CPVC HOT AND COLD WATER DISTRIBUTION PIPING

by
David A. Wojcieszak, P.E., C.I.A.Q.P. and Darcee A. McAninley, P.E., C.I.A.Q.P.
Wojcieszak & Associates, Inc., P.O. Box 2528, Stuart, Florida 34995
E-Mail: darcee@dwojo.com
(772) 286-8696

Introduction

Although the Florida Building Code – Plumbing allows the use of CPVC for hot and cold water distribution provided it conforms with Chapter 6, its use is not recommended, especially in buildings where water leaks would cause substantial damage. Any savings a building owner and/or contractor would realize using CPVC over specified Copper could quickly be wiped out when a problem arises.

Derating of Hot Water Piping and Fittings

When piping is used for hot water piping, it must meet the requirements for FBC-Plumbing, Section 605.5. This states that it must have a minimum pressure rating of 100 psi at 180°F. The pressure rating at this temperature must be derated by 75%. For example, Schedule 80 CPVC, non-threaded, 2-inch pipe is rated at 400 psi at 73°F. At 180°F, it would be derated to 100 psi. This is the minimum allowed without a safety factor. Piping above 3-inches in diameter does not meet the code. See attached ***Recommended Product Specification, Pressure Ratings,*** and ***Pressure/Temperature Relationship*** (Industrial Technical Manual).

Piping Installation

Piping installation is a multi-step process. The quality of the installation is installer dependent. The step most commonly left out is cleaning the pipe with a solvent. If this step is skipped, then the glue will not form a good bond between the two materials. This could lead to water leaks.

Piping Supports

Piping must be properly supported. Support spacing is dependent on both temperature and pipe size. See attached ***Support Spacing for PVC and Corzan CPVC Pipe*** (Industrial Technical Manual).

Piping Hangers

Support hangers must allow for the expansion and contraction of the pipe. Rigid connections are not recommended. Improper hangers could cause the pipe and fittings to leak. See attached literature ***Recommended Pipe Hangers, Clamps and Supports*** (Industrial Technical Manual).

Screwed Connections

Avoid using screwed adapters, especially in hot water piping. These connections are significantly derated. The derating makes screwed connections non-compliant with the code in most sizes. Instead, use flanged or glued connections.

Expansion Loops

Expansion loops must be installed to allow for the expansion and contraction of the pipe. Installing this loop is time consuming and is often left out. It also requires space for installation. For example, 50 feet of CPVC pipe will expand 1-1/2 inches when filled with 70°F water and operated with 140°F water. See attached product literature ***Expansion and Contraction of ABS, PVC and CPVC*** (Industrial Technical Manual).

Booster Pumps

Booster pumps are often installed in buildings. It is important to make sure that the pipe is rated for the hydrostatic and pump pressures. In the event that the total pressure exceeds the pipe pressure rating, an alternate material must be used.

Disclaimer

This Technical Bulletin is not a specification for CPVC piping, fittings or installation. The use of CPVC piping is at the owner's and contractor's discretion.

Suggested Specification

System: **Corzan® CPVC Schedule 40 and 80 Pressure Pipe and Fitting System**

Scope: This specification covers CPVC Schedule 40 and 80 pipe and Schedule 80 fittings for pressure applications. This system is intended for pressure applications where the operating temperature will not exceed 200°F.

Specification: Pipe and fittings shall be manufactured from virgin rigid CPVC (chlorinated polyvinyl chloride) vinyl compounds with a Cell Class of 23447-B as identified in ASTM D 1784.

CPVC Schedule 40 and 80 pipe shall be Iron Pipe Size (IPS) conforming to ASTM F 441. CPVC Schedule 80 fittings shall conform to ASTM F 439. CPVC Schedule 80 threaded fittings shall conform to ASTM F 437. Pipe and fittings shall be manufactured as a system and be the product of one manufacturer. All pipe and fittings shall be manufactured in the United States. Pipe and fittings shall conform to National Sanitation Foundation (NSF) Standard 61 or the health effects portion of NSF Standard 14.

Installation shall comply with the latest installation instructions published by Charlotte Pipe and Foundry and shall conform to all local plumbing, building, and fire code requirements. Solvent cement joints shall be made in a two step process with primer manufactured for thermoplastic piping systems and solvent cement conforming to ASTM F 493. The system shall be protected from chemical agents, fire stopping materials, thread sealant, plasticized vinyl products, or other aggressive chemical agents not compatible with CPVC compounds. Systems shall be hydrostatically (water) tested after installation. Testing with compressed air or gas is not recommended.

Referenced Standards:

ASTM D 1784	Rigid Vinyl Compounds
ASTM F 437	Threaded CPVC Plastic Fittings, Schedule 80
ASTM F 439	CPVC Plastic Fittings, Schedule 80
ASTM F 441	CPVC Plastic Pipe, Schedules 40 and 80
ASTM F 493	Solvent Cements for CPVC Pipe and Fittings
NSF Standard 14	Plastic Piping Components and Related Materials
NSF Standard 61	Drinking Water System Components - Health Effects

Note: Latest revision of all standards apply.

MAXIMUM OPERATING PRESSURE (PSI) AT 73°F

Nominal Pipe Size	Schedule 80 PVC and CPVC		Schedule 40 PVC and CPVC (2)	SDR 26 PVC (2)	SDR 21 PVC (2)	SDR 13.5 PVC (2)
	Plain End	Threaded				
1/4	1130	570	780	—	—	—
3/8	920	460	620	—	—	—
1/2	850	420	600	—	—	315
3/4	690	340	480	—	200	—
1	630	320	450	—	200	—
1 1/4	520	260	370	160	200	—
1 1/2	470	240	330	160	200	—
2	400	200	280	160	200	—
2 1/2	420	210	300	160	200	—
3	370	190	260	160	200	—
4	320	160	220	160	200	—
5	290	Threading	190	160	200	—
6	280	pipe above	180	160	200	—
8	250	4" is not	160	160	200	—
10	230	recommended	140	160	200	—
12	230		130	160	200	—
14	220 (1)		130 (1)	160	—	—
16	220 (1)		130 (1)	160	—	—

The operating pressures listed above are based on the hydrostatic design of the pipe using water at 73° F as the test medium. See page 17 for correction factors for temperatures above 73° F.

The PVC pipe shown is for PVC 1120 with a cell class of 12454. The CPVC pipe shown is for CPVC 4120 with a cell class of 24448 or 23447.

The pressure ratings for the pipe shown were derived by using the following equation:

$$P = \frac{2ST}{D-T}$$

Where: **P** = pressure (psi)
D = average outside diameter
T = minimum wall thickness
S = hydrostatic design stress (HDS)*

*The HDS for Charlotte Pipe and Foundry's PVC and CPVC compounds is 2,000 psi.
(1) PVC only.
(2) Threading is not recommended. Also, PVC and CPVC Schedule 80 pipe operating above 130° F should not be threaded.

PVC AND CPVC PIPING PRODUCTS ARE NOT RECOMMENDED FOR SYSTEMS WHICH TRANSPORT OR STORE COMPRESSED AIR OR GASES. DO NOT TEST PVC OR CPVC PIPING SYSTEMS WITH COMPRESSED AIR OR GASES. ALWAYS BLEED ALL ENTRAPPED AIR FROM THE SYSTEM PRIOR TO TESTING.

PRESSURE/TEMPERATURE RELATIONSHIP

The operating pressure of PVC and CPVC pipe will be reduced as the operating temperature increases above 73° F. To calculate this reduction, multiply the operating pressures shown on the previous page by the correction factors shown below:

Operating Temperature (°F)	Correction Factors PVC	CPVC
73	1.00	1.00
80	.88	1.00
90	.75	.91
100	.62	.82
110	.50	.77
120	.40	.65
130	.30	.62
140	.22	.50
150	NR	.47
160	NR	.40
170	NR	.32
180	NR	.25
200	NR	.20

For example, the operating pressure for 6" Schedule 80 CPVC pipe is 280 psi. If the operating temperature is 140° F, the maximum operating pressure is now 140 psi (280 x .50).

Note: Operating temperatures above 140° F for PVC and 200° F for CPVC piping products are not recommended.

SUPPORT SPACING FOR PVC AND CORZAN CPVC PIPE

CHARLOTTE PIPE AND FOUNDRY COMPANY®

Adequate support for any piping system is a matter of great importance. In practice, support spacings are a function of pipe size, operating temperatures, the location of heavy valves or fittings, and the mechanical properties of the pipe material.

To ensure the satisfactory operation of a PVC or CPVC piping system, the location and type of hangers should be carefully considered. The principles of design for steel piping systems are generally also applicable to PVC and CPVC piping systems, but with some notable areas where special consideration should be exercised.

(1) Concentrated loads (valves, flanges, etc,) should be supported directly so as to eliminate high stress concentrations. Should this be impractical, then the pipe must be supported immediately adjacent to the load.

(2) In systems where large fluctuations in temperature occur, allowance must be made for expansion and contraction of the piping system. Since changes in direction in the system are usually sufficient to allow expansion and contraction, hangers must be placed so as not to restrict this movement.

(3) Changes in direction should be supported as close as practical to the fitting to avoid introducing excessive torsional stresses into the system.

(4) Since PVC and CPVC pipe expand or contract approximately five times as much as steel, hangers should not restrict this movement. When using a clamp type hanger, the hanger should not force the pipe and fittings into position.

(5) Hangers should provide as much bearing surface as possible. To prevent damage to the pipe, file smooth any sharp edges or burrs on the hangers or supports.

(6) Valves should be braced against operating torque.

(7) PVC and CPVC lines must not be placed alongside steam or other high temperature pipe lines or other high temperature objects.

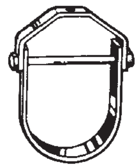
(8) Support spacing for horizontal piping systems is determined by the maximum operating temperatures the systems will encounter. The piping should be supported on uniform centers with supports that do not restrict the axial movement of the pipe. The chart below shows the recommended support spacing according to size, schedule, and operating temperatures. These spacings apply to continuous spans of uninsulated lines, with no concentrated loads, conveying liquids with specific gravities of up to 1.00.

SUPPORT SPACING (IN FEET)

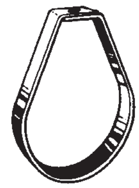
Nom. Pipe Size (in.)	PVC PIPE															CPVC PIPE											
	PR 160 & 200					Schedule 40					Schedule 80					Schedule 40						Schedule 80					
	Temp. °F					Temp. °F					Temp. °F					Temp. °F						Temp. °F					
	60	80	100	120	140	60	80	100	120	140	60	80	100	120	140	60	80	100	120	140	180	60	80	100	120	140	180
½	3½	3½	3	2		4½	4½	4	2½	2½	5	4½	4½	3	2½	5	5	4½	4½	4	2½	5½	5½	5	4½	4½	2½
¾	4	3½	3	2		5	4½	4	2½	2½	5½	5	4½	3	2½	5½	5	5	4½	4	2½	5½	5½	5½	5	4½	2½
1	4	4	3½	2		5½	5	4½	3	2½	6	5½	5	3½	3	6	5½	5½	5	4½	2½	6	6	6	5½	5	3
1¼	4	4	3½	2½		5½	5½	5	3	3	6	6	5½	3½	3	6	5½	5½	5½	5	3	6½	6½	6	6	5½	3
1½	4½	4	4	2½		6	5½	5	3½	3	6½	6	5½	3½	3½	6½	6½	6½	5½	5	3	7	7	6½	6	5½	3½
2	4½	4	4	3		6	5½	5	3½	3	7	6½	6	4	3½	6½	6	6	5½	5	3	7	7	7	6½	6	3½
2½	5	5	4½	3		7	6½	6	4	3½	7½	7½	6½	4½	4	7½	7	7	6½	6	3½	8	7½	7½	7½	6½	4
3	5½	5½	4½	3		7	7	6	4	3½	8	7½	7	4½	4	8	7	7	7	6	3½	8	8	8	7½	7	4
4	6	5½	5	3½		7½	7	6½	4½	4	9	8½	7½	5	4½	8½	7½	7½	7	6½	4	9	9	9	8½	7½	4½
6	6½	6½	5½	4		8½	8	7½	5	4½	10	9½	9	6	5	9½	8½	8	7½	7	4½	10	10½	9½	9	8	5
8	7	6½	6	5		9	8½	8	5	4½	11	10½	9½	6½	5½	9½	8½	8	7½	7	5	11	11	10½	10	9	5½
10						10	9	8½	5½	5	12	11	10	7	6	10	9½	9	8	7½	5½	11½	11½	11	10½	9½	6
12						11½	10½	9½	6½	5½	13	12	10½	7½	6½	10½	10½	10	9	8	6	12½	12½	12½	11	10½	6½
14						12	11	10	7	6	13½	13	11	8	7												
16						12½	11½	10½	7½	6½	14	13½	11½	8½	7½												

This data is based upon information provided by the raw material manufacturers. It should be used only as a reference and not as a guarantee of performance. Installations must comply with all local plumbing codes and regulations.

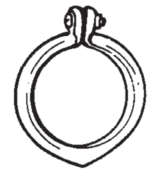
RECOMMENDED PIPE HANGERS, CLAMPS, AND SUPPORTS



Clevis Hanger
$^{1}/_{2}$ to 30 in. pipe

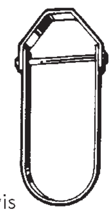


Band Hanger
$^{1}/_{2}$ to 8 in. pipe



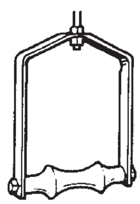
Split Ring Hanger
$^{3}/_{8}$ to 8 in. pipe

Split Ring Hanger
Adj. Swivel Ring
$^{3}/_{4}$ to 8 in. pipe

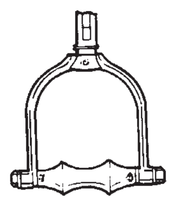


Adj. Clevis
For Insulated Lines
$^{3}/_{4}$ to 12 in. pipe

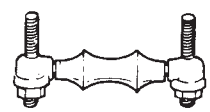
Adj. Swivel Ring
$^{1}/_{2}$ to 8 in. pipe



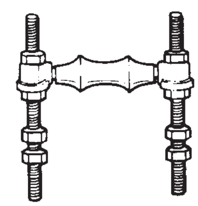
Roller Hanger
$2^{1}/_{2}$ to 20 in. pipe



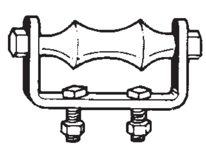
Adj. Swivel Roller Hanger
$2^{1}/_{2}$ to 12 in. pipe



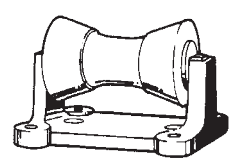
Single Pipe Roll
1 to 30 in. pipe



Adj. Pipe Roll Support
1 to 30 in. pipe

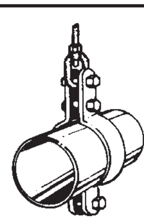


Roller Chair
2 to 12 in. pipe

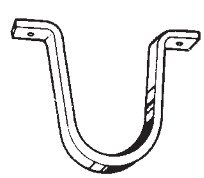


Pipe Roll Stand
2 to 42 in. pipe

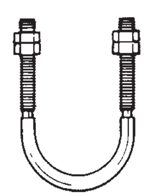
Pipe Clamp
$^{1}/_{2}$ to 24 in. pipe



Double Bolt Pipe Clamp
$^{3}/_{4}$ to 36 in. pipe



Anchor Strap
$^{1}/_{2}$ to 4 in. pipe



U Bolt
$^{1}/_{2}$ to 30 in. pipe

ABS and PVC pipe, like other piping materials, undergo length changes as a result of temperature variations above and below the installation temperature. They expand and contract 4.5 to 5 times more than steel or iron pipe. The extent of the expansion or contraction is dependent upon the piping material's coefficient of linear expansion, the length of pipe between directional changes, and the temperature differential.

The coefficients of linear expansion (Y) for ABS, PVC, and CPVC (expressed in inches of expansion per 10°F temperature change per 100 feet of pipe) are as follows:

Material	Y (in./10°F/100 ft)
ABS	0.66
PVC	0.36
CPVC	0.408

The amount of expansion or contraction can be calculated using the following formula:

$$\Delta L = \frac{Y\,(T_1 - T_2)}{10} \times \frac{L}{100}$$

ΔL = Dimensional change due to thermal expansion or contraction (in.)

Y = Expansion coefficient (See table above.) (in./10°F/100 ft)

(T_1-T_2) = Temperature differential between the installation temperature and the maximum or minimum system temperature, whichever provides the greatest differential (°F).

L = Length of pipe run between changes in direction (ft)

Example:
How much expansion can be expected in a 300 foot straight run of 2" diameter PVC pipe installed at 70°F and operating at 120°F?
Solution:

$$\Delta L = .360\ \frac{(120 - 70)}{10} \times \frac{300}{100} = .360 \times 5 \times 3 = 5.4 \text{ inches}$$

There are several ways to compensate for expansion and contraction. The most common methods are:

1. Expansion loops which consist of pipe and 90° elbows (See Figure 1)
2. Piston type expansion joints* (See Figure 2)
3. Flexible bends*
4. Bellows and rubber expansion joints*

*The manufacturers of these devices should be contacted to determine the suitability of their products for the specific application.

Expansion loops are a simple and convenient way to compensate for expansion and contraction when there is sufficient space for the loop in the piping system. A typical expansion loop design is shown below.

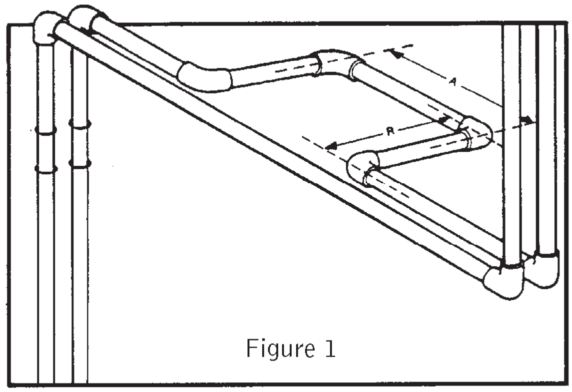


Figure 1

The length of leg "R" can be determined by using the following formula to ensure that it is long enough to absorb the expansion and contraction movement without damage. The length of leg "A" should be 1/2 the length of leg "R".

$$R = 1.44\sqrt{D\,\Delta L}$$

R = Expansion loop leg length (ft)

D = Nominal outside diameter of pipe (in.) (See table below.)

ΔL = Dimensional change due to thermal expansion or contraction (in.)

Example: How long should the expansion loop legs be to compensate for the expansion in a system that has 215 feet of 3" diameter PVC pipe installed at 75°F and operating at 135°F?

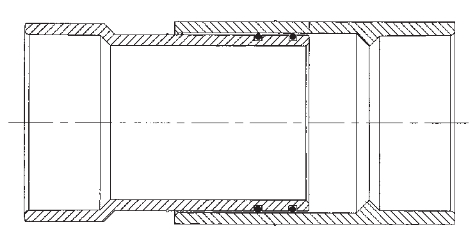
Solution: $R = 1.44\sqrt{3.500 \times 4.644} = 1.44\sqrt{16.254} = 5.80'$

$$A = \frac{5.80'}{2} = 2.90'$$

When installing the expansion loop, no rigid or restraining supports should be placed within the leg lengths of the loop. The loop should be installed as closely as possible to the mid-point between anchors. Piping support guides should restrict lateral movement and direct axial movement into the loop. Lastly, the pipe and fittings should be solvent cemented together, rather than using threaded connections.

Compensation for expansion and contraction in underground applications is normally achieved by snaking the pipe in the trench. Solvent cemented joints must be used.

Figure 2



Piston-type expansion joint illustrated.