Volume V: AquaRise CPVC Hot & Cold Water Systems

Mechanical Technical Manual Series

SECOND EDITION

IPEX

AquaRISE®

Tough solvent weld system for commercial, industrial and high-rise buildings.

We build tough products for tough environments®

AquaRise CPVC Hot & Cold Water Systems

Mechanical Technical Manual Series

Vol. V, 2nd Edition

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LITERATURE & WEBSITE DISCLAIMER

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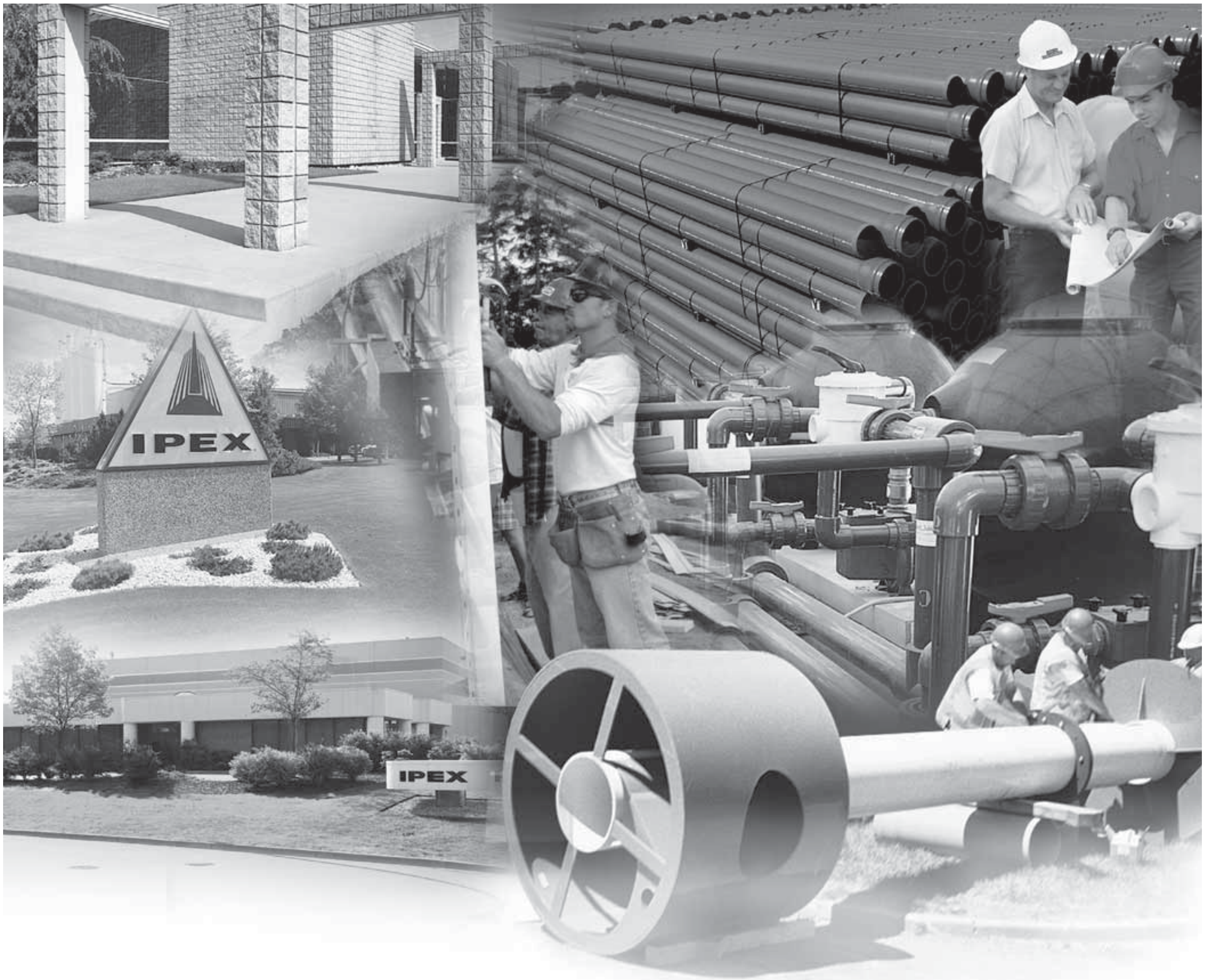

About IPEX

At IPEX, we have been manufacturing non-metallic pipe and fittings since 1951. We formulate our own compounds and maintain strict quality control during production. 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 and are involved in several standards committees and are members of and/or comply with the organizations listed on this page.

For specific details about any IPEX product, contact our customer service department.

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SECTION ONE: GENERAL INFORMATION

Overview

AquaRise pipe and fittings are made from a specialty plastic known chemically as chlorinated polyvinyl chloride (CPVC). AquaRise CPVC is the result of new technology that ensures increased product toughness year round. AquaRise water distribution systems are assembled with readily available, inexpensive tools. AquaRise utilizes environmentally friendly Low VOC solvent cemented joints - proven with more than 40 years of successful service history - assuring the reliability of an AquaRise plumbing system.

AquaRise pipe and fittings are available in Iron Pipe Size Outside Diameter (IPS OD) from 1/2" to 3" and are manufactured with a Standard Dimensional Ratio 11 (SDR 11) wall thickness.

AquaRise pipe and fittings have been listed to meet 25/50 Flame and Smoke requirements of Canadian Building Codes as per CAN/ULC S102.2 test methods.

Applications for AquaRise include High-Rise office or residential, hotels, medical facilities and commercial buildings for hot and cold potable water supply and distribution. AquaRise is also ideally suited for retrofits of domestic water distribution or hot water recirculation lines.

This manual provides instruction for design, handling and installation of an AquaRise water piping system.
Before commencing installation, a user should understand and confirm local code approval and installation requirements for CPVC water distribution systems. Should designers or contractors require additional information or clarification, please contact IPEX.

Complete Product Line

AquaRise is a complete CPVC water distribution package designed to maximize system integrity. The system has specifically formulated pipe, fittings, valves and cements.

Standards and Listings

AquaRise pipe and fittings are produced to meet the following standards:

CSA B137.6	CPVC Pipe, Tubing, and Fittings for Hot and Cold Water Distribution Systems
NSF 61	Potable Water Listing
ASTM F493	Solvent Cement
CAN/ULC S102.2	Flame Spread and Smoke Development. **Contact IPEX for potential restrictions**

AquaRise CPVC pipe, fittings, valves, and solvent cements are certified by NSF International for use with potable water (NSF-pw). The NSF certification is applicable for all water pH levels.

Pressure Capacity

AquaRise pipe and fittings in sizes 1/2" through 3", including the joint, are rated for a continuous working pressure of 400 psi at 73°F (2760 kPa at 23ºC) and 100 psi at 180°F (689 kPa at 82ºC).

Improved Flow

IPEX AquaRise pipe and fittings exhibit a substantially lower roughness factor compared to metal piping materials; and since thermoplastics do not rust, pit, scale or corrode, their interior walls remain smooth in virtually any service condition.

Lower Installation Costs

In addition to lower material costs, Aquarise CPVC can significantly reduce labor and transportation costs on a typical installation. How?

Thermoplastic piping products are easily handled, stored, cut, and joined. This CPVC system eliminates the cumbersome tools and torches required to install conventional piping systems.

Corrosion Resistance

CPVC is well known for resistance to internal and external corrosion.

AquaRise piping systems are nonconductive and therefore immune to galvanic and electrolytic erosion. In addition, the non-corroding properties of these systems ensure there is no deterioration in flow characteristics over the life of the installation, which cuts maintenance costs and lengthens performance life.

Fire Performance

AquaRise pipe compound has been listed to the CAN/ULC S102.2 standard for flame and smoke generation and meet the building code requirements for use in:

- Non-Combustible Construction
- Air Plenums
- High Rise Buildings

Four features combine to make AquaRise the most fire-resistant CPVC piping product available today:

- AquaRise cannot be an ignition source. The ignition point of AquaRise CPVC is several hundred degrees higher than many construction products.
- The inherent self-extinguishing feature of AquaRise ensures that, in the absence of flame, the product won't cause a fire to spread.
- With CPVC's electrically non-conductive characteristics, the system will not cause a fire if in contact with an electrical short.
- AquaRise has a low heat release value during combustion, much less than wood and other types of thermoplastics.

Firestopping

When AquaRise CPVC pipe penetrates a rated fire separation a Firestop system tested and listed under CAN/ULC S115 must be used.

There are numerous manufacturers of Firestopping products suited to and listed for use on hot and cold water CPVC plumbing pipes such as AquaRise.

IPEX can assist in directing installers to these firestop suppliers for product alternatives, ratings and installation details for specific project requirements.

SECTION TWO: PHYSICAL PROPERTIES

Material Description

AquaRise thermoplastic pipe and fitting material is a specially formulated Chlorinated Polyvinyl Chloride (CPVC) compound and carries an ASTM D1784 Cell Class of 24447. It is characterized by distinctive physical properties and is resistant to corrosion and attack from a variety of chemicals. CPVC has proven to be an excellent piping material for hot and cold water distribution and similar applications above the temperature range of PVC.

Physical Properties

Property	CPVC	ASTM
Specific Gravity	1.55	D792
IZOD Impact Strength (ft. lbs./inch, notched)	3.0	D256A
Modulus of Elasticity, @ 73°F, psi	4.23×10^5	D638
Ultimate Tensile Strength, psi	8,400	D638
Compressive Strength, psi	9,600	D695
Poisson's Ratio	.35 - .38	-
Working Stress @ 73°F, psi	2,000	D1598
Hazen-Williams C Factor	150	-
Coefficient of Linear Expansion in./(in. °F)	3.8×10^{-5}	D696
Thermal Conductivity BTU/hr./ft²/°F/in.	0.95	C177
Limiting Oxygen Index	60%	D2863
Electrical Conductivity	Non Conductor	

When AquaRise is used at temperatures above 73°F (23°C), its cold water pressure rating of 400 psi must be reduced by multiplying the rating by the appropriate correction factor from the table below.

Modulus of Elasticity and Working Stress for CPVC

Temperature °F	Temperature °C	Modulus, E psi	Stress, S psi	Pressure Derating Factor
73	23	423,000	2,000	1.00
90	32	403,000	1,800	0.91
110	43	371,000	1,500	0.74
120	49	355,000	1,300	0.65
140	60	323,000	1,000	0.50
160	71	291,000	800	0.38
180	82	269,000	500	0.25

It should also be noted that these temperature correction factors must also be applied to AquaRise valves and flanges whose cold water ratings are 232 psi and 150 psi respectively.

Pipe Dimensions and Weights

AquaRise pipe is produced (1/2" through 3") in SDR 11 dimensions with IPS (Iron Pipe Size) outside diameters. SDR, or Standard Dimension Ratio, means the wall thickness is directly proportional to the outside diameter. This results in all diameters carrying the same pressure ratings of 400 psi at 73°F and 100 psi at 180°F.

AquaRise Pipe Dimensions & Weights IPS / SDR 11 (Imperial)

Nominal Size (Inches)	Average OD (Inches)	Average ID (Inches)	Average Wall Thickness (inches)	Weight - Empty lb/ft
1/2	0.840	0.679	0.081	0.130
3/4	1.050	0.847	0.101	0.202
1	1.315	1.061	0.127	0.319
1-1/4	1.660	1.340	0.160	0.507
1-1/2	1.900	1.534	0.183	0.663
2	2.375	1.917	0.229	1.037
2-1/2	2.875	2.321	0.277	1.519
3	3.500	2.826	0.337	2.250

AquaRise Pipe Dimensions & Weights IPS / SDR 11 (Metric)

Nominal Size (mm)	Average OD (mm)	Average ID (mm)	Average Wall Thickness (mm)	Weight - Empty Kg/m
12	21.3	17.2	2.06	0.19
19	26.7	21.6	2.58	0.30
25	33.4	27.0	3.22	0.47
32	42.2	34.1	4.07	0.76
38	48.3	39.0	4.66	0.99
50	60.3	48.7	5.82	1.55
63	73.0	58.9	7.03	2.26
75	88.9	71.8	8.57	3.35

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AquaRise Ball Valves

AquaRise high performance ball valves are fully listed to NSF 61 and are molded using the same high performance compound as used in AquaRise fittings. AquaRise ball valves are fitted with EPDM o-rings and a specially designed handle which doubles as a removal tool for easy maintenance if required. These valves range from 1/2" to 2" with a maximum pressure rating of 232 psi at 73°F (1.6 MPa at 23°C). For sizes over 2", please contact IPEX for valve options.

Dimensions (in)

Size	d	L	Z	C	E	H	B	X	ø	W (lb)	Fig.
1/2"	0.84	0.89	2.76	4.53	1.85	1.77	2.60	1.22	0.22	6.7	A
3/4"	1.05	1.00	3.27	5.28	2.24	2.17	3.07	1.22	0.22	11.0	A
1"	1.32	1.13	3.33	5.59	2.68	2.64	3.39	1.57	0.26	15.6	A
1-1/4"	1.66	1.26	3.94	6.46	3.39	3.27	3.94	1.77	0.31	26.8	B
1-1/2"	1.90	1.38	4.13	6.89	3.86	3.58	4.33	1.97	0.31	37.6	B
2"	2.38	1.50	4.94	7.95	4.80	4.37	5.12	1.97	0.31	68.3	B

Dimensions (mm)

Size	d	L	Z	C	E	H	B	X	ø	W (g)	Fig.
1/2"	21.3	22.5	70.0	115.0	47.0	45.0	66.0	31.0	5.5	170	A
3/4"	26.7	25.5	83.0	134.0	57.0	55.0	78.0	31.0	5.5	280	A
1"	33.5	28.7	84.6	142.0	68.0	67.0	86.0	40.0	6.5	395	A
1-1/4"	42.2	32.0	100.0	164.0	86.0	83.0	100.0	45.0	8.0	680	B
1-1/2"	48.3	35.0	105.0	175.0	98.0	91.0	110.0	50.0	8.0	955	B
2"	60.5	38.2	125.6	202.0	122.0	111.0	130.0	50.0	8.0	1735	B

Figure A

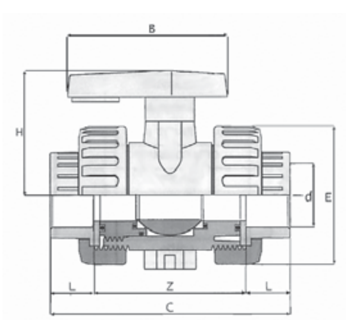

Figure B

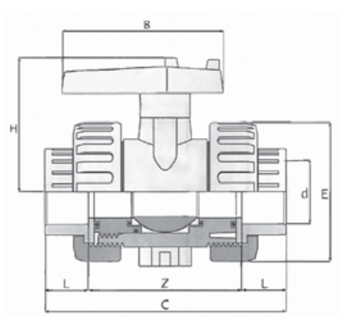

Figure C

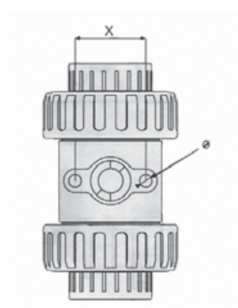

Figure D

Mounting Instructions

To mount the valves onto a fixed structure, holes on the face and base of AquaRise ball valves are not intended to be drilled as through holes. To mount the valves, threaded metal inserts designed for use with plastic (Figure D) should be friction fit into the mounting holes.

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Thermal Conductivity

Compared to traditional metal materials, the thermal conductivity of thermoplastics is low, thus giving excellent insulating properties. Therefore, the potential for condensation forming on the pipe exterior is greatly reduced with AquaRise versus metallic piping. Conversely, most metal piping products require insulation to limit condensation. Should insulation be specified by the designer, the rigid nature of AquaRise allows for easy installation.

Note: To maximize system efficiency for hot water recirculation systems, it is recommended that AquaRise or any other pipe should be insulated.

Coefficients of Thermal Conductivity

Material	BTU/hr./ft2/°F/in	W/m/ºK
AquaRise	0.95	0.137
Carbon Steel	360	51.922
Aluminum	1,000	144.23
Copper	2,700	389.42

Sound Attenuation

AquaRise CPVC exhibits a significant sound attenuating property, especially when compared to metallic piping. Having a larger inside diameter than copper tube sized plastic pipes, AquaRise will deliver a given flow volume at a lower velocity and thus have less potential for water hammer noise than those products.

Chemical Resistance

CPVC can be damaged by contact with chemicals found in some construction products (and site preparations). Reasonable care needs to be taken to ensure that products coming into contact with CPVC systems are chemically compatible. Common piping components such as firestop materials and thread sealants should be checked for chemical compatibility prior to installation. If chemical compatibility with CPVC is in question, contact IPEX for further instruction.

Caution should be taken when using Ethylene or Propylene Glycol / water mix, commonly found in radiant heating applications. Consult your IPEX representative before using AquaRise for such heating system applications.

Direct contact with flexible wire and cable that utilize insulation containing plasticizers is not recommended. Most local electrical codes require wire and cable to be secured by staples, cable ties, straps, or hangers. Air ducts, pipes and ceiling grid are not acceptable supports for wire and cable.

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

Note: On page 6 and 7, two lists of common piping products that have been formally tested and classified as either Acceptable or Unacceptable products for use with AquaRise CPVC. For further information, contact IPEX.

The following list of products has been found through testing to be fully COMPATIBLE with AquaRise CPVC piping. Products may be added to this list from time to time and users are advised to consult with IPEX with respect to any products not found on this list.

ALWAYS CHECK THE PRODUCT MANUFACTURER'S RECOMMENDATION IN THIS REGARD.

Acceptable Products for Use with AquaRise

Firestop Products	
Company	Product
3M	Fire Plug
	Fire Strap
	Plastic Pipe Device (PPD)
	Cast-in-Place Devices
	IC 15 WB+ Caulking
	3000 WT Sealant
	Fire Barrier WT 1000 NS
	Fire Barrier WT 1003 SL
Hilti	FS-One
	CP 648-S / CP 648-E
	CP 680-N / CP 680-P
	Top Seal Plug
	Water Barrier Module
Tremco	Fyre-Caulk
	TREMstop 1A
ProSet	ProSeal Plug - White
Thread Sealants	
Dupont	PTFE (Teflon) Tape
Anti-Seize Technology	Slickon GTS Gold
Black Swan Mfg.	Big White
FPPI	Pipefit
IPS Corp.	White Seal Plus
LA-CO	Slic-Tite Paste
Oatey	Great White
JC Whitlam	Power Seal Plus
Hercules	Pro Dope
Rector Seal	T Plus 2
LynCar Products	Pro Seal Plus

IPEX recommends the use of PTFE (Teflon®) tape as the preferred thread sealant.

Note: The above is a partial list of products found to be chemically **compatible** when in contact with AquaRise. This list is subject to change after publication. Contact IPEX for more information.

Unacceptable Products for Use with AquaRise

Firestop Products	
Company	Product
3M	CP25WB+ Caulk Fire Barrier 2003 Silicone
ProSet	Proseal Plug - Black Proseal Plug - Red
Thread Sealants	
Allied Rubber (ARGCO)	Super Dope
Anti-Seize Technology	TFE Paste
Devcon	Super Lock Hi-Strength, Stud Lock Grade 2271
General Sealant	GS-600
G.F. Thompson	Masters ProDope with Teflon
Hercules	Brush-On / Blue Bock
Hernon Mfg.	Powerseal #932
JC Whitlam	Seal Unyte Thread Sealer
Jet Lube Inc.	Jet Lube V-2
Jomar	Tighter-than-Tite
Locktite	Threadlocker 242
LynCar Products	Proseal
National Starch and Chemical	Permabond LH-050 Permabond LH-054
Permatex Co.	Permatex 14H
Rule	High Performance Teflon Thread
Saf-T-Lok Chemical	Sealant Compound TPS Anaerobic Adhesive / Sealing Compound
Swagelok Company	SWAK
General Caulkings	
OSI Sealants	Polyseamseal Tub and Tile
Dartworth Company	Polyseamseal All Purpose Caulk
Ohio Sealants	Pro-Series PC-158 Caulk
John Wagner Assoc.	Grabber Acoustical Sealant
United States Gypsum	Sheetrock Brand Acoustical Sealant
White Lightning	3006 All Purpose Adhesive Caulk

Note: The above is a partial list of products found to be chemically **incompatible** when in contact with AquaRise. This list is subject to change after publication. Contact IPEX for more information.

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

NOTE:

- IPEX recommends the use of PTFE (Teflon®) tape as the preferred thread sealant.
- If it is necessary to use leak detectors on CPVC systems, only the following leak detectors are approved for use with IPEX AquaRise CPVC; Gasoila® Leak-Tech Gold, RectorSeek™ Better Bubble™, or megabubble® Leak Detector. While common ordinary soaps are not detrimental to CPVC, most modern dish washing liquids contain synthetic detergents, some of which may cause environmental stress cracking of fittings.
- Direct contact with vinyl electrical tape, flexible wire and cable that utilize insulation containing plasticizers is not recommended. Most local electrical codes require wire and cable to be secured by staples, cable ties, straps, or hangers. Air ducts, pipes and ceiling grids are not acceptable supports for wire and cable.
- HVAC applications – Some heat exchangers or condenser coils may contain residual oils from the manufacturing process which can cause cracking of CPVC. Caution should be exercised when installing CPVC in combination hot water/air heating units or as condensate drain lines for air conditioning systems.
- Confirm the compatibility of CPVC with the residual oils prior to installation. The interior of heat exchangers or the exterior of condenser coils may be thoroughly flushed with mild detergent solution to remove incompatible oils prior to piping installation. A rinse with clean water to completely clean the system is advisable as a final flushing.

System Flushing

When connecting AquaRise pipe and fittings to Hydronic fan coils, heat exchangers or other appliances containing Copper coils, special consideration must be taken to remove residual lubricating oils that may have accumulated in the coils during the formation of the bends.

A 1-2 % solution of TSP (Tri Sodium Phosphate) has been found to work effectively as a flushing agent to remove the oil and will not damage AquaRise pipe and fittings. This flushing of the coils must take place before connecting to the AquaRise system.

A good flushing practice would be to flush the units with water for 4 hours, followed by the TSP solution for 3 hours, followed by water for 2 hours.

- When CPVC pipe is installed in kitchen areas, the pipe must be protected from contact with grease or cooking oils. Consideration must be given to not only protecting the pipe from direct contact with grease or oil, as well as contact that may occur from airborne grease or oil.
- When performing repairs to leaks in existing systems, care should be taken to isolate CPVC pipe from direct contact with heavy concentrations of fungicide products which may be applied during cleanup of water damage. CPVC may be damaged by fungicides when fungicides are sprayed on surrounding drywall and wood framing to prevent the growth of mold and mildew in the affected area. Common sense precautions will prevent problems with repairs to existing systems. When repairs are made to an existing system, and the possibility exists that fungicides will be applied to treat damp drywall and wood framing surrounding the repair site, exposed piping should be sleeved with a compatible plastic sleeving or pipe insulation material to prevent direct contact of the fungicide with the plumbing system.

SECTION THREE: DESIGN CONSIDERATIONS

Thermal Expansion and Contraction

Like all piping materials, AquaRise CPVC piping undergoes expansion or contraction when subjected to varying temperatures. The exact coefficient of thermal expansion for AquaRise compound is 3.8 x 10^{-4} in/in/°F which translates into 0.456 in. per 10 feet of pipe per 100°F temperature change. Accordingly, allowances should be made for this resultant movement potential.

Expansion is obviously more of a design concern for hot water lines rather than cold due to the limited temperature variance for cold water piping. Below is a table illustrating the potential linear expansion of AquaRise piping for various levels of temperature increase:

AquaRise CPVC Linear Thermal Expansion ($\Delta\ell$) in inches

Temp. Change DT (ºF)	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

AquaRise CPVC Linear Thermal Expansion ($\Delta\ell$) in mm

Temp. Change DT (ºC)	Length of Run (m)									
	3	6	9	12	15	18	21	24	27	30
5	1.0	2.1	3.1	4.1	5.1	6.2	7.2	8.2	9.2	10.3
10	2.1	4.1	6.2	8.2	10.3	12.3	14.4	16.4	18.5	20.5
15	3.1	6.2	9.2	12.3	15.4	18.5	21.5	24.6	27.7	30.8
20	4.1	8.2	12.3	16.4	20.5	24.6	28.7	32.8	36.9	41.0
25	5.1	10.3	15.4	20.5	25.7	30.8	35.9	41.0	46.2	51.3
30	6.2	12.3	18.5	24.6	30.8	36.9	43.1	49.2	55.4	61.6
35	7.2	14.4	21.5	28.7	35.9	43.1	50.3	57.5	64.6	71.8
40	8.2	16.4	24.6	32.8	41.0	49.2	57.5	65.7	73.9	82.1
45	9.2	18.5	27.7	36.9	46.2	55.4	64.6	73.9	83.1	92.3
50	10.3	20.5	30.8	41.0	51.3	61.6	71.8	82.1	92.3	102.6

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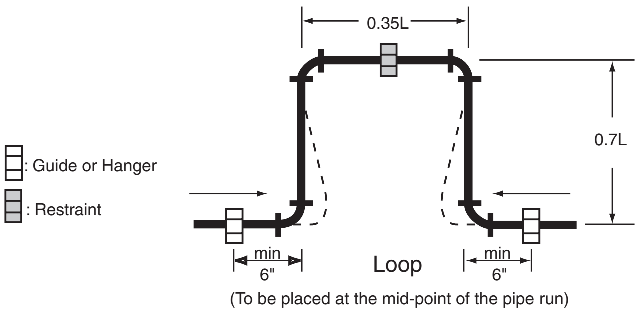
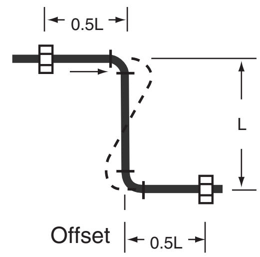
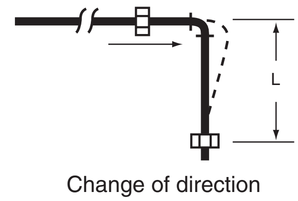
Pipe Configurations for Expansion/Contraction







Three standard methods of accommodating expansion movement in pipelines are expansion loops, offsets and changes in direction. A critical value required for each of these designs is the loop length, L, which can be calculated using the following equation:

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

where:

- L = total expansion loop length (in)
- E = modulus of elasticity at maximum operating temperature (psi)
- S = working stress at maximum operating temperature (psi)
- D = nominal outside diameter of pipe (in)
- $\Delta\ell$ = change in length due to thermal expansion or contraction (in)

Example

For a run of 90 ft of 3" AquaRise, installed at 65ºF and operating at 140ºF, how long should the expansion loop legs be in order to compensate for the expansion?

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

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

Known: L = 90 ft, T = 140ºF, F = 65ºF,
Y = 0.456in/10ºF/100ft
(Coefficient of Thermal Expansion)

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

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

Step 2: Calculate the expansion loop length.

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

Known: $\Delta\ell$ = 3.08 in., E = 323,000 psi, S = 1000 psi
(from Pg 3 - Modulus of Elasticity & Working Stress for CPVC), D = 3.5 in
(from OD, Pg 3, Dimensions & Weights)

$$L = \sqrt{\frac{3 \times 323000 \times 3.5 \times 3.08}{1000}}$$

$$L = 102.2 \text{ inches}$$

0.7L = 71.5 inches
0.5L = 51.1 inches
0.35L = 35.8 inches

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

In order to assist in calculating L, a table of its values has been prepared for various run lengths and temperature changes. It should be noted that this table has been prepared assuming the maximum system temperature is 140°F

AquaRise CPVC IPS O.D., SDR11 Calculated Loop (Offset) Lengths

	Nominal D (in)	Outside D (in)	Run Length (ft) 20	40	50	60	80	100
			L = in inches					
ΔT = 60°F	1/2	0.840	21	30	33	37	42	47
	3/4	1.050	24	33	37	41	47	53
	1	1.315	26	37	42	46	53	59
	1-1/4	1.660	30	42	47	51	59	66
	1-1/2	1.900	32	45	50	55	63	71
	2	2.375	35	50	56	61	71	79
	2-1/2	2.875	39	55	62	68	78	87
	3	3.500	43	61	68	75	86	96
ΔT = 80°F	1/2	0.840	24	34	39	42	49	54
	3/4	1.050	27	39	43	47	54	61
	1	1.315	30	43	48	53	61	68
	1-1/4	1.660	34	48	54	59	69	77
	1-1/2	1.900	37	52	58	63	73	82
	2	2.375	41	58	65	71	82	92
	2-1/2	2.875	45	64	71	78	90	101
	3	3.500	50	70	79	86	99	111
ΔT = 100°F	1/2	0.840	27	39	43	47	54	61
	3/4	1.050	30	43	48	53	61	68
	1	1.315	34	48	54	59	68	76
	1-1/4	1.660	38	54	61	66	77	86
	1-1/2	1.900	41	58	65	71	82	92
	2	2.375	46	65	72	79	92	102
	2-1/2	2.875	50	71	80	87	101	113
	3	3.500	56	79	88	96	111	124
ΔT = 120°F	1/2	0.840	30	42	47	52	60	67
	3/4	1.050	33	47	53	58	67	75
	1	1.315	37	53	59	65	75	83
	1-1/4	1.660	42	59	66	73	84	94
	1-1/2	1.900	45	63	71	78	90	100
	2	2.375	50	71	79	87	100	112
	2-1/2	2.875	55	78	87	96	110	123
	3	3.500	61	86	96	106	122	136

Should any of these three standard methods be impractical for specific projects, please contact IPEX for alternative solutions to accommodating thermal expansion.

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

Hydraulic Design

Sizing CPVC Pipe

An AquaRise system may use similar size pipe that a copper system would for a typical installation. As with all materials, a proper sizing design will be a balance of velocity, volume flow and head loss.

Design Velocity

The process for establishing a limiting or maximum flow velocity that is applicable to any piping material is not well defined. For some materials, there may be velocities that can create abrasion or erosion, but there is no evidence that this occurs with CPVC piping under any known operating conditions. An investigation of some CPVC systems revealed that velocities of 7 to 17 ft/s could be developed under maximum flow conditions.

The true maximum velocity to which AquaRise piping may be subjected is 10 ft/s. However, IPEX recommends using a maximum design velocity of 8 ft/s for all plastic piping in water supply or distribution. This limit is consistent with recommendations of the American Society of Plumbing Engineers (ASPE) and is considered a good balance between maximizing flow capacity while minimizing water hammer potential. It also lessens concerns for erosion of any metallic components and fixtures. Designers are also encouraged to obtain specific velocity design limits for metallic piping when considering for use.

The system should be designed and installed utilizing good engineering practices. To minimize water hammer and damage to the system, slow closing valves and water hammer arrestors should be used when the velocities exceed 5ft/sec. It is acceptable to use quick closing valves on the smaller (under 2") branch lines.

Improved Flow

Friction Loss (psi/100 ft @ 5 USGPM)

Nominal Size (in)	PEX	CTS CPVC	Type L Copper	AquaRise CPVC
1/2	31.40	33.41	16.08	5.55
3/4	5.84	4.92	2.72	1.87
1	1.72	1.39	0.74	0.63
1-1/4	0.65	0.51	0.27	0.20
1-1/2	0.29	0.23	0.11	0.10

In comparison to other thermoplastics such as PEX and Copper Tube Size CPVC, AquaRise has a significantly greater ID contributing to greater flow and lower head loss.

Hazen-Williams C Factor

Hydraulic calculations for sizing of AquaRise CPVC pipe and fittings should be calculated using a Hazen-Williams C Factor of 150. Since an AquaRise CPVC system is not subject to pitting or scaling, the C Factor will remain constant as the system ages.

Head Loss Characteristics - Pipe

The flow characteristics of water flowing through piping systems are affected by several factors including system configuration, pipe size and length, friction at the pipe and fitting surfaces, etc.

These and other factors cause a reduction in pressure (head loss also expressed as pressure drop) over the length of the system. This section deals only with the head-losses that result from frictional forces in the various sizes of CPVC pipe and fittings.

The following formulae were used to calculate water velocities, head-losses and pressure drops as function of flow rates. The results are given in the tables below.

The Hazen-Williams formula can be used to adequately describe these losses:

Head Loss Formula

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

Velocity Formula

$$V_W = 0.4085Q/d_I^2$$

Where:

H_L = Frictional head loss (ft. water/100 ft)

C = Hazen-William factor (150 for CPVC)

Q = Flow rate (U.S. gal/min.)

d_I = Inside diameter of pipe (in)

V_W = Velocity of water (ft/s)
One foot of water = 0.4335 psi

Water Hammer Arrestors

AquaRise pipe and fittings have excellent energy absorbing properties which effectively absorb the shock waves generated by solenoid operating valves. The use of water hammer arrestors or air chambers may not be required for domestic installations. Should AquaRise pipe and fittings be used where severe and repeated water hammer might be encountered at elevated temperatures, such as a commercial laundry, the use of a water hammer arrestor is advisable.

Note: Some code jurisdictions require water hammer arrestors for specific applications. Verify code requirements prior to installation.

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

CARRYING CAPACITY AND FRICTION LOSSES FOR CPVC, IPS O.D., SDR11

GPM	cu ft/sec	1/2"			3/4"			1"			1 1/4"		
		Velocity (ft/s)	Friction Head Loss (ft water/100ft)	Friction Pressure (psi/100ft)	Velocity (ft/s)	Friction Head Loss (ft water/100ft)	Friction Pressure (psi/100ft)	Velocity (ft/s)	Friction Head Loss (ft water/100ft)	Friction Pressure (psi/100ft)	Velocity (ft/s)	Friction Head Loss (ft water/100ft)	Friction Pressure (psi/100ft)
1	0.002	0.89	0.65	0.28									
2	0.004	1.78	2.35	1.02	1.14	0.79	0.34	0.73	0.27	0.12			
5	0.011	4.44	12.83	5.55	2.84	4.32	1.87	1.81	1.45	0.63	1.14	0.47	0.20
7	0.016	6.22	23.92	10.36	3.98	8.06	3.49	2.54	2.71	1.17	1.59	0.87	0.38
10	0.022	8.89	46.31	20.05	5.68	15.59	6.75	3.63	5.24	2.27	2.27	1.68	0.73
12	0.027	10.66	64.92	28.10	6.82	21.86	9.46	4.35	7.35	3.18	2.73	2.36	1.02
15	0.033				8.52	33.04	14.30	5.44	11.11	4.81	3.41	3.57	1.54
20	0.045				11.36	56.29	24.37	7.26	18.92	8.19	4.55	6.08	2.63
25	0.056							9.07	28.60	12.38	5.69	9.19	3.98
30	0.067							10.89	40.09	17.36	6.82	12.88	5.57
35	0.078										7.96	17.13	7.42
40	0.089										9.10	21.94	9.50
45	0.100										10.24	27.28	11.81
50	0.111												
55	0.123												
60	0.134												
65	0.145												
70	0.156												
75	0.167												
80	0.178												
90	0.201												
100	0.223												
125	0.279												
150	0.334												
175	0.390												
200	0.446												

GPM	1 1/2"			2"			2 1/2"			3"		
	Velocity (ft/s)	Friction Head Loss (ft water/100ft)	Friction Pressure (psi/100ft)	Velocity (ft/s)	Friction Head Loss (ft water/100ft)	Friction Pressure (psi/100ft)	Velocity (ft/s)	Friction Head Loss (ft water/100ft)	Friction Pressure (psi/100ft)	Velocity (ft/s)	Friction Head Loss (ft water/100ft)	Friction Pressure (psi/100ft)
1												
2												
5												
7	1.22	0.45	0.19									
10	1.74	0.87	0.38	1.11	0.29	0.13						
12	2.08	1.22	0.53	1.33	0.41	0.18	0.91	0.16	0.07			
15	2.60	1.85	0.80	1.67	0.62	0.27	1.14	0.25	0.11			
20	3.47	3.15	1.36	2.22	1.06	0.46	1.52	0.42	0.18	1.02	0.16	0.07
25	4.34	4.76	2.06	2.78	1.61	0.70	1.90	0.63	0.27	1.28	0.24	0.11
30	5.21	6.67	2.89	3.33	2.25	0.98	2.27	0.89	0.38	1.53	0.34	0.15
35	6.08	8.87	3.84	3.89	3.00	1.30	2.65	1.18	0.51	1.79	0.45	0.20
40	6.94	11.36	4.92	4.45	3.84	1.66	3.03	1.51	0.66	2.05	0.58	0.25
45	7.81	14.13	6.12	5.00	4.78	2.07	3.41	1.88	0.82	2.30	0.72	0.31
50	8.68	17.18	7.44	5.56	5.81	2.51	3.79	2.29	0.99	2.58	0.88	0.38
55	9.55	20.49	8.87	6.11	6.93	3.00	4.17	2.73	1.18	2.81	1.05	0.45
60	10.42	24.08	10.42	6.67	8.14	3.52	4.55	3.21	1.39	3.07	1.23	0.53
65				7.23	9.44	4.09	4.93	3.72	1.61	3.32	1.43	0.62
70				7.78	10.83	4.69	5.31	4.27	1.85	3.58	1.64	0.71
75				8.34	12.31	5.33	5.69	4.85	2.10	3.84	1.86	0.81
80				8.89	13.87	6.00	6.07	5.47	2.37	4.09	2.10	0.91
90				10.00	17.25	7.47	6.82	6.80	2.94	4.60	2.61	1.13
100							7.58	8.27	3.58	5.11	3.17	1.37
125							9.48	12.50	5.41	6.39	4.80	2.08
150										7.67	6.72	2.91
175										8.95	8.94	3.87
200										10.23	11.45	4.96

Caution: For flow rates in excess of 5 ft/s precautions should be taken to combat water hammer.

Maximum Expected Surge Pressure Calculations for AquaRise CPVC

The following formulas can be used to calculate the expected maximum surge pressure.

a = wave velocity, ft/s

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

DR = Dimensional Ratio, (11 for AquaRise)

E = Modulus of Elasticity for the pipe, (see Table on Pg. 3)

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

P = pressure surge, psi

ΔV = maximum velocity change, ft/s

$$a = \frac{4660}{\sqrt{1+\frac{k\,(DR-2)}{E}}} \qquad P = \frac{a(\Delta V)}{2.31g}$$

Example:

A flow of 1ft/s is suddenly stopped in a 3 inches AquaRise CPVC pipe (IPS O.D., SDR11). Calculate the expected maximum surge pressure if the system is operating at 82ºC.

First calculate the wave velocity (a):

$$a = \frac{4660}{\sqrt{1+\frac{k\,(DR-2)}{E}}}$$

$$a = \frac{4660}{\sqrt{1+\frac{(300{,}000)(11-2)}{269{,}000}}}$$

$$a = 1403 \text{ ft/sec}$$

Calculate the Surge Pressure:

$$P = \frac{a(\Delta V)}{2.31g}$$

$$P = \frac{(1403)(1)}{2.31\,(32.2)}$$

$$P = 18.9 \text{ psi}$$

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

Head Loss Characteristics – Valves and Fittings

In addition to head losses that result from frictional forces in the pipe, losses also occur when water flows through valves, fittings, etc., in the system. These losses are difficult to calculate due to the complex internal configuration 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 valves and fittings can be found below.

Friction Loss through Fittings (Equivalent pipe length in feet)

Size (in.)	Fittings			
	Tee Run	Tee Branch	90° Elbow	45° Elbow
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

Friction Loss through Valves

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:

C_V for AquaRise Ball Valves

Size (in)	Cv
1/2	14
3/4	27
1	54
1-1/4	77
1-1/2	123
2	238

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

$$\mathbf{f = sg\,(Q/C_v)^2}$$

Where:

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

sg = specific gravity (water = 1.0)

Q = flow through the valve (US gpm)

C_v = flow rate coefficient

Example:

What is the pressure loss across a 2 (in) ball valve in an AquaRise CPVC system having a flow rate of 50 (US gpm). Calculate answer in equivalent feet of pipe and psi.

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

$$Q = 50 \text{ US gpm}$$

$$C_v = 238$$

$$f = 1 \times \left(\frac{50}{238}\right)^2 = 0.044 \text{ psi}$$

From the pipe flow chart: 50 US gpm through a 2" pipe generates a loss of 2.51 psi/100ft.

Therefore:

$$\frac{0.044}{(2.51/100)} = 1.75 \text{ ft of pipe}$$

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

SECTION FOUR: PRACTICAL CONSIDERATIONS

AquaRise Solvent Cement and Primer

AquaRise Low VOC Cement and Primer have been specially formulated to perform with AquaRise pipe and fittings. AquaRise CPVC systems require the use of primer under all installation conditions. A proper joint is the most critical part of any piping system, thus proper solvent cementing procedures, as outlined below, should always be followed.

Solvent Cementing Instructions for AquaRise CPVC Pipe and Fittings
Solvent Cementing with Primer (Required)
AquaRise cement and primer is required on all installations in order to maintain product / system warranty.

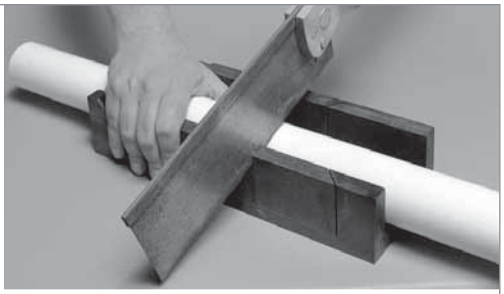
** White pipe and grey cement/primer used for visual effect only. Ensure the proper AquaRise cement and primer are used.*

STEP 1 PREPARATION

Assemble proper materials for the job. This includes AquaRise cement, primer and applicator for the size of piping system to be assembled. See Page 19 for guidelines to estimate the amount of cement required.

STEP 2 CUT PIPE

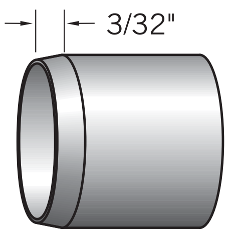
Pipe must be cut as square as possible. (A diagonal cut reduces bonding area in the most effective part of the joint.) Use a handsaw and miter box or a mechanical saw.



Plastic tubing cutters may also be used for cutting plastic pipe; however, some produce a raised bead at the end of the pipe. This bead must be removed with a file or reamer, as it will wipe the cement away when pipe is inserted into the fitting.

STEP 3 DEBURR PIPE ENDS

Use a knife, plastic pipe deburring tool, or file to remove burrs from the end of small diameter pipe. Be sure to remove all burrs from around the inside as well as the outside of the pipe. A slight chamfer (bevel) should be added to the end to permit easier insertion of the pipe into the fitting. Failure to chamfer the edge of the pipe may remove cement from the fitting socket, causing the joint to leak. One recommended tool for use in beveling the cut ends of AquaRise pipe in sizes 1-1/4" through 3" is the Deb. No.4 as manufactured by Reed Manufacturing Co.



CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

STEP 4 CLEAN PIPE ENDS

Remove all dirt, grease and moisture. A thorough wipe with a clean dry rag is usually sufficient. (Moisture will retard cure; dirt or grease can prevent adhesion).

STEP 5 CHECK FIT

Check pipe and fittings for dry fit before cementing together. For proper interference fit, the pipe must go easily into the fitting one quarter to three quarters of the way. Too tight a fit is not desirable; you must be able to fully bottom the pipe in the socket during assembly. If the pipe and fittings are not out of round, a satisfactory joint can be made if there is a "net" fit, that is, the pipe bottoms in the fitting socket with no interference, without slop.

STEP 6 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 7 PRIMING

Primer is always required with AquaRise. The purpose of a primer is to penetrate and soften pipe surfaces so that they can fuse together. The proper use of a primer provides assurance that the surfaces are prepared for fusion.

Check the penetration or softening on a piece of scrap before you start the installation, or if the weather changes during the day. Using a knife or other sharp object, drag the edge over the coated surface. Proper penetration has been made if you can scratch or scrape a few thousandths of an inch of the primed surfaces away.

Weather conditions can affect priming and cementing action, so be aware of the following:

- repeated applications to either or both surfaces may be necessary
- in cold weather, more time may be required for proper penetration
- in hot weather, penetration time may be shortened due to rapid evaporation

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

STEP 8 PRIMER APPLICATION – FITTING

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.

STEP 9 PRIMER APPLICATION – PIPE

Next, 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 – FITTING

Second application of primer in the socket is recommended.

STEP 11 CEMENT APPLICATION – PIPE

Stir the cement or shake can before using. Using the correct size applicator, aggressively work a full 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 within a few seconds.

STEP 12 CEMENT APPLICATION – FITTING

Aggressively work a medium layer of cement into the fitting socket.

Avoid puddling the cement in the socket. Do not coat beyond the socket depth or allow cement to run down into the fitting beyond the socket.

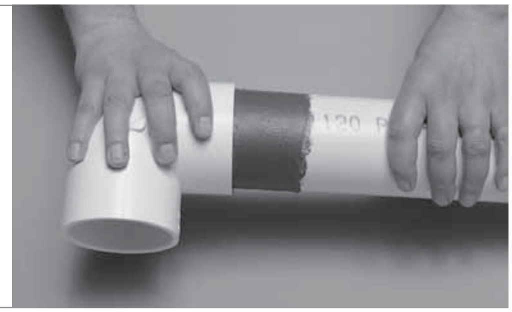
CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

STEP 13   CEMENT APPLICATION – PIPE

Apply a second full, even layer of cement on the pipe.

STEP 14   ASSEMBLY

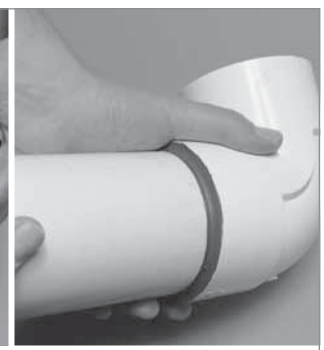
Without delay, while the cement is still wet, assemble the pipe and fittings. Use sufficient force to ensure that the pipe bottoms in the fitting socket. If possible, twist the pipe a quarter turn as you insert it.



STEP 15   ASSEMBLY

Hold the pipe and fitting together for 10 - 15 seconds to avoid push out.

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 16   JOINT CLEANING

Using a rag, remove the excess cement from the pipe and fitting, including the ring or bead, as it will needlessly soften the pipe and fitting and does not add to joint strength. Avoid disturbing or moving the joint.

STEP 17   JOINT SETTING & CURING

Handle newly assembled joints carefully until initial set has taken place.
Allow curing to take place before pressurizing the system. (Note: in humid weather allow for 50% more curing time.)

For initial set and cure times for IPEX cements, refer to the Schedules on page 19.

Average Initial Set Schedule For AquaRise 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 3"
60º – 100ºF	2 minutes	5 minutes	30 minutes
40º – 60ºF	5 minutes	10 minutes	2 hours
0º – 40ºF	10 minutes	15 minutes	12 hours

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

** These figures are estimates based on our laboratory tests using water; due to the many variables in the field, these figures should be used as a general guide only.

Average Joint Cure Schedule For AquaRise Solvent Cement**

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 3"	
Temperature Range during assembly and cure periods	Up to 160 psi[l]	Above 160 to 370 psi[l]	Up to 160 psi[l]	Above 160 to 315 psi[l]	Up to 160 psi[l]	Above 160 to 315 psi[l]
60º – 100ºF	15 min	6 hrs	30 min	12 hrs	1-1/2 hrs	24 hrs
40º – 60ºF	20 min	12 hrs	45 min	24 hrs	4 hrs	48 hrs
0º – 40ºF	30 min	48 hrs	1 hr	96 hrs	72 hrs	8 days

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

** These figures are estimates based on our laboratory tests. Due to the many variables in the field, these figures should be used as a general guide only.

[l]Indicates the maximum test pressure of the piping system. The system should not be pressurized at all until this cure time has elapsed.

PRACTICAL CONSIDERATIONS

Joints Per Quart

Pipe Diameter (inches)	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3
Number of Joints	300	200	125	110	90	60	50	40

** These figures are estimates based on our laboratory tests. Due to the many variables in the field, these figures should be used as a general guide only.

Required primer quantities are estimated to be 50% those for cement.

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

Hangers and Supports

Horizontal Piping

Horizontal runs of AquaRise pipe should be supported per the hanger support spacing found in the adjacent table. Piping should not be anchored tightly to supports, but rather secured with smooth straps or hangers that allow for movement caused by expansion and contraction. It is recommended to use full circle talon straps, which cannot pin the pipe tightly against joists or other structures. Hangers should not have rough or sharp edges, which come in contact with the pipe. Any residual oils on metallic hangers should be wiped off with a clean dry rag or cloth before usage with AquaRise.

Typical Pipe Hangers

Recommended Maximum Support Spacing (ft) for IPS CPVC, SDR11

Pipe Size(in)	73°F (23°C)	100°F (38°C)	120°F (49°C)	140°F (69°C)	160°F (71°C)	180°F (82°C)
1/2	2.8	2.7	2.6	2.6	2.5	2.4
3/4	3.2	3.2	3.1	3.0	2.9	2.8
1	3.8	3.7	3.6	3.5	3.3	3.2
1-1/4	4.4	4.3	4.2	4.0	3.9	3.8
1-1/2	4.8	4.7	4.5	4.4	4.3	4.1
2	5.6	5.4	5.3	5.1	4.9	4.8
2-1/2	6.4	6.2	6.0	5.8	5.6	5.5
3	7.2	7.0	6.8	6.6	6.4	6.2

Note: Installers should also consult local plumbing codes for support spacing limits on CPVC pipe.

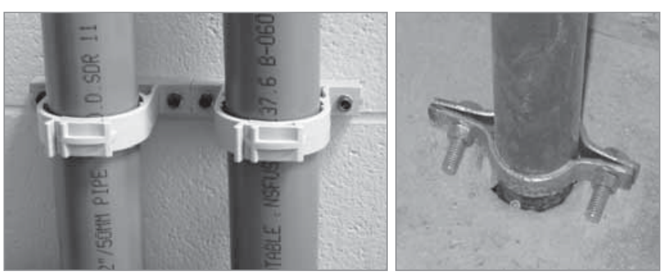
The objective is to control expansion by restraining the pipe in the lateral direction while allowing free axial movement.

A hanger-type support does not provide lateral restraint to the pipe, but it does encourage snaking and should be avoided whenever possible.

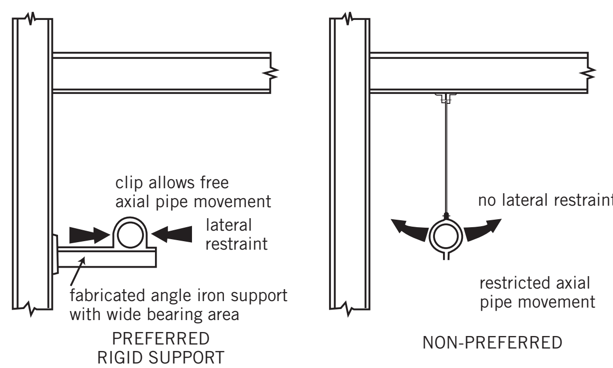
The diagram below illustrates preferred and non-preferred support arrangements.

Vertical Piping (Risers)

Vertical runs (risers) of AquaRise pipe should be supported by pipe clamps, or hangers located on the horizontal connection close to the riser. Hangers and straps that do not distort, abrade the piping should be utilized. Maintain piping in straight alignment with supports at each floor plus a mid-story guide or as specified by the design engineer to allow for expansion/contraction.



Typical Riser Supports



In some cases, it may be physically impossible or impractical to install a rigid support in between two widely spaced columns. In this event, hanger rods with loose fitting clips should be used.

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

Joints Under Slab

AquaRise pipe with joints is permitted for under slab installations by all national plumbing codes (verify local code acceptance prior to installation). Under slab installations of pipe and fittings should be pressure tested prior to pouring the slab.

When performing installations under slab, care should be taken to isolate CPVC pipe from direct contact with heavy concentrations of termiticides. CPVC may be damaged by termiticides if they are injected into the annular space between the pipe wall and sleeving material trapping the termiticide against the pipe wall.

Light spray applications in an open-air environment should not pose a problem. Common sense precautions will prevent installation problems.

Installations Embedded in Concrete

AquaRise pipe and fittings may be installed embedded in concrete. AquaRise pipe and fittings are not harmed by direct contact with concrete. In addition to normal installation practices, the following guidelines should be followed:

1. The pipe should be protected from damage by tools and equipment utilized to finish the concrete.
2. Care must be taken to avoid abrasion damage to the pipe and fittings from contact with the wire mesh and/or reinforcing bar. This is mainly a concern before the concrete is poured.
3. Expansion and contraction are not a concern for the pipe and fittings embedded in the concrete. However, proper design considerations must be incorporated in the portion of the system that is not embedded in the concrete. Failure to accommodate expansion and contraction may result in unacceptable stresses where the pipe enters and exits the concrete. Reference the Thermal Expansion and Contraction section of this manual.
4. AquaRise pipe and fittings are to be joined per the procedures outlined in this manual.
5. Installations with joints embedded in the concrete should be pressure tested prior to pouring the concrete. Installations without joints in the embedded concrete do not require pressure testing prior to pouring the concrete.
6. If AquaRise pipe should pass through a concrete wall or structure, a flexible water-tight seal should be used. Consult with IPEX to ensure chemical compatibility.

The pipe should be protected from damage by tools and equipment utilized to finish the concrete. Because CPVC does not react with concrete or stucco and it is inert to acidic soil conditions, it does not need to be sleeved.

Note: Some code jurisdictions may require sleeving at slab penetrations. Verify code requirements prior to installation.

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

UNDERGROUND INSTALLATION GUIDELINES

Installation Procedures

This procedure will cover the typical steps encountered in underground installations: trench design, trench preparation, piping assembly, laying of pipe, and backfilling.

Trench Design

Width: The trench should be of adequate width to allow for convenient installation, but as narrow as possible depending on whether the piping will be assembled inside or outside of the trench.

Depth: The trench depth should be sufficient to place the pipe deep enough to meet frost, above-ground load, and any trench bedding requirements.

Frost: Piping to be at least 12" below the frost line.

Loads: Piping should be deep enough to keep external stress levels below acceptable design stress. Design stress will be determined by pipe size and operating temperature and may be governed by various codes.

Bedding: Maximum particle size to be 1/2" (12mm)

Trench Preparation

The trench bottom should be continuous, relatively smooth and free of rocks. If ledge rock, hardpan, boulders, or rocks that are impractical to remove are encountered, it will be necessary to pad the trench bottom to protect the piping from damage. 4" to 6" of tamped earth or sand bedding will be sufficient in such situations.

Piping Assembly/Placement

Piping may be assembled using conventional solvent cementing techniques either inside or outside of the trench depending on the specific installation requirements. Solvent cement will require time for the cemented joint to cure properly. During this critical curing process, every effort should be made to minimize the stress on any joints. As a result, the piping should not be moved during the curing period, nor should the pipe be backfilled, or otherwise constrained during curing. Consult the Solvent Cementing Guidelines in this manual regarding joint curing time to determine the exact curing requirements for a specific installation.

If the piping was assembled outside of the trench, the pipe may be placed into the trench after proper curing, but MUST NOT be rolled or dropped into place. Long lengths of joined piping should be properly supported as the piping is put into place to prevent excessive stress.

Backfilling

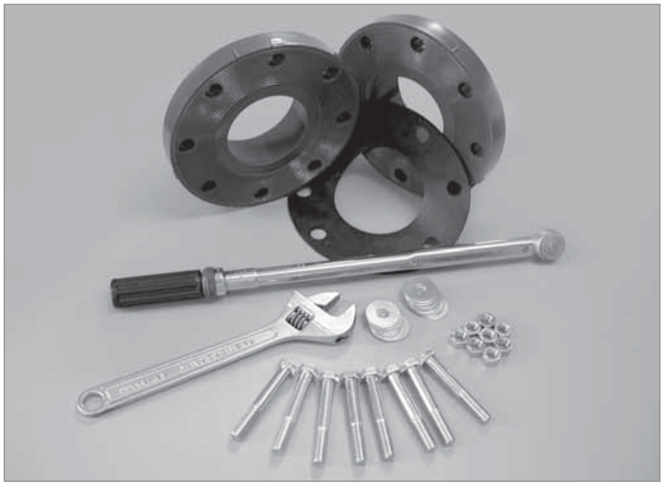
Backfilling should only proceed after all solvent cement joints have been properly cured and the piping brought close to normal operating temperature, if operation will be more than 15°F different than the current ambient temperature. The piping should be uniformly supported over its entire length on firm, stable material.

Backfill material in contact with the pipe should be free of rocks and have a particle size no greater than 1/2." Piping should initially be surrounded with backfill to provide between 6" and 8" of cover. The backfill should be compacted using vibratory methods. Backfill containing a significant amount of fine-grained material, such as silt or clay, should be hand or mechanically tamped.

The remainder of the backfill should be placed and spread in approximately uniform layers to completely fill the trench without voids. Particle size for this final fill should not exceed 3".

Grounding

Because AquaRise CPVC is non-conductive, it cannot be used as an electrical ground and care must be taken to provide a suitable ground whenever CPVC piping is being installed to replace metal piping that has been used as a ground. Alternative methods such as grounding rods or plates must be used. Because plastic water service lines are being used extensively, and because of galvanic corrosion to metal piping systems from ground faults, many codes prohibit grounding to any type of hot and cold water pipe. Check with your local authority having jurisdiction regarding this issue.



CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

FLANGING

Introduction

Flanging is used extensively for plastic process lines that require periodic dismantling, or for convenient transition to metallic piping or components. Thermoplastic flanges and factory flanged fittings for AquaRise CPVC are available in a full range of sizes and types for joining to pipe by solvent welding and threading. Gasket seals between the flange faces should be an elastomeric full-faced gasket with a hardness of 50 to 70 durometer A. If piping is used for potable water service, the gasket must be approved for potable water.

Dimensions

AquaRise CPVC flanges have 150 lb bolt hole patterns as per ANSI B16.1. Threads are tapered iron pipe size threads per ANSI B2.1. The socket dimensions conform to ASTM D2467 which describes 1/2" through 3". Flanges 1/2" to 3" are third party certified by NSF to meet ASTM F1970. Quantities and sizes of flange bolt sets are listed on Page 24.

Design

Flange joint connections may be utilized with AquaRise in all available pipe sizes. Flanges are advantageous where periodic dismantling may be required or for transitions to metallic piping or components.

AquaRise CPVC flanges have socket ends and a 150 lb. bolt pattern which yields a pressure rating of 150 psi at 73°F (23°C). All flanges conform to ASTM F 1970 and are made using AquaRise CPVC fitting compound which is listed to NSF Standard 61 for potable water. Should AquaRise flanges be used at temperatures above 73°F (23°C), the maximum operating pressures shown below should be observed for the system:

Maximum Pressures for Flanged Systems

Operating Temperature		Max. Operating Pressure (psi)
ºF	ºC	CPVC
73	23	150
80	27	144
90	32	137
100	38	123
110	43	111
120	49	98
130	54	87
140	60	75
150	66	68
160	71	60
170	77	50
180	82	38

If it is necessary to use flange joints with AquaRise at pressures beyond the above operating pressures, contact IPEX to discuss alternative methods.

Gasket seals within the flange joint are not provided by IPEX but should be elastomeric and full-face with a durometer hardness of between 50-70. Gaskets must also be approved for potable water.

Installation Guidelines

The faces of IPEX flanges have a phonographic-grooved finish providing positive seal on the gasket when the bolts are properly tightened.

After cementing the flange socket to AquaRise pipe, use the following guidelines to assemble the flange joint:

1) Make sure all bolt holes of the matching flanges are aligned.
2) Insert all bolts.
3) Make sure the faces of the mating flanges are not separated by excessive distance prior to bolting down the flanges.
4) The bolts on the plastic flanges should be tightened by pulling down the nuts diametrically opposite each other using a torque wrench. Complete tightening should be accomplished in stages using the final torque values in the Recommended Torque Table. Uniform stress across the flange will eliminate leaky gaskets.
5) For optimum results, the bolts should be well lubricated, utilizing flat face washers on both sides of the connection and the gasket shall be full-face.
6) If the flange is mated to a rigid and stationary flanged object or a metal flange, particularly in a buried situation where settling could occur with the plastic pipe, the plastic flange, and fitting or valve must be independently supported to eliminate potential stressing.

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

Recommended Torque

Flange Size (in.)	Recommended Maximum Torque (ft. lbs.)*
1/2 - 1-1/2	15
2 - 3	30

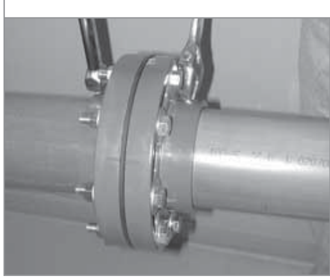
Flange Bolt Set

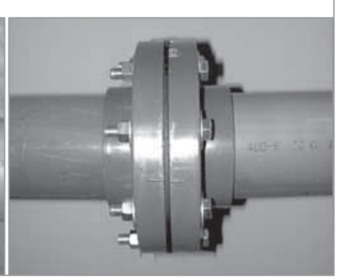
Pipe Size	# of Holes	Bolt Diameter	Bolt Length
1/2	4	0.50	1.75
3/4	4	0.50	2.00
1	4	0.50	2.00
1-1/4	4	0.50	2.25
1-1/2	4	0.50	2.50
2	4	0.63	2.75
2-1/2	4	0.63	3.00
3	4	0.63	3.00

Notes: Bolt length will vary if metal backing rings are used. Dimensions are in inches.

CAUTION

1. Do not over-torque flange bolts.
2. Use the proper bolt tightening sequence.
3. Make sure the system is in proper alignment.
4. Flanges should not be used to draw piping assemblies together.
5. Flat washers must be used under every nut and bolt head.
6. Full face gaskets should be used.





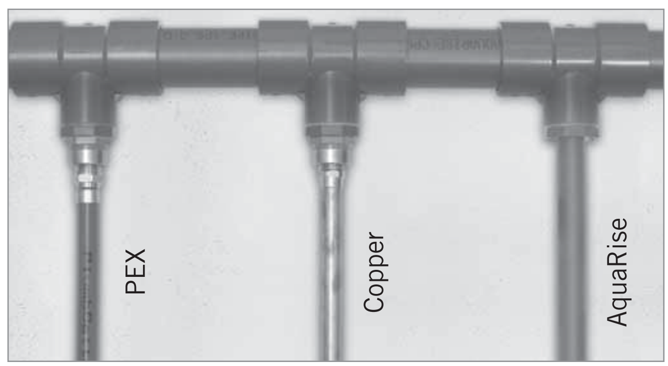
Transition Joints

Inevitably in any piping system transitions will be made to connect up to appliances, metal valves etc. Aside from flanging, one of the most common methods of transitioning is to use threaded fittings. IPEX does not recommend using a purely thermoplastic male nor female adapter for a threaded connection. Part of the reason is the de-rating of the system pressure when using threaded thermoplastic fittings, but also due to problems that may occur with differential expansion and contraction of the plastic and metal under varying temperature conditions.

Included in the AquaRise package is a female threaded Stainless Steel reinforced adapter that is NSF approved for potable water applications. This fitting eliminates fittings expansion, ensuring positive thread contact and greater sealing capability. The superior strength of this fitting eliminates the need for pressure derating normally associated with non-reinforced fittings.

This fitting will also have better ability to withstand the higher radial stresses naturally imposed on the female component of a threaded pipe connection.

Thus, threaded AquaRise transitions to metal piping or plastic tubing can only be made using a metal male fitting or pipe end with the SR female adapter.



Thread Sealants

TFE (Teflon®) thread tape is always safe for making CPVC threaded connections. Some paste-type sealants contain solvents that may be damaging to CPVC. If the use of a paste or pipe dope is preferred, always check with the manufacturer for written confirmation regarding its compatibility with CPVC. Use of an improper paste or dope can result in failure of CPVC systems. (Refer to the chemical compatibility section of this manual for additional information on compatibility).

PRACTICAL CONSIDERATIONS

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

Water Heater Hook-Ups

Conditions

When AquaRise piping is connected to a gas fired water heating appliance, a metal nipple should be installed in a manner that keeps the AquaRise piping at least 6" away from excessive radiant heat build up from chimney vent. When connecting to electric water heaters, a metal nipple should still be utilized and then connected to the AquaRise system with a stainless reinforced CPVC female adapter.

Note: Verify code requirements prior to installation.

Hot Water Recirculating Systems

AquaRise is ideally suited for hot water recirculating piping systems. Its pressure rating of 200 psi at 140°F along with its strong resistance to chlorinated water and abrasion will ensure a long, trouble-free life in a recirculation application. Due to its ease of installation, AquaRise makes an excellent replacement or retrofit product should metallic pipe fail prematurely in the rigorous application.

Caution should be taken when using Ethylene or Propylene Glycol / water mix, commonly found in radiant heating applications. Consult your IPEX representative before using AquaRise for such heating system applications.

Freeze Issues

CPVC, like all other piping materials, needs to be protected from freezing conditions. All model plumbing codes require that piping exposed to freezing temperatures be properly insulated.

Should water filled CPVC pipe becomes frozen, immediate action should be taken to eliminate the source of the freeze condition. Then thaw the water line, if possible. When thawing a frozen CPVC water line, it is important to remember to limit the heat source to 180°F or less.

If the frozen section of pipe is accessible, heated air can be blown directly onto the freeze area by using a low wattage heater/blower. A second option is to apply electrical heat tapes to the problem area.

Penetration of Studs and Joists

Wooden Studs and Joists

It is acceptable for AquaRise pipe to pass through wood studs and joists. Insulators, between the CPVC and the wood structure, are not necessary. To permit movement caused by expansion and contraction, holes drilled in the wood joists and studs should be 1/4" larger than the outside diameter of the pipe. Wood or plastic wedges that restrain the pipe as it passes through the wood joist or stud should not be used.

Metal Studs

When AquaRise pipe passes through metal studs, some form of protection must be used to protect the pipe from abrasion.

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

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 structural loads, such as valves, are installed. These forces must be reduced by means of anchors, risers, restraining hangers, thrust blocks or encasement. The method chosen will depend on whether the system is buried or above ground. See also the section on installation of buried pipes in this manual.

The size 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 that the thrust created at unrestrained fittings can be considerable (as shown in table below) and should be addressed during installation.

Thrust at Fittings in pounds per 100 psi (internal pressure)

Pipe Size (in.)	Blank ends & junctions	90° Bends	45° Bends	22-1/2° Bends	11-1/4° Bends
1/2	60	85	50	25	15
3/4	90	130	70	35	20
1	140	200	110	55	30
1-1/4	220	320	170	90	45
1-1/2	300	420	230	120	60
2	450	630	345	180	90
2-1/2	650	910	500	260	130
3	970	1,360	745	385	200

Handling and Storage

AquaRise CPVC is a tough, corrosion resistant material, but reasonable care should be exercised in handling pipe and fittings. Pipe should not be dropped, stepped on, nor have objects thrown on it. If improper handling or excessive impact results in cracks, splits, or gouges, cut off at least 2" beyond the visible damage and discard.

AquaRise CPVC should not be exposed to direct sunlight for extended periods of time. AquaRise CPVC must be stored using a form of UV protection in order to maintain product warranty.

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

TESTING

Site Pressure Testing

The purpose of an onsite pressure test is to establish that the installed section of line, and in particular all joints and fittings, will withstand the design working pressure, plus a safety margin, without loss of pressure or fluid.

Generally a test pressure of 1.5 times the safe working pressure for the pipe installed is adequate. Whenever possible, it is recommended that hydrostatic testing be carried out before commissioning the line into usage. It is suggested that the following hydrostatic test procedure be followed after the solvent-welded joints have been allowed to cure fully (timed from the cure of last joint). For more details, refer to the joint cure schedules on pg 19.

Pressure testing with compressed air is strictly prohibited with AquaRise.

Hydrostatic Test Procedure

1) Fully inspect the installed piping for evidence of mechanical abuse and/or dry suspect joints.
2) Split the system into convenient test sections not exceeding 1,000 ft.
3) Slowly fill the pipe section with water, preferably at a velocity of 1.0 fps or less. Any entrapped air should 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. Do not pressurize further at this stage.
6) Leave the section pressurized for 10 minutes. If the pressure decays, inspect for leaks. If the pressure remains constant, slowly increase the hydrostatic pressure to 1.5 times the nominal working pressure.
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. This must be removed before further testing.

Any joint leaks should be repaired and allowed to cure fully before re-pressurizing. For more detail, refer to the joint cure schedules on pg 19.

WARNING

- NEVER use compressed air or gas in AquaRise pipe and fittings.
- NEVER test AquaRise pipe and fittings with compressed air or gas, or air-over-water boosters.
- ONLY use AquaRise pipe for water and approved chemicals.

Use of compressed air or gas in AquaRise pipe and fittings can result in explosive failures and cause severe injury or death.

Safety

Extensive studies of CPVC piping demonstrate that no significant health risks are associated with installing CPVC pipe, and that risk levels are well below accepted standards, especially when new, Low VOC cement is used.

IPEX fully endorses safety and protective measures recommended by government agencies when installing AquaRise CPVC pipe, other plastic pipe or metal pipe.

Whenever possible, ensure proper ventilation when applying primers and cements and/or soldering materials.

Avoid unnecessary skin or eye contact with primers and cements and/or soldering materials.

Wash immediately if contact occurs to avoid prolonged exposure.

Follow all manufacturer-recommended precautions when cutting or sawing pipe or when using any flame, heat or power tools.

After testing, thoroughly flush the system for at least 10 minutes to remove residual trace amounts of solvent cement or flux/solder components.

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

NOTES

SECTION FIVE: BUILDING CODE CONSIDERATIONS

Code Compatibility

AquaRise pipe and fittings, not only satisfies National and Provincial Building Codes but also provides a cost effective trouble-free long-term installation.

- The fire resistance rating of thermoplastic piping is attained by successful testing as confirmed by a listing to be prescribed test method, in this this CAN/ULC S102.2 National and Provincial Codes specify the test requirements in 3.1.12.1.(2). In the case of thermoplastic piping the prescribed test method is ULC/CAN S102.2.
- To use thermoplastic piping in a building classified as noncombustible, the material must meet a Flame Spread Rating of 25 or less. Approval to use thermoplastic piping in noncombustible buildings is detailed in clause 3.1.5.16 of the building code.
- Products for use within air plenums must meet a Flame Spread of 25 or less and a Smoke Developed Classification of 50 or less. (Building Code article 3.6.4.3. (1).)
- Products to be used within a building deemed to be high-rise must also meet the Smoke Developed Classification of 50 or less. (Building Code article 3.2.6.).
- AquaRise may not be permitted to be used in a Vertical Shaft. Contact IPEX or the local Authority Having Jurisdiction for more information regarding local regulations.

By using an AquaRise water distribution system, designers and contractors can maximize the potential installation and cost benefits offered by thermoplastic systems.

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

AquaRise CPVC Easy Spec

Use of Piping as per 2005 National Building Code

Product	Size Range	Standards	Applications	Above Ground		Underground	
				Cold	Hot	Under Building	Outside Building
AquaRise	1/2" - 3"	CSA B137.6 CAN/ULC S102.2 NSF-61	Risers, Mains and Laterals for Potable Water Hot Water Recirculation Lines	P (1) (2)	P (1) (2)	P	P

Notes:

1. Combustible piping in non-combustible construction is subject to the requirements of 3.1.5.16.(1) of the 2005 NBC.
2. Combustible water distribution piping may not be permitted in a Vertical Shaft. Contact IPEX for more information.

Applications as per 2005 NBC Suitability for Use

AquaRise	**Combustible Building Construction**	**Non Combustible Building Construction**			
		Low-Rise Construction	High-Rise Construction	Plenums	Vertical Shafts
	P	P	P	P	**

Legend: P = Permitted
N = Not Permitted
** = Check with Local Authorities

BUILDING CODE CONSIDERATIONS

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

SECTION SIX: SPECIFICATIONS

AquaRise Pipe, Valves and Fittings

AquaRise pipe and fittings are certified to CSA B137.6. When used in noncombustible construction, high-rise buildings and air plenums, AquaRise pipe shall be tested and listed in accordance with CAN/ULC S102.2 and clearly marked with the certification logo indicating a Flame-Spread Rating not more than 25 and a Smoke-Developed Classification not exceeding 50. AquaRise pipe and fittings shall be be SDR 11 thickness and IPS outside diameter.

Firestopping Devices

Firestopping systems shall be listed under CAN/ULC S115 with an additional requirement of 50 Pa pressure differential for the Province of Ontario. Listed firestop systems are required wherever the system penetrates fire-rated vertical or horizontal separations.

Solvent Cements

AquaRise Low VOC cements and primers are mandatory for all applications, sizes and installation temperatures to a lower limit of 0ºF (-18ºC). The use of a primer is required for all situations. AquaRise cements and primers are certified to CSA B137.6 and are NSF Standard 61 listed for use with potable water. Proper solvent cementing procedures must be followed at all times.

SPECIFICATIONS

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

NOTES

CAUTION: Do not use or test the products in this manual with compressed air or other gases including air-over-water-boosters.

SALES AND CUSTOMER SERVICE

Canadian Customers call IPEX Inc.

Toll free: (866) 473-9462

www.ipexinc.com

About the IPEX Group of Companies

As leading suppliers of thermoplastic piping systems, the IPEX Group of Companies provides our customers with some of the largest and most comprehensive product lines. All IPEX 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 established a reputation for product innovation, quality, end-user focus and performance.

Markets served by IPEX group products are:

- Electrical systems
- Telecommunications and utility piping systems
- PVC, CPVC, PP, ABS, PEX, FR-PVDF and PE pipe and fittings (1/4" to 48")
- Industrial process piping systems
- Municipal pressure and gravity piping systems
- Plumbing and mechanical piping systems
- PE Electrofusion systems for gas and water
- Industrial, plumbing and electrical cements
- Irrigation systems

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A policy of ongoing product improvement is maintained. This may result in modifications of features and/or specifications without notice.

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