual.

FLANGE CONNECTIONS

1. Make sure all bolt holes of the matching flanges are aligned.
2. Ensure a proper full-faced gasket is installed between the flange surfaces.
3. Make sure mating flange faces are in contact with each other prior to tightening bolts. Do not use bolt tightening to close gaps between flange faces as this can lead to excessive stress on the flange.
4. Xirtec CPVC flanges can be installed against mating surfaces that include an integrated gasket, like wafer-style butterfly valves.
5. To assist with tightening, lubricate bolt threads with a lubricant fully compatible with Xirtec CPVC such as IPEX mechanical joint lubricant.
6. Always tighten nuts in incremental stages following the cross star bolt tightening sequence on the following page. Always use a torque wrench to ensure values in the Recommended Torque Table below are not exceeded. Uniform stress across the flange will prevent leaks.
7. Always support the flange connection and accessory (pump, valve, etc.) to eliminate potential stress.

Solid and Vanstone Flanges – Bolt Dimensions Recommendation

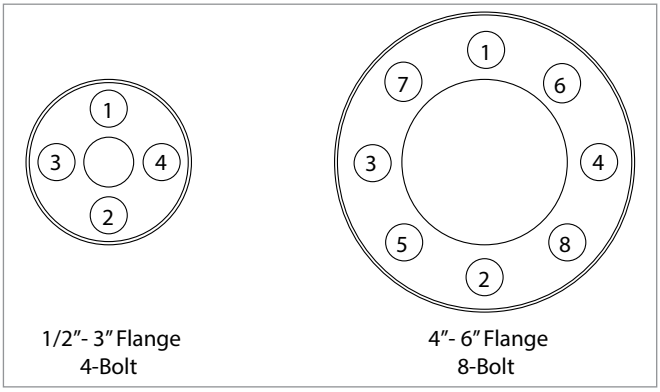
Pipe Size (in.)	# of Holes	Bolt Diameter (in.)	Bolt Length (in.)
1/2	4	0.50	1.75
3/4	4	0.50	2.00
1	4	0.50	2.00
1-1/4	4	0.50	2.25
1-1/2	4	0.50	2.50
2	4	0.63	2.75
2-1/2	4	0.63	3.00
3	4	0.63	3.00
4	8	0.63	3.25
6	8	0.75	3.50

Note: Bolt length will vary if metal backing rings are used.

One-Piece and Vanstone Flanges – Maximum Bolt Torque Values

Flange Size (in.)	Recommended Maximum Torque (ft.lb)
1/2 to 1-1/2	15
2 to 4	30
6	50

CROSS STAR BOLT TIGHTENING SEQUENCE



1/2"- 3" Flange
4-Bolt

4"- 6" Flange
8-Bolt

FULL PRESSURE (FP) FLANGE KIT INSTALLATION

This kit is for installation on one-piece Xirtec CPVC flanges only. Do not install this kit on Vanstone flanges. This kit must be installed using all the components supplied. Any substitution of components such as longer bolts or a replacement gasket must comply with the original kit specifications. Failure to comply with kit specifications nullifies the kit certification and may compromise the pressure rating and flange performance.

INSTALLATION PROCEDURE

1. Assemble the one-piece Xirtec CPVC flange hub to a Xirtec CPVC pipe in accordance with solvent cement installation procedures detailed in this manual.
2. Allow the joint to fully cure set before installing the remaining components of the Full-Pressure Kit. Refer to the tables in the Average Joint Set and Cure Schedules Section of this Manual.
3. Begin kit installation by placing the backing ring over the back of the hub of the Xirtec CPVC flange, ensuring that the bolt holes are aligned.
4. Slip the gasket provided between the two flanges and bring the Xirtec CPVC and mating flanges together.
5. Insert the bolts through the matching holes of both the flanges and backing ring. Use only the bolts supplied or recommended. A flat washer should be installed beneath each nut and the bolt head.

   Note: The bolt length will vary for flange size and assembly configuration. The length of bolts supplied in this kit is assuming connection to a metal flange. For Xirtec CPVC to Xirtec CPVC flange connections, bolts should be 1/2" longer so that the bolts extend approximately 1/4" minimum beyond the nut after final assembly.
6. When the bolts are installed, a torque wrench should be placed over the nut (not on bolt head). Tighten the nut as per Step 1 in the table below. Please refer to the cross star bolt tightening sequence above.
7. Next, tighten the nuts to the specified torque values as per Step 2 in the table below. A multi-step tightening process is recommended with each step requiring the installer to tighten the nuts in a star pattern.

Incremental Torque Values

Size (in.)	Step 1 (ft.lb)	Step 2 (ft.lb)	Step 3 (ft.lb)	Step 4 (ft.lb)
2-1/2	20	40	70	–
3	20	40	70	–
4	20	40	80	110
6	20	40	80	110

8. Once this assembly is complete, perform a check pass of the bolts by starting at one and going around in a clockwise direction, ensuring each nut is tightened to the highest recommended torque level for that size.

Notes:

1. Do not use the flanged connection to support the weight of a metal system component such as a ball or butterfly valve. Those items should be supported independently.
2. FP Flange Kits cannot be installed against mating surfaces that include an integrated gasket, like wafer-style butterfly valves. The gasket provided in the Full-Pressure Flange Kit must be the only gasket used in the assembly.
3. This flange assembly has been certified to ASTM F 1970. As such, any components that are replaced must comply with the listing in order to maintain the certification.
4. Replacement parts shall be: Stress-Saver XP gasket (75-80 Durometer Hardness), SAE J429 Grade 8 bolts with associated hex nut, two (2) flat washers per bolt.
5. Installers must use a torque wrench for proper assembly.

CAUTION

1. Do not over-torque flange bolts
2. Use the proper bolt tightening sequence provided in this manual
3. Make sure the system is in proper alignment
4. Flange joints must not be used to draw piping assemblies together
5. Full-face gaskets must be used
6. Flat washers must be used under every nut and bolt head
7. Gaskets must be approved for potable water and must be chemically compatible with Xirtec CPVC

NOTICE

Hot Water Flange Connections

For flange connections in hot water systems, FP Flange Kits are required when connecting to solid flanges. This provides a full pressure rating of 150 psi at 160°F.

CPVC THREADED ADAPTER FITTINGS

CPVC threaded adapter fittings are offered in a range of fitting configurations from 1/2" through 2". Both male and female threaded adapter fittings utilize American National Standard Taper Pipe Threads (NPT) and allow for quick connection from Xirtec CPVC to alternative materials or metallic threaded accessories such as valves and pumps.

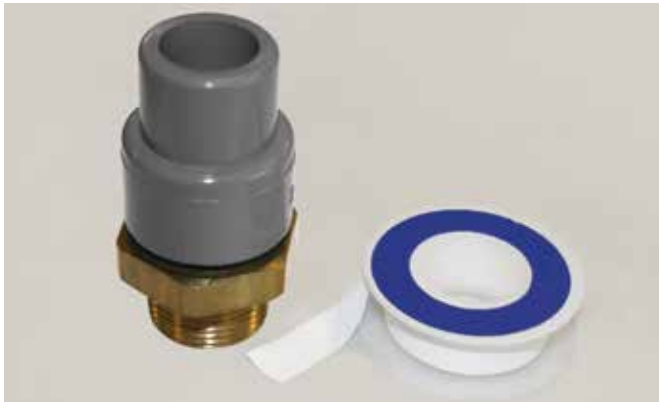
The strength of the high grade metallic alloy provides a robust thread design, while the material composition of the alloy provides resistance to dezincification and stress cracking caused by harsh water treatment chemicals such as chloramines.

The threaded adapter fittings will provide the following performance: 400 psi at 73°F (2,758 kPa at 23°C), 150 psi at 160°F (1,034 kPa at 71°C), and are listed to CSA B137.6 and ASTM F1970. These fittings carry a potable water listing as per NSF/ANSI 61 and are certified as lead free to NSF/ANSI 372.

INSTALLATION GUIDELINES

1. Begin by applying the PTFE (Teflon™) tape to the male threaded end of the joint. Wrap the tape around the entire thread length beginning with the number two thread from the end. The tape should slightly overlap itself going in the same direction as the threads to prevent the tape from unraveling when the male end is tightened into a female adapter. Overlapping in the wrong direction and/or the use of too much tape can affect tolerances between threads and generate undue stress in the wall of female fittings.

2. After applying the tape, the threaded joint should be started carefully and hand tightened. Fittings should be threaded together until hand-tight, followed by 1 to 2 turns with an appropriate wrench. Tighten the male adapter into the female adapter taking care not to cross-thread the fittings.



NOTICE

DO NOT overtighten the threaded joint.

NOTICE

When connecting to CPVC threaded adapter fittings, use PTFE (Teflon™) tape only, with a minimum of two wraps as the thread sealant.

NOTICE

Use PTFE (Teflon™) tape with a minimum thickness of 2.5 mil.

NOTICE

Make certain no solvent cement, primer, or cleaner is on the threaded portion of the adapter fitting.

NOTICE

It is imperative that solvent welded connections for CPVC threaded adapter fittings be given sufficient time to cure to withstand possible pulling and torsion forces.

NOTICE

Do not wrench or clamp the plastic portion of the adapter fitting. Use an 18" pipe wrench or smaller with sufficient clearance between the wrench and the plastic during installation.

NOTICE

DO NOT thread any Xirtec CPVC pipe used in any water application.

CAUTION

Do not connect Xirtec CPVC products directly to a hot water heater or boiler. When Xirtec CPVC piping is connected to a gas-fired or electric water heater, use a metal nipple to ensure Xirtec CPVC piping is a minimum 12" away from the appliance.

NOTE: Verify Code requirements prior to installation.

CAUTION

Xirtec CPVC must be installed at least 6" away from any external heat source with a surface temperature greater than 160°F.

PIPE SUPPORTS AND RESTRAINTS

Hangers/supports, guides, and/or clamps MUST:

- Have all residue oils wiped off with a clean, dry rag or cloth before contacting the Xirtec CPVC product
- Be free of rough or sharp edges which come in contact with the Xirtec CPVC System
- NOT be over tightened causing distortion of pipe or fittings
- NOT contain rubber or incompatible coatings with plasticizers that contact Xirtec CPVC products

HORIZONTAL PIPING

Horizontal runs of Xirtec CPVC pipe must be supported as per the hanger support spacing found in the table below. Piping must not be anchored tightly to supports, but rather secured with smooth straps or hangers that allow for movement caused by expansion and contraction.

Recommended Maximum Horizontal Support Spacing (ft.) for Xirtec CPVC Piping

Nominal Pipe Diameter (in)	Temperature (°F)				
	73°F	100°F	120°F	140°F	160°F
1/2	3.1	3.0	2.9	2.8	2.7
3/4	3.5	3.4	3.3	3.2	3.1
1	4.1	3.9	3.8	3.7	3.6
1-1/4	4.6	4.5	4.4	4.2	4.1
1-1/2	5.0	4.8	4.7	4.6	4.4
2	5.6	5.5	5.3	5.2	5.0
2-1/2	6.5	6.3	6.1	5.9	5.7
3	7.2	7.0	6.8	6.6	6.4
4	8.3	8.1	7.8	7.6	7.4
6	10.4	10.1	9.8	9.5	9.2

NOTICE

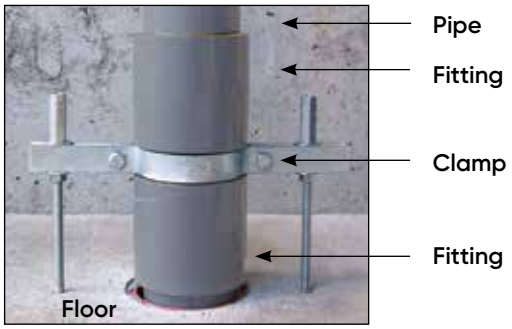
Maximum support spacing recommendations should always be referenced against local Codes as well as the local Authority Having Jurisdiction.

VERTICAL PIPING (RISERS)

Vertical piping shall be supported at its base, and at each floor or every ten feet, whichever is less (as per *International Plumbing Code - Section 308.5, and Uniform Plumbing Code - Section 313.3).* Supports suitable for this purpose include riser clamps or double bolt type clamps. Supports shall be installed as per the instructions detailed below.

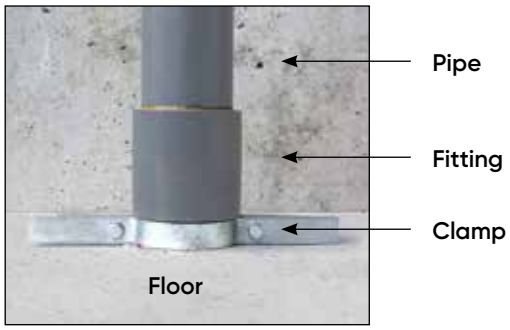
ANCHORING Xirtec CPVC in a vertical application:

Anchors in an Xirtec CPVC system are intended to prevent all movement at a particular point in the system. To achieve this, pipe clamps shall be tightened to a friction fit between two fittings as per the diagram below. The pipe clamp can then be anchored to the building. Do NOT over tighten the clamps compressing and distorting the pipe.



SUPPORTING Xirtec CPVC in a vertical application:

Xirtec CPVC vertical piping shall be supported by a combination of pipe clamps and fittings as per the diagram below. Pipe clamps shall be tightened to a friction fit directly below a fitting (tee or coupling). The fitting shall rest on the pipe clamp transferring the weight of the Xirtec CPVC system into the clamp. Do NOT over tighten the clamps compressing and distorting the pipe.



MID-STORY GUIDES

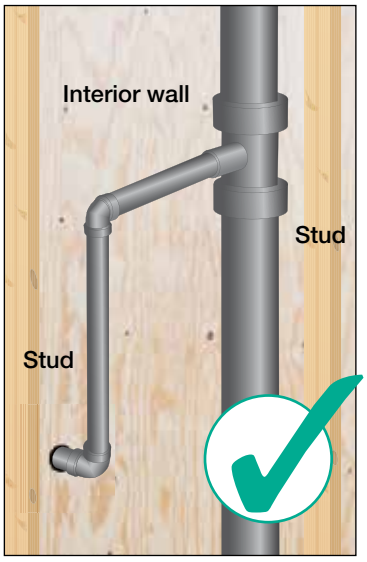
Vertical piping shall have a mid-story guide firmly attached to the structure to prevent lateral movement, while still allowing longitudinal movement of the piping.

SUPPORTING HORIZONTAL TAKE-OFFS

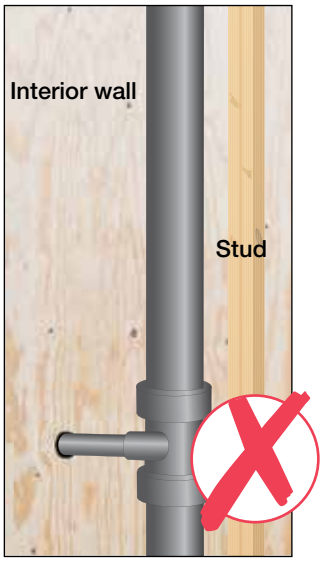
Horizontal take-offs from the vertical riser should be supported independently. Horizontal take-off should be placed as close to the support or anchor as possible. Utilize offset configurations with at least one change in direction on horizontal run tie-ins to the riser, which will minimize stress on the horizontal connection if movement of the riser occurs.

A straight horizontal run from the riser tee through the wall should not be used on Xirtec CPVC hot water lines.

ILLUSTRATIONS ARE REPRESENTATIVE EXAMPLES
(NOT TO SCALE)



Offset Configuration



Straight Horizontal run through a wall

NOTICE

SUPPORTS AND GUIDES must be designed for CPVC piping; designed to withstand the forces generated by thermal expansion and contraction; designed to accommodate the pipe column weight; and must not compress, distort, cut or abrade the piping.

SYSTEM ACCEPTANCE (HYDROSTATIC PRESSURE) TEST

After the Xirtec CPVC system has been installed, it is important to test and inspect it for joint integrity. Leave all concealed pipe and fittings uncovered until the required test is completed and approved by the local Authority Having Jurisdiction.

Generally, a test pressure of 1.5 times the system working pressure for the pipe installed is adequate to a maximum test pressure of 150 psi at 73 °F. It is recommended that hydrostatic testing be carried out before commissioning the line into usage. The following hydrostatic test procedure should be followed after all the solvent welded joints, in the section to be tested, have been allowed to cure fully (see tables in Average Joint and Cure Schedule in this Manual).

Pressure testing with compressed air is strictly prohibited with Xirtec CPVC.

Prior to testing, precautions must be taken to protect personnel and property in case of test failure.

HYDROSTATIC TEST PROCEDURE

1. Where possible, visually inspect the installed piping for evidence of physical damage or deficiencies.
2. Split the system into convenient test sections, not exceeding 1,000 feet.
3. Slowly fill the pipe section with water, preferably at a velocity of 1.0 ft/s or less. Any entrapped air must be evacuated by venting from the high points. Do not pressurize at this stage.
4. Leave the section for at least 1 hour to allow equilibrium temperature to be achieved.
5. Check the system for leaks. If clear, check for and remove any remaining air and increase pressure up to 50 psi (345 kPa). Do not pressurize further at this stage.
6. Leave the section pressurized for 10 minutes. If the pressure drops, inspect for leaks. If the pressure remains constant, slowly increase the hydrostatic pressure to 1.5 times the system working pressure but do not exceed the maximum working pressure of any system components.
7. Leave the section pressurized for a period not exceeding 1 hour. During this time, the pressure should not change if the test is successful. If there is a significant drop in static pressure or extended times are required to achieve pressure, either joint leakage has occurred or air remains in the line. Inspect for leakage and if none is apparent, reduce the pressure and check for trapped air. All air must be removed before further testing.
8. Any joint leaks should be repaired and allowed to cure fully before re-pressurizing and testing. For more details, refer to the tables in the Average Joint Set and Cure Schedules sections of this Manual.

WARNING

- **NEVER** use compressed air or gas in Xirtec CPVC pipe, fittings and valves.
- **NEVER** use or test Xirtec CPVC with compressed air or other gases. Do not use air-over-water boosters.

Use of compressed air or gas in Xirtec CPVC pipe, fittings, and valves can result in explosive failures and cause severe injury or death.

NOTICE

Do not exceed the maximum working pressure of any system components including pipe, fittings, valves, threaded adapters, unions, maintenance couplings or flanges.

- The pressure rating of all components must be reduced when operating temperatures exceed 73°F. Refer to the Xirtec CPVC Correction Factor Table in the System Pressure and Temperature Ratings section of this Manual.
- Exceeding the maximum working temperature or pressure of the system may result in system failure and/or property damage.

GENERAL MAINTENANCE

Building maintenance staff and or Plumbing/HVAC maintenance staff should perform routine inspection of piping systems within the building. For Xirtec CPVC, ensure that system operating conditions do not exceed the maximum allowable operating temperature and pressure ratings for the Xirtec CPVC system. Make system adjustments as needed and contact IPEX for further assistance if operating conditions exceed Xirtec CPVC limitations.

Ensure that no materials or chemicals that may be incompatible with Xirtec CPVC have come into contact with the Xirtec CPVC system. For additional information, contact IPEX.

Ensure that no other piping systems, accessories or elements of the building are hung from the Xirtec CPVC piping system. All other systems, accessories and building materials must be properly anchored and supported in accordance with local Plumbing and Building Codes.

Ensure that no electrical wires or data cabling are wrapped around or in contact with Xirtec CPVC pipe and fittings. The plasticizers contained in the plastic jackets of these wires and cables may not be compatible with Xirtec CPVC. Remove any wires that are in contact with Xirtec CPVC and contact IPEX for further assistance.

Ensure that Xirtec CPVC pipe maintains straight alignment and do not bend or snake after the piping system is commissioned. This movement after installation signifies that expansion and contraction forces may not be properly accounted for in the piping system. This movement can cause excessive stresses on solvent welded joints, flange connections, pipes, fittings and lateral branch lines. Contact IPEX for recommendations and assistance if this misalignment is observed.

AGING OF CORZAN CPVC

Inspect all mechanical joints and components (such as Flanges, Unions, T.E.D).

Like all materials, Corzan® CPVC ages during its operating life. Aging can result in changes to physical characteristics such as increased brittleness and the reduction in impact resistance. This can be caused by prolonged elevated operating temperatures or prolonged exposure to UV light. As a result, avoid any forcible contact or impact with the piping system to reduce the chance of cracks or fractures occurring.

SYSTEM REPAIR

Inspect pipes for any damage such as cracking and deep gouges. Locate the end of any pipe cracks and be sure to cut at least 2" beyond the crack line to ensure it is removed.

Carefully inspect any fittings for damage and remove and replace them accordingly.

Additional precautions must be taken when modifying or repairing aged products made with Corzan CPVC as they may be subject to a reduction in impact resistance, (increased brittleness) making them more prone to cracking.

CAUTION

When modifying or repairing CPVC pipe, use only wheel cutters or fine tooth saws that are new and sharp. DO NOT use ratchet style cutters.

Repairs can be made by solvent welding new sections of pipe and fittings. However, installation conditions during a repair vary greatly when compared to a new installation. Repairs or cut-ins to an existing system are typically done in confined spaces, on closed end piping systems, and often have more humidity present. All of these factors can inhibit the evaporation of the solvent leading to increased set and cure times. As such, IPEX recommends that the standard set and cure times be increased by at least 50% for repairs or cut-ins. Refer to the tables in the Average Joint Set and Cure Schedules Section of this Manual.

When a repair cannot be scheduled or delayed, Maintenance Couplings in conjunction with pre-solvent welded assemblies can get a system back to service in a shorter time.

NOTICE

Removal of threaded connections:
Use a rubber strap wrench to grip the stationary fitting while backing out the threaded component.
Failure to do so will put torque stresses on the pipe and may damage the piping system.

MAINTENANCE COUPLINGS

The Xirtec CPVC Maintenance Coupling is designed for use with Xirtec CPVC pipe. It is NSF 61 listed for potable water and offers full pressure ratings of 400 psi at 73°F and 150 psi at 160°F. The couplings have been tested to ensure reliable long-term performance in hot and cold potable water applications.

The metallic components of the coupling are made with 304 stainless steel. Its steel gripping ring is designed to provide pull-out resistance for Xirtec CPVC pipe by providing a low profile, extra wide gripping surface with three rows of gripping teeth. The EPDM sealing gasket is PTFE coated for resistance to aggressive water and potable water treatment chemicals.

The mechanical joint end connections and rubber-lined stainless steel construction provide a fast 'pipe to pipe' alternative connection for Xirtec CPVC. They are ideal for quick repairs of Xirtec CPVC pipe in need of maintenance without possible delays due to necessary cure times associated with solvent welding. The couplings also permit easier tie-ins to the existing Xirtec CPVC system when used with pre-welded pipe-end assemblies.

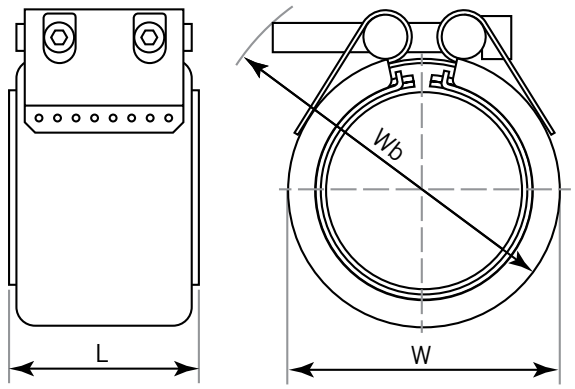
System changes can be planned in advance with pre-assembly of solvent welded sections done off-site. These new sections can then be quickly and simply connected to the existing Xirtec CPVC piping system using Xirtec CPVC Maintenance Couplings.

NOTICE

Maintenance Couplings are suitable for pipe to pipe connections only.

Dimensions and Torque: Maintenance Couplings

Nominal Diameter	Length, L	Body Width, W	Overall Width including Bolt, Wb	Torque Wrench Allen Socket Size	Insertion Depth, C
inches	inches	inches	inches	mm	inches
1	1.81	2.05	2.95	6	0.81
1-1/4	2.40	2.44	3.54	6	1.10
1-1/2	2.40	2.68	3.74	6	1.10
2	3.03	3.23	4.33	6	1.42
2-1/2	3.70	3.94	5.12	8	1.65
3	3.70	4.61	5.71	8	1.65
4	3.70	5.47	6.50	8	1.65



MAXIMUM OPERATING PRESSURE

400 psi at 73°F
150 psi at 160°F

OPERATING LIMITATIONS

- For use on Xirtec CPVC pipe to pipe connections only
- Always operate within the allowable pressures and temperatures
- Coupling not intended to account for misalignment or change in direction

FAILURE PREVENTION

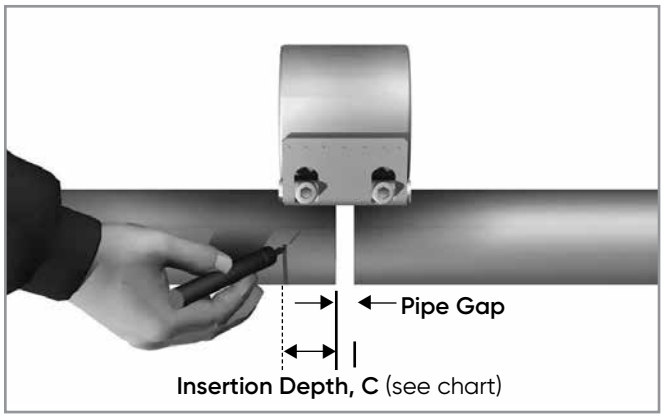
- Follow all installation instructions provided with the couplings
- Couplings must be tightened to the specified torque values as printed on each coupling
- Failure to follow all instructions can result in leakage, property damage or injury

MAINTENANCE COUPLING INSTALLATION GUIDELINES

STEP 1: PREPARE XIRTEC CPVC PIPE

- Cut pipe squarely
- Remove all sharp edges and burrs on the inner and outer edges of the pipe end with sandpaper
- Clean the pipe surface of all impurities and dirt
- Pipe ends must be clean and free of dirt to ensure a proper seal

STEP 2: PROPERLY FIT THE COUPLING



- Ensure proper gap between pipe ends. See chart below for details

Pipe	Pipe Gap
1" – 2"	0.2"
2-1/2" – 4"	0.4"

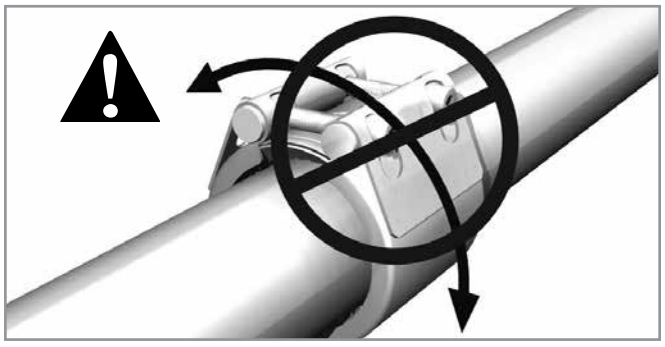
- Centre coupling over the gap between pipe ends
- Mark each pipe end to indicate the outer edge of the coupling

STEP 3: INSTALL THE COUPLING

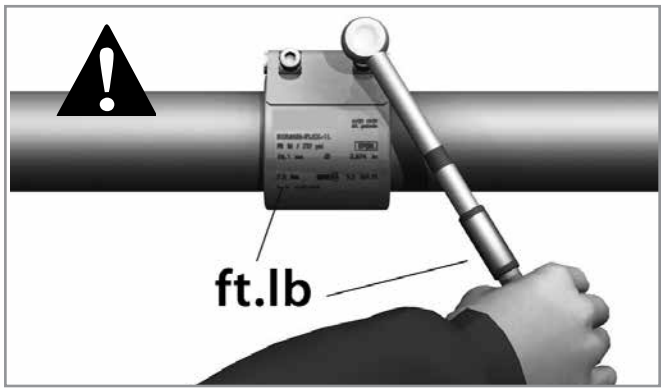
- Fit the coupling over the pipe ends
- Ensure coupling is aligned with marks on pipe ends

STEP 4: TIGHTEN LOCKING BOLTS

- Using a torque wrench, tighten locking bolts lightly and alternately
- Ensure torque wrench is set to the proper torque level shown on the coupling label
- Do not rotate coupling on the pipe joint once teeth are engaged

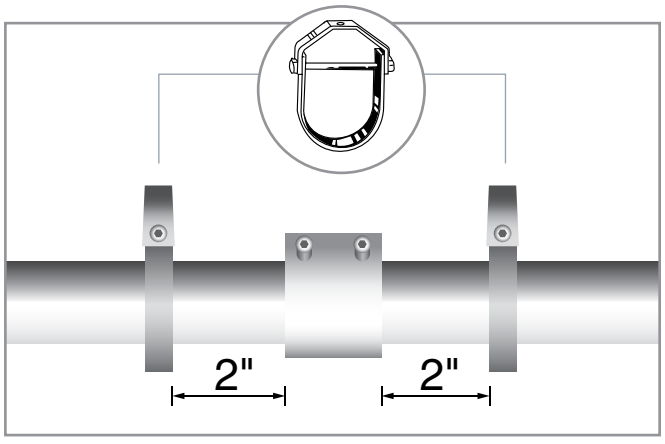


- Tighten locking bolts with a torque wrench to the final prescribed torque shown on the coupling label



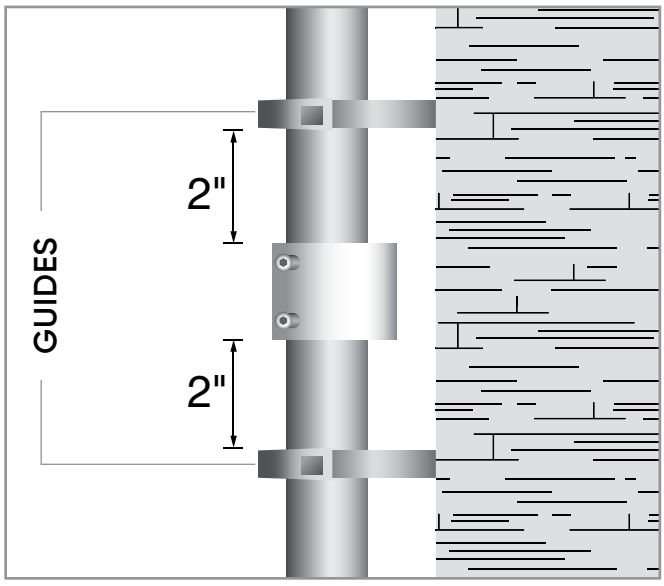
STEP 5: SUPPORT COUPLINGS

- Always maintain straight alignment of pipe and coupling
- For horizontal installations, install recommended pipe supports 2" beyond each side of coupling



WARNING: Do not use or test Xirtec® CPVC with compressed air or other gases. Do not use air-over-water boosters.

- For vertical installations, install recommended guides 2" above and below coupling



REQUIRED MAINTENANCE

Xirtec CPVC Maintenance Couplings are maintenance-free. Never retighten bolts.

WARNING: Do not use or test Xirtec® CPVC with compressed air or other gases. Do not use air-over-water boosters.

NOTICE

SAFETY MEASURES BEFORE REMOVING THE MAINTENANCE COUPLING

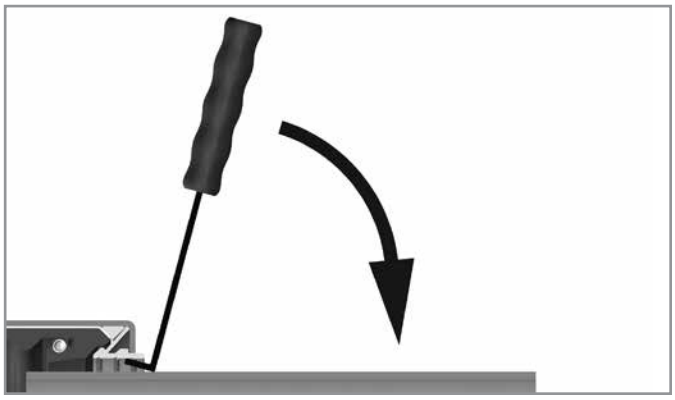
- Ensure system is not pressurized
- Drain piping system
- Protect yourself and surroundings against spilling water
- Make sure the maintenance coupling is not supporting the pipe ends

DISASSEMBLY

- Loosen bolts alternately but do not remove completely
- Do not rotate pipe joint on pipe as long as teeth are engaged
- If necessary, loosen teeth engagement
- Insert tool underneath casing and lift

DO NOT HARM RUBBER SEALING SURFACE

- Turn and move coupling smoothly
- Slide coupling beyond pipe joint
- Check rubber seal for any signs of damage
- Clean pipe joint
- Replace damaged coupling with a new coupling
- Reassemble according to instructions



WARNING: Do not use or test Xirtec® CPVC with compressed air or other gases. Do not use air-over-water boosters.

GENERAL REQUIREMENTS
Operating temperature for Xirtec CPVC used in hot and cold water distribution systems shall not exceed 160°F. Installation practices shall conform to IPEX USA LLC guidelines.

SCOPE
This specification sheet covers the manufacturers' requirements for Xirtec CPVC Schedule 80 IPS pressure pipe and Schedule 80 IPS pressure fittings. The pipe and fittings meet or exceed all applicable ASTM and NSF standards and are suitable for potable water.

XIRTEC CPVC MATERIALS
Rigid CPVC (chlorinated polyvinyl chloride) used in the manufacturing of Xirtec CPVC Schedule 80 pipe complies with the material requirements of ASTM D1784 and has a cell classification of 24448. Rigid CPVC used in the manufacturing of Schedule 80 Fittings shall meet the material requirements of ASTM D1784 and have a cell classification of 23447. Raw material used in the manufacturing shall contain the standard specified amounts of color pigment, stabilizers, and other additives. The compounds used are listed to the requirements of NSF 61 for use in potable water service. The compound must be Corzan grade. The pipe compound shall be listed and labeled as having a Flame Spread Index (FSI) of not more than 25 and a Smoke Developed Index (SDI) of not more than 50 when tested in general accordance with ASTM E84 or UL 723.

DIMENSIONS
Physical dimensions and properties of Xirtec CPVC Schedule 80 pipe shall meet or exceed the requirements of ASTM F441. Physical dimensions and properties of CPVC Schedule 80 fittings – socket type – shall meet the requirements of ASTM F439.

Physical dimensions and properties of Xirtec CPVC special engineered fittings shall meet the requirements of ASTM F1970.

MARKING
Xirtec CPVC Schedule 80 pipe is marked as prescribed in ASTM F441 and NSF 14. The marking includes the following: IPEX; Xirtec CPVC 24448; IPS CPVC and the schedule pressure rating at 73°F; ASTM F441; NSF 14; and NSF 61 Potable. CPVC Schedule 80 fittings are marked as prescribed in ASTM F437 and F439, or F1970. The marking includes the following: IPEX; CPVC and the size of the fitting; ASTM F437 or ASTM F439; NSF 14; and NSF 61 potable.

SAMPLE SPECIFICATION
All Xirtec CPVC Schedule 80 pipe shall conform to ASTM F441/F441M and be third party certified to NSF 14. All Xirtec CPVC Schedule 80 pipe from 1/2" to 6" shall be made with a CPVC compound having a minimum cell classification of 24448. Pipe shall be of 10- or 20-foot lengths.

All Xirtec CPVC fittings must me third party certified to NSF 14. All Xirtec CPVC Schedule 80 fittings from 1/2" to 6" shall be made with a CPVC compound having a minimum cell classification of 23447.

All Xirtec CPVC Schedule 80 socket fittings shall conform to ASTM F439.

All Xirtec CPVC flanges shall have a 150-lbs bolt pattern as per ANSI B16.5 and conform to ASTM F1970 with pressure ratings of 150psi at 73°F.

All Xirtec CPVC Schedule 80 unions socket shall conform to ASTM F439 and meet ASTM F1970 with pressure ratings of 150 psi at 73°F.

All Xirtec CPVC one-piece ball valves & threaded adapters shall meet ASTM F1970 with pressure ratings of 400 psi at 73°F and 100 at 180°F.

The CPVC fitting compound shall be pressure rated in accordance with ASTM D2837 and have a hydrostatic design basis of 4000 psi at 72°F and 1000 psi at 180°F as listed in PPI publication TR-4. All CPVC Schedule 80 pipe and fittings shall be made from a 4000 psi HDB PPI rated compound.

All pipe, fittings and valves shall be compatible, manufactured using Corzan compound and be produced by one manufacturer as supplied by IPEX.

SECTION 6: XIRTEC® CPVC SPECIFIC TERMS AND CONDITIONS OF SALE AND LIMITED WARRANTY AND LIMITATION OF LIABILITY

1. Scope

All sales of Xirtec® CPVC products ("**Xirtec® CPVC Products**" or the "**Products**") are subject to these product-specific terms and conditions ("Specific T&Cs") as posted on the Vendor's website at the time of sale. Purchaser's order is accepted subject to the applicable Specific T&Cs and to any terms and conditions agreed to in writing by the Vendor and Purchaser. **It is expressly agreed that any terms and conditions contained in the Purchaser's order or otherwise stipulated will be deemed for the Purchaser's internal use only and will not be binding on the Vendor.**

2. Orders

Purchaser's orders are conditional upon satisfactory credit approval by the Vendor. The Vendor will only accept orders in excess of $100 before taxes or such greater amount as may be specified for certain products. Once confirmed by the Vendor, orders for custom-made or non-stocked products cannot be canceled, modified or returned, except with the Vendor's written consent and upon terms which provide for indemnification of the Vendor for the costs and expenses incurred.

3. Shipments, Title to the Products and Risk of Loss

Any delivery schedules stipulated are approximate only and shipment will be made within reasonable proximity thereto. Under no circumstances will the Vendor be responsible for any damage whatsoever caused by delays in shipment, whether resulting from causes within or beyond the control of the Vendor.

All shipments are F.O.B. origin (Vendor's location) (American standard) or Ex Works (Vendor's location) (ICC Incoterms), as indicated on the invoice. Freight prepaid orders, when applicable, will be delivered by the carrier of the Vendor's selection, unless the use of other carriers is agreed to in writing with the Purchaser.

Risk of loss and title to the Products shall in any case pass to the Purchaser upon delivery of Products to the carrier at Vendor's shipping dock or upon the invoicing of the Products, whichever occurs first.

Purchaser must verify quantities and report discrepancies within 2 business days of receipt.

4. Prices

All prices quoted or published are F.O.B. origin (Vendor's location) or Ex Works (Vendor's location), and do not include any sales, use, excise or any other tax or levy imposed by any present or future law, regulation or other order, on any of the Products.

Published prices are subject to change without notice until orders are accepted by the issuance of an order confirmation, whereupon prices will remain firm for those shipments that take place within the 30-day period following the date of the order confirmation. For specific projects, contracts or quotations, the Vendor may agree in writing to protect prices for an extended period of time. Each order may be shipped in whole or in part at the Vendor's discretion. Each shipment made will be immediately invoiced.

In order to be exempt of the applicable taxes, Purchaser must provide the Vendor with applicable tax exemption certificates or other documents.

5. Terms of Payment

Unless other terms of payment are agreed to in writing by the Vendor, payment is due upon delivery of the Products. If applicable, cash discounts, expressed as a percentage, are calculated on the net invoiced prices before any taxes, freight or other charges and can only be deducted from payment if the Vendor receives payment from Purchaser on or prior to the due date. Net 30 days means that payment is due within 30 days of the date of invoice and no cash discount is applicable. Overdue accounts shall bear interest at a rate of 18% per annum. The granting of credit by the Vendor is at all times based on its evaluation of the Purchaser's financial condition. If such financial condition does not justify continuance of shipment on credit, the Vendor may require full or partial payment in advance.

6. Return of Products

The Vendor may accept the return of Products, at its sole discretion, but is subject in all cases to the following: a) prior to returning any Products, the Purchaser must obtain a Return Material Authorization (RMA) number from the Vendor; b) Products must be returned freight prepaid, unless otherwise authorized by the Vendor; and c) Products must be received in good saleable condition and, if required, in full carton quantities and in their original packaging. A minimum return charge of 25% of the purchase price will be applied against any credit issued pursuant to the return of Products, except in the case of a Vendor shipping error. The Vendor may apply additional charges against the credit to cover remarketing costs or may refuse to issue any credit, but will advise the Purchaser accordingly.

Certain Products, such as pressure pipe and fittings, custom-made products or configurations, perishable products, obsolete products, large quantities or other specialty products cannot be returned.

In certain circumstances, the Vendor may direct that Products be destroyed for credit rather than returned.

7. Changes to Products

The Vendor reserves the right to make changes or improvements to its Products without assuming any further obligation.

8. Patent Rights

If any claim is made against the Purchaser based on the allegation that any of the Products sold by the Vendor constitute an infringement of any patent, the Purchaser shall notify the Vendor immediately. The Vendor shall have the right, at its own option and expenses, to take any actions to protect and defend its rights.

9. Force Majeure

The Vendor shall in no event be responsible or liable for any non-performance or delay in performance hereunder or any loss or damage of any kind or nature whatsoever, direct or indirect, suffered by the Purchaser, subsequent purchasers, end-users of the Products or any other person, as a result of any causes beyond the reasonable control of the Vendor including, without limitation, fires, floods, civil commotion, riots, wars, acts of God, embargos, acts of or acts authorized by any government or standard organizations, adoption of laws or regulations, strikes/slowdowns, lock-outs/walk-outs, labor shortages, accidents, breakdowns, power outages, delays in shipments, manufacture, transportation or delivery of goods or materials, shortages of materials or supplies, or price alterations.

10. Governing Law

This agreement and all rights and obligations hereunder shall be governed by the laws of North Carolina and all actions commenced pursuant hereto shall be brought in a court of competent jurisdiction residing in Charlotte, North Carolina. The parties agree to exclude this Agreement and the purchases made thereunder from the application of the United Nations' Convention on the Sale of Goods.

11. Non-waiver

No delay, failure, change or waiver by the Vendor to exercise any one or more of its rights under these terms and conditions of sale shall be construed or shall operate to be a waiver thereof or a continuing waiver of such terms and conditions.

12. Warranty and Limitation of Liability

12.1 The Vendor warrants that its Xirtec® CPVC Products are, at the time of their sale by Vendor, free from defects resulting from Vendor's faulty manufacturing.

12.2 THERE IS NO WARRANTY, CONDITION OR REPRESENTATION OF ANY NATURE WHATSOEVER, EXPRESSED OR IMPLIED, BY STATUTE OR OTHERWISE, EXCEPT AS HEREIN CONTAINED. ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND/OR FITNESS OF THE PRODUCTS FOR A SPECIAL PURPOSE AND ANY OTHER WARRANTY OF QUALITY ARE EXPRESSLY DISCLAIMED.

12.3 The Vendor will, at its entire discretion either refund or replace with a Product of the same type and size as the original Product, free of charge, including shipping charges at the original point of delivery, any Product which is found to breach this Limited Warranty.

12.4 THIS LIMITED WARRANTY IS VALID ONLY AND WILL ONLY APPLY IF ALL OF THE FOLLOWING CONDITIONS ARE MET:

12.4.1 The Product must have been used only in applications and under conditions (handling, installation, testing, use, water temperature, maintenance, repairs, etc.) that are strictly in compliance with these specific terms and conditions and with the Vendor's Xirtec® CPVC technical manuals and installation instructions currently available from the Vendor at the time of installation. The Xirtec® CPVC system for hot and cold water applications is designed as a system and must be installed as such. Only products approved by IPEX as part of the Xirtec® CPVC system for hot and cold water applications must be used. Mixing pipe, fittings, valves, sealants or joining methods not approved by IPEX can results in unsafe conditions and will void the warranty of the affected system.

12.4.2 The alleged defect must not be due to faulty installation, misalignment of products, vibration, ordinary wear and tear, corrosion, erosion, U.V. degradation, incompatible lubricants, pastes and thread sealants, unusual pressure surges or pulsation, water hammer, temperature shocking, or fouling.

12.4.3 The Product must have been installed in good and workmanlike manner consistent with the Vendor's latest published instructions available from the Vendor at the time of installation and with the state of the art industry standards and practices and in conformance with all applicable laws and regulations.

12.4.4 The Product must have not been altered, damaged or modified after leaving the Vendor's premises, and must have been used in no more than one installation, show no evidence of disassembly or tampering, and have not been subjected to abnormal operating conditions, accident, abuse, misuse, unauthorized alteration, or repair.

12.4.5 The Product must not have been subject to acts of nature such as earthquakes, fire, flood, or lightning, or any other event of force majeure.

12.4.6 The Product must not have been subject to freezing inside any of its components.

12.4.7 If the Product is perishable, the Product must have been used prior to the expiration date as indicated on the Product.

12.4.8 The Claimant must notify the Vendor in writing within ten (10) days of when the alleged defect was discovered, or should have been discovered in the exercise of ordinary care, and the alleged defective Product must be promptly returned to the Vendor. Notice of an alleged defective Product under this Limited Warranty must be directed to your local IPEX Customer Service representative. Claimant must provide documentary evidence of failure, as well as the failed components themselves or representative samples of the Product that is alleged to have failed, and must agree to allow a meaningful and reasonable opportunity for Vendor to inspect the system in which the alleged defective Product was installed.

12.5 IN ADDITION, IF THE PRODUCTS ARE USED WITH HOT AND COLD POTABLE WATER DISTRIBUTION SYSTEM, THIS LIMITED WARRANTY IS VALID ONLY FOR THE PERIOD OF 10 YEARS FROM THE DATE OF SALE OF THE PRODUCT ALLEGED TO BE DEFECTIVE BY VENDOR.

12.6 ANY LIABILITY IN RESPECT TO THE PRODUCTS IS STRICTLY LIMITED TO THEIR REFUND OR REPLACEMENT AS HEREINBEFORE SPECIFIED AND THERE SHALL NOT, IN ANY EVENT, BE ANY LIABILITY FOR ANY LABOUR CHARGES OR DAMAGES, INCLUDING WITHOUT LIMITATION DIRECT, INCIDENTAL, CONSEQUENTIAL, SPECIAL OR PUNITIVE DAMAGES.

12.7 Without limiting the generality of the foregoing, any liability or responsibility is disclaimed:

12.7.1 for labor, materials, and/or other expenses required to replace a defective Product;

12.7.2 for any damage resulting from a defective Product;

12.7.3 for calculations, product drawings, or engineering design specifications;

12.7.4 regarding the accuracy of any plans, drawings, or specifications furnished to the purchaser as part of the sale of any of its products;

12.7.5 for loss or damage resulting from failure to abide by manufacturer's warnings, safety instructions, or other precautionary guidelines.

12.8 ANY CLAIM, WHETHER IN CONTRACT OR IN TORT (INCLUDING NEGLIGENCE) OR OTHERWISE, WITH RESPECT TO OR ARISING OUT OF THE SALE, DELIVERY, INSTALLATION, REPAIR OR USE OF ANY PRODUCTS SOLD TO PURCHASER SHALL NOT IN ANY EVENT EXCEED THE PURCHASE PRICE OF THE PRODUCTS FOUND TO BE DEFECTIVE. It is the responsibility of the owner to obtain and pay for emergency repairs.

12.9 No statement, conduct, or description by the Vendor, any of its affiliates, their respective representatives, distributors or agents, in addition to or beyond this Limited Warranty, shall constitute a warranty. This Limited Warranty may only be modified in a writing signed by an officer of the Vendor.

13. Important

Without limiting any other restriction in any of the Vendor's documentation, the Products must not be used in any way related to nuclear material or to a nuclear facility and must not be used or located in Iran, North Korea, Syria, Cuba or Sudan at any time.

IPEX USA LLC

Xirtec® CPVC Products

Specific Terms and Conditions of Sale and Limited Warranty and Limitation of Liability (August 2020)

APPENDIX

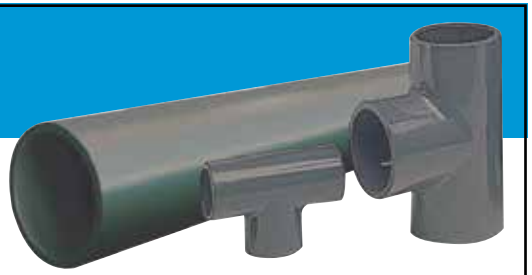
For your convenience, additional copies of Jobsite Notices are provided here to be cut out and posted at the jobsite.

If additional copies of any instructions are needed, or for any questions concerning the safe and proper installation of IPEX products, contact IPEX Toll Free (800) 463-9572
For the most up-to-date information on Xirtec CPVC products, visit ipexna.com

Always adhere to local jobsite and workplace safety regulations.

WARNING: Do not use or test Xirtec® CPVC with compressed air or other gases. Do not use air-over-water boosters.

NOTICE



Xirtec® CPVC Potable Water Piping System

Please read the following notice before beginning any activity which could come in contact with this system:

Xirtec CPVC piping components may become damaged by certain substances and construction practices.

DO NOT stack, support, hang equipment, or hang flexible wire/cable, especially communications cable, or other material on the Xirtec CPVC piping system.

ONLY system compatible materials including, but not limited to, solvent cements, caulks and sealants, as noted in the Xirtec CPVC Technical Manual, should be used in contact with the Xirtec CPVC piping system.

DO NOT expose Xirtec CPVC products to incompatible substances, such as cutting oils, non-water based paints, packing oils (commonly found in pumps), traditional pipe thread paste and dope, fungicides, termiticides, insecticides, detergents, building caulks, adhesives tape, solder flux, flexible wire/cable (with special consideration for communications cabling), and non-approved spray foam insulation materials.

DO NOT expose Xirtec CPVC products to open flame, solder, or soldering flux.

DO NOT drop, distort, or impact Xirtec CPVC products or allow objects to be dropped on them.

DO NOT handle Xirtec CPVC products with gloves contaminated with oils (hydrocarbons) or other incompatible materials.

Failure to follow this notice may cause cracks or fractures to develop in Xirtec CPVC products resulting in personal injury and property damage due to leaks or flooding. The presence of any visible cracks may require partial or full system replacement. For additional information contact the general contractor or system installer.

REFER TO THE XIRTEC CPVC POTABLE WATER TECHNICAL MANUAL AND FOR ADDITIONAL XIRTEC CPVC PRODUCT INFORMATION, CONTACT IPEX AT 800-463-9572 OR VISIT IPEXNA.COM

WARNING: Do not use or test Xirtec® CPVC with compressed air or other gases. Do not use air-over-water boosters.

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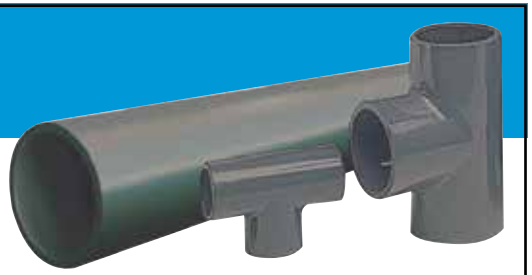

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WARNING: Do not use or test Xirtec® CPVC with compressed air or other gases. Do not use air-over-water boosters.

Notes:

WARNING: Do not use or test Xirtec® CPVC with compressed air or other gases. Do not use air-over-water boosters.

SALES AND CUSTOMER SERVICE

Customers call IPEX USA LLC
Toll free: (800) 463-9572
ipexna.com

About IPEX by Aliaxis

As leading suppliers of thermoplastic piping systems, IPEX by Aliaxis provides our customers with some of the world's largest and most comprehensive product lines. All IPEX by Aliaxis products are backed by more than 50 years of experience. With state-of-the-art manufacturing facilities and distribution centers across North America, we have earned a reputation for product innovation, quality, end-user focus and performance.

Markets served by IPEX by Aliaxis products are:

- Electrical systems
- Telecommunications and utility piping systems
- PVC, CPVC, PP, PVDF, PE, ABS, and PEX pipe and fittings
- Industrial process piping systems
- Municipal pressure and gravity piping systems
- Plumbing and mechanical piping systems
- Electrofusion systems for gas and water
- Industrial, plumbing and electrical cements
- Irrigation systems

IPEX by aliaxis

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