Double-See™
PVC and CPVC Double Containment Piping Systems

Technical Manual

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GEORG FISCHER
PIPING SYSTEMS

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Introduction: Double-See PVC and CPVC Double Containment Piping Systems

Product Overview

The Dilemma

Double containment piping systems are ideal for ensuring safety when transporting corrosive, toxic, or otherwise hazardous media. When a leak occurs in a conventional, single-walled piping system, the contents of the pipe escape into the surroundings. Leaking fluid can cause harm to people, the environment, equipment, machines, and buildings. The owner may face fines and penalties, lawsuits, expensive clean-up efforts, increase in insurance premiums, or loss in production while the system has to be shut down for repairs.

The Solution

However, end-users who install a double containment piping system can avoid these issues. When a leak from the primary pipeline occurs in a double containment system, the fluid is safely contained by the secondary pipe. End-users typically implement a leak detection system to alert operators when a leak has occurred. The secondary containment buys operators critical time to shut off the primary pipe system and fix the leak. The end-user can continue with normally scheduled production and deal with the malfunction when doing so would not be as counter-productive.

The Savings

The added protection given by Double-See's fail-safe design will likely pay for itself in the event of a major leak by avoiding a spill situation. Double-See vinyl double containment system uses cost-effective, lightweight PVC and CPVC joined by solvent cementing, which saves the end-user time and money compared to more complex installation methods. The broad use of vinyl materials and ease of installation allow Double-See to be applied in either above- or below-ground applications.

Features, Advantages, Benefits

Why Double-See Vinyl Double Containment System?

Drawing from industry feedback on the shortcomings of existing double containment systems, GF Piping Systems' team of engineers developed a new and improved approach to double containment piping. Our vinyl double containment system combines unique centralizing and coupling designs, solid PVC/CPVC construction, a multitude of pre-fabricated fittings, and a wide range of sizes with our world-renowned GF quality, support, and competitive pricing to offer the ultimate double containment product line. Below are just a few of the unique advantages of our double containment product line:

- **Innovative centralizer design:** Our patented expansion-compensating centralizer design allows for flexibility in the system which reduces forces on joints caused by thermal expansion/contraction of the primary system. This flexible centralizer design is simpler and safer than systems that use a rigid centralizer design which results in stress at the joint.
- **Pre-assembled/pre-fabricated parts:** Unlike some competing systems, all of our fittings come pre-assembled and factory tested. This ensures quality and reduces the time and cost of installation.
- **Cut length guidance system:** A pipe cut length guidance system is built-in to the exterior wall of fittings to take the guess work out of measuring and cutting the primary and secondary pipe segments.
- **Extensive part selection:** A complete range of fittings, valve boxes, leak detection tees, access tees, and termination fittings are available in a wide range of material and size options: with PVC × PVC, CPVC × CPVC, and CPVC × PVC, in sizes ranging from ½"×2" to 6"×10", there is a suitable option for just about every application.
- **Modular components:** The modular design of our components is customizable, offering a limitless number of installation configurations to suit a wide range of applications.
- **Universally compatible fittings:** All of our parts are compatible with standard PVC and CPVC (Schedule 80 and 40) piping sizes
- **Leak detection options:** Visual leak detection fittings and easy access to joints for leak detection system installation
- **Reliable construction:** Reliable GF Piping Systems' Schedule 80 PVC and CPVC construction
- **GF quality:** Unparalleled quality and precision in molded and fabricated GF fittings, parts, and piping
- **Customized fabrication available:** Our in-house custom fabrication department is an industry leader in customizing job-specific components and sub-assemblies.
- **Customer Service:** First-rate technical support and customer service
- **Competitive pricing**

The Double-See Vinyl Double Containment System is ideal for the following applications:

- Airports
- Battery manufacturing
- Chemical delivery
- Chemical processing
- Food processing
- Gas lines
- Laboratories
- Landfills
- Life science
- Metal working/finishing
- Microelectronics
- Paper/cellulose production
- PCB production
- Power plants
- Shipbuilding
- Waste collection
- Waste water treatment
- Water treatment

Environmental Considerations

Environmental protection is one of GF's longest-standing core values. From conserving resources through optimizing the efficiency of our operations, to developing products which enhance ecological protection, we strive for "greenness." This commitment to the environment has solidified GF Piping Systems as an industry leader in sustainability.

Double-See Vinyl Double Containment System embodies this green vision. In addition to obvious safety benefits, our fail-safe Double-See Vinyl Double Containment system ensures that our customers will avoid environmentally harmful leaks and spills, while fulfilling local, state, and federal environmental and safety regulations. Double-See, when implemented and installed correctly (with an adequate leak detection system), complies with all current and relevant EPA and IFC (International Fire Code) standards regarding secondary containment piping, and complies with ASME B31.3 protocol during installation. All of these regulatory considerations promote environmental protection and demonstrate the high quality of service the Double-See system delivers.

GF pipe is manufactured with tighter tolerances than required by the pipe standard. Use of pipe from other manufacturers may result in leaks. Only GF pipe should be used in the Double-See system.

System Components

All parts and fittings listed below are Schedule 80 PVC and CPVC. Schedule 40 PVC pressure pipes may be installed with this system if Schedule 40 PVC/CPVC is deemed an appropriate material for the desired application. All fittings are pre-fabricated and assembled in-house, and compatible with standard PVC and CPVC.

All material and size combinations are listed as *Primary × Secondary* (e.g., *1 × 3* refers to a 1" primary pipe size with a 3" secondary pipe).

Materials	PVC × PVC CPVC × PVC CPVC × CPVC	
Sizes (inch)	½ × 2 ¾ × 3 1 × 3 1½ × 4	2 × 4 3 × 6 4 × 8 6 × 10
Fittings	90° Elbow 45° Elbow Tee Closure Coupling Termination Fitting Test Termination Fitting Access Tee Access Tee (liquid tight)	Low Point Drain / High Point Vent Tee Leak Detection Drain/Vent Tee Pressure Rated Manual Ball Valve Pressure Rated Valve Tee Manual Valve Box* Manual Valve Box (external handle)* Actuated Valve Box* Flange/Union Box*

*Non-Pressure Rated

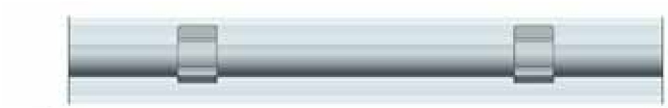
Installation Options

Double-See Vinyl Double Containment System offers the installer the flexibility of two joint assembly methods: Both methods use solvent cement for joining.

Simultaneous Joining Method

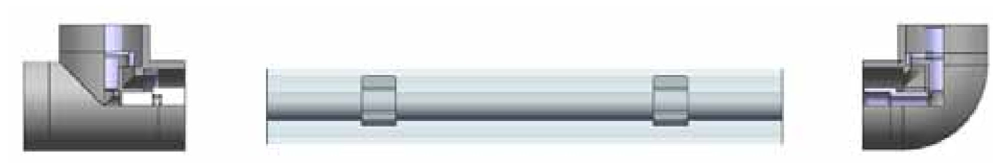
In the event that there is not enough space in a given installation for the implementation of the closure coupling joining method, or if the contractor deems that the closure coupling method is inappropriate for connecting a given joint, the installer may use the simultaneous joining method.

1. Pipe centralizers are pre-assembled to primary pipe and spaced according to pipe size.

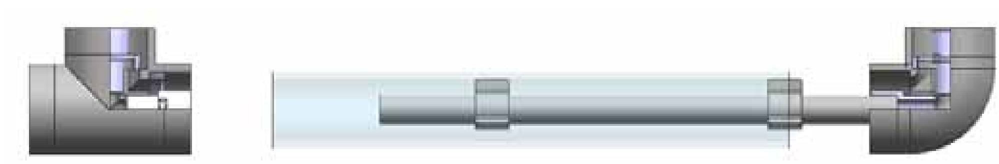


2. Cut primary and secondary pipes to size (using fitting length guidance marks). Pipes should be the same length.

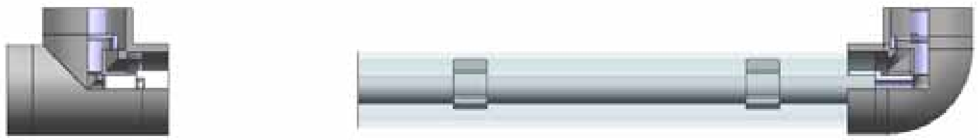
3. Align piping between fittings.



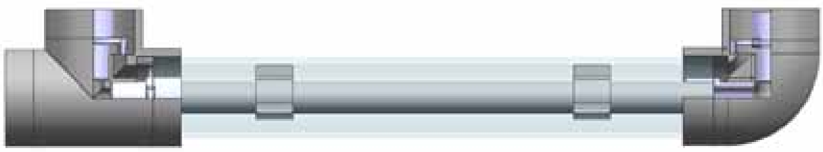
4. With primary pipe within the secondary pipe, cement primary into first fitting and insert into socket until pipe bottoms out.



5. Cement secondary pipe into first fitting and insert until pipe bottoms out.



6. Cement both the primary and secondary pipes into their respective sockets in the opposite fitting. Insert simultaneously and make sure both pipes are fully inserted until pipe bottoms out.



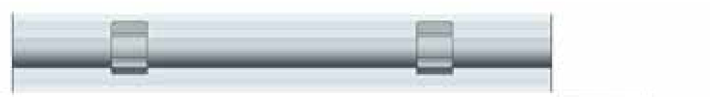
It is important to note that this method does not comply with B31.3 part 345.3.1 and may lead to more difficult repairs and adjustments of the primary pipe system.

However, if the contractor deems this to be an appropriate method, based on spatial or other limitations, simultaneous joining is a legitimate option that is frequently used in other double containment systems.

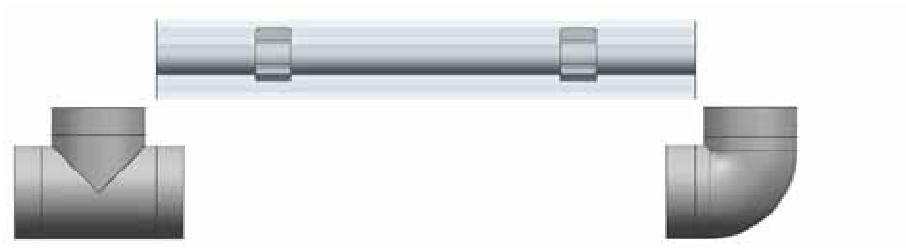
Closure Coupling Joining Method to Expose Primary Pipe for Pressure Testing

Note: It is recommended to use orange [CPVC] cement on closure couplings for color contrast.

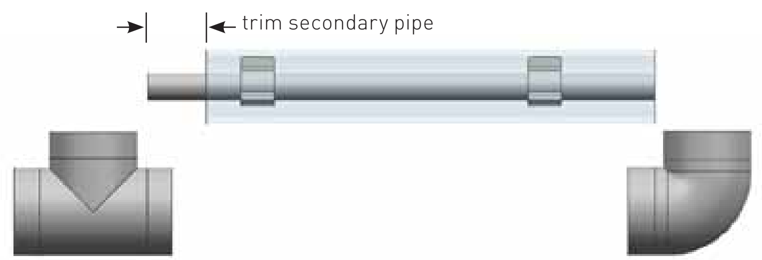
1. Pipe centralizers are pre-assembled to primary pipe and spaced according to pipe size.



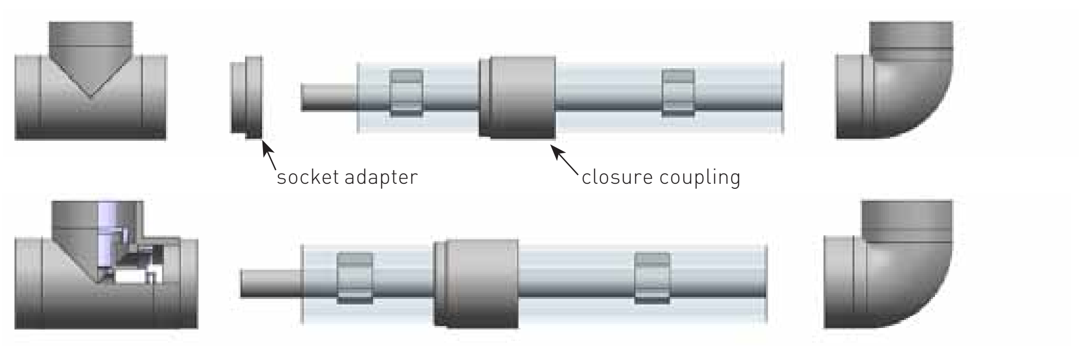
2. Insert primary pipe inside secondary pipe, and cut both pipes to size (using fitting length guidance marks)



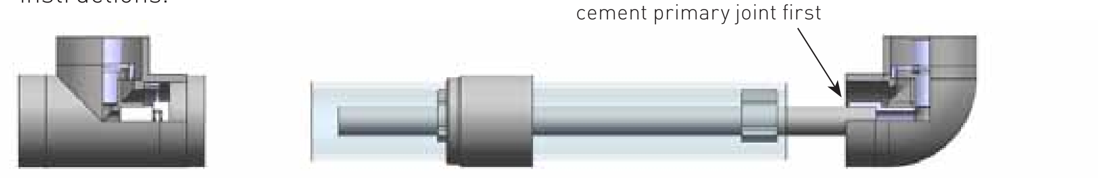
3. Trim secondary pipe so that it is shorter than the primary pipe. (Trim length is slightly less than the diameter of the secondary pipe and shown in chart on page 43.)



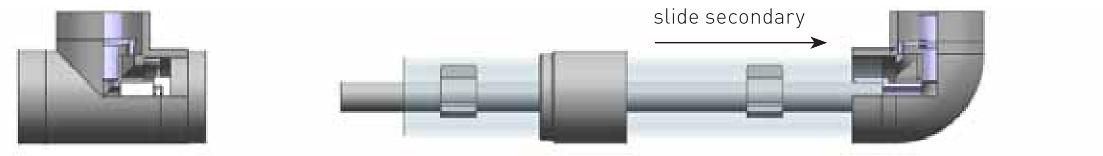
4. Slide closure coupling over secondary pipe (noting appropriate direction, and place socket adapter on fitting) and align piping between fittings.



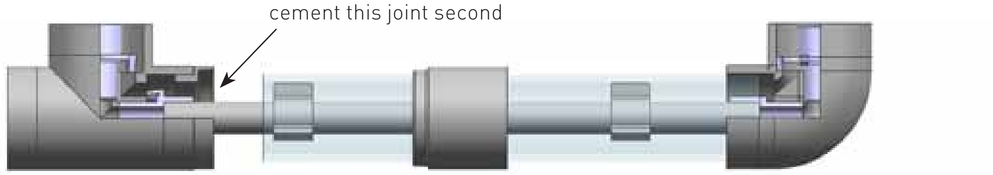
5. With primary pipe within the secondary pipe and closure coupling, prime and cement primary into first fitting and insert into socket until pipe bottoms out. Refer to page 31 for detailed solvent cement instructions.



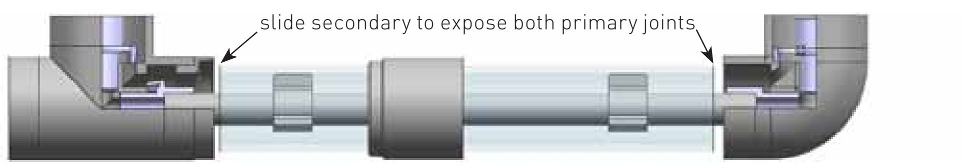
6. Without cementing the pipe, slide the secondary pipe into the secondary socket of the first (same) fitting.



7. Without moving secondary pipe, cement primary into second fitting (opposite) and insert into the socket until pipe bottoms out.

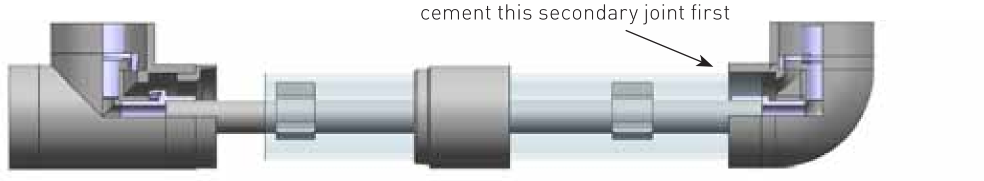


8. Slide the secondary pipe back out of the first fitting so that it is centered between the two fittings

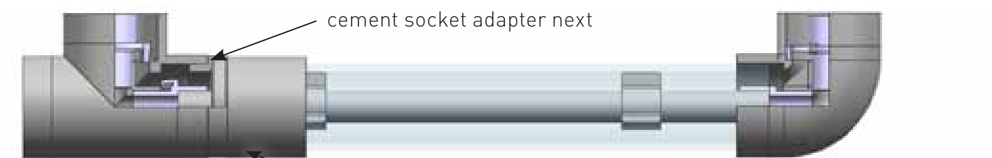


⚠ **Stop after this step for all connections. Perform appropriate pressure testing of the primary system while the DC system is in this configuration so that all primary pipe joints are exposed.**

9. After primary pressure testing, cement non-coupled end of secondary pipe to first fitting (note the orientation of the closure coupling)



10. Slide the closure coupling toward the finished joint, and slide the socket adapter into the fitting socket to expose the secondary pipe's end. Apply orange (CPVC) primer and cement to the socket adapter. Apply primer and cement to the exposed end of the secondary pipe and closure coupling. Slide the closure coupling into place to bridge the gap. Seal the coupling by applying a special two-part adhesive on the pipe side of the coupling. This side of the coupling has a large bevel area to receive the adhesive. Apply adhesive around the entire coupling, using the applicator tip, to completely fill the gap. Allow adhesive to cure 1–2 hours before pressure testing.



This method allows the installer to examine all primary joints during the pressure test, complying with Section B31.3 Part 345.3.1 of ASME Standard, which states:

> "All joints, welds (including structural attachment welds to pressure-containing components), and bonds shall be left uninsulated and exposed for examination during leak testing, except that joints previously tested in accordance with this Code may be insulated or covered. All joints may be primed and painted prior to leak testing unless a sensitive leak test (para.345.8) is required."

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Engineering Data

Material Data

Polyvinyl Chloride (PVC) and Chlorinated Polyvinyl Chloride (CPVC) are tough, lightweight, and flexible thermoplastics that are incredibly resistant to corrosion. PVC and CPVC pipe, fittings, and valves are suitable for over half of all applications pertaining to chemical processing and have been widely used in industry for over half of a century.

Our use of these materials in our double containment system not only provides the end-user with a high quality, durable system that will hold up to the long-term demands of the given application, but it also saves the end-user money by dramatically reducing installation and maintenance costs compared to other piping technologies.

PVC and CPVC are highly resistant to acids, alkalis, alcohols among other corrosive materials. For more specific details on the chemical resistancy of these vinyls, please consult the "Chemical Resistance Guide" at www.gfpiping.com, or contact your local GF sales representative.

With proper installation, PVC and CPVC are noted for their years of leak-free, maintenance-free service. These thermoplastics are not susceptible to rust, scaling, pitting, corroding, or electrolysis; when buried, they are not affected by galvanic corrosion or soil conditions. If piping is to be exposed to significant sunlight, GF recommends painting the exposed areas with two or more coats of white (or light-colored) water-base latex outdoor paint for added protection.

Pressure Rating – Primary Pipe

Determining pressure-stress pipe relationships

ISO Equation: The pressure rating of a pipe is determined by the circumferential stress which results from internal pressure. The relationship between internal pressure, circumferential stress, wall thickness, and diameter is governed by an ISO equation. In various forms this equation is:

$$P = \frac{2S}{R-1} = \frac{2St}{D_0-t} \qquad \frac{2S}{P} = \left(\frac{D_0}{t}\right) - 1$$

$$\frac{2S}{P} = R-1 \qquad S = \frac{P\,(R-1)}{2}$$

Where:
- P = Internal Pressure, psi
- S = Circumferential Stress, psi
- t = Wall Thickness, in.
- D_0 = Outside Pipe Diameter, in.
- R = D_0/t

Long-Term Strength: To determine the long-term strength of thermoplastic pipe, lengths of pipe are capped at both ends (see Fig. 1-C) and subjected to various internal pressures, to produce circumferential stresses that will produce failure within 10 to 10,000 hours. The test is run according to ASTM D 1598 — Standard Test for Time Hydrostatic Pressure.

The resulting failure points are used in a statistical analysis (outlined in ASTM D 2837) to determine the characteristic regression curve that represents the stress/time-to-failure relationship for the particular thermoplastic pipe compound under test. This curve is represented by the equation:

$$\text{Log } T = a + b \log S$$

Where:
a and b are constants describing the slope and intercept of the curve, and T and S are time-to-failure and stress, respectively.

The regression curve may be plotted on a log-log paper, as shown in the Regression Curve figure below, and extrapolated from 10,000 to 100,000 hours (11.4 years). The stress at 100,000 hours is known as the Long Term Hydrostatic Strength (LTHS) for that particular thermoplastic compound. From this (LTHS) the Hydrostatic Design Stress (HDS) is determined by applying the service factor multiplier, as shown on the next page.

Long-Term Strength Test per ASTM D-1598

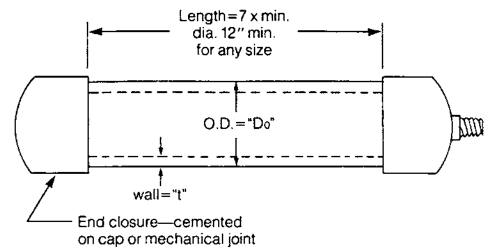
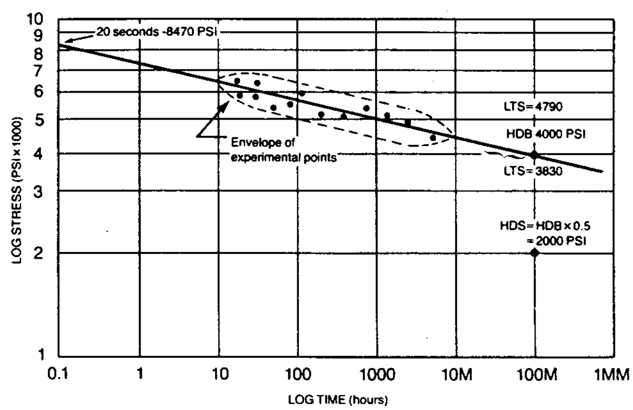


Figure 1-C

Pipe test specimen per ASTM D-1598 for "Time-to-Failure of Plastic Pipe Under Long-Term Hydrostatic Pressure"

Regression Curve — Stress/Time-to-Failure for PVC Type 1



Service Factor: The Hydrostatic Stress Committee of the Plastics Pipe Institute (PPI) has determined that a service (design) factor of one-half the Hydrostatic Design Basis would provide an adequate safety margin for use with water to ensure useful plastic-pipe service for a long period of time. While not stated in the standards, it is generally understood within the industry that this "service life" is a minimum of 50 years.

Accordingly, the standards for plastic pipe, using the 0.5 service factor, required that the pressure rating of the pipe be based upon this Hydrostatic Design Stress, again calculated with the ISO equation.

While early experience indicated that this service factor, or multiplier, of 0.5 provided adequate safety for many if not most uses, some experts felt that a more conservative service factor of 0.4 would better compensate for water hammer pressure surges, as well as for slight manufacturing variations and damage suffered during installation.

The PPI issued a statement recommending this 0.4 service factor. This is equivalent to recommending that the pressure rating of the pipe should equal 1.25 times the system design pressure for any particular installation. Based upon this calculation, many thousands of miles of thermoplastic pipe have been installed in the United States without failure.

While this service factor serves as a good general guideline, it is important to consider the actual surge conditions, as outlined later in this section. Additionally, reductions in working pressure should be considered when handling aggressive chemical solutions and in high-temperature service.

The table below shows numerical relationships for service factors and design stresses of PVC and CPVC.

Service Factors and Hydrostatic Design Stress (HDS)*

(Hydrostatic Design Basis equal 4000 psi) (27.6 MPa)

Service Factor	HDS
0.5	2000 psi (13.8 MPa)
0.4	1600 psi (11 MPa)

*Material: PVC Type I & CPVC

Maximum Pressures: The pressure ratings of thermoplastic pipe represent the maximum allowable operating pressure within a piping system for water at 73°F (22.8°C) based upon a service factor of 0.5.

Maximum Pressure Rating for Schedule 80 PVC/CPVC Pipe at 73°F

Size	PSI	Bar
½"	848	57.7
¾"	688	46.8
1"	630	42.9
1¼"	520	35.4
1½"	471	32.0
2"	404	27.5
2½"	425	28.9
3"	375	25.5
4"	324	22.0
6"	279	19.0
8"	246	16.7
10"	234	15.9
12"	228	15.5

External Pressures — Collapse Rating

Thermoplastic pipe is frequently specified for situations where uniform external pressures are applied to the pipe, such as underwater applications. In these applications, the collapse rating of the pipe determines the maximum permissible pressure differential between external and internal pressures. The basic formulas for collapsing external pressure applied uniformly to a long pipe are:

1. For thick wall pipe where collapse is caused by elastic instability of the pipe wall:

$$Pc = \frac{Ó}{2D_0^2}(D_0^2 - Di^2)$$

2. For thin wall pipe where collapse is caused by elastic instability of the pipe wall:

$$Pc = \frac{2cE}{1-v^2}\left(\frac{t}{Dm}\right)^3$$

Where:

- Pc = Collapse Pressure (external minus internal pressure), psi
- Ó = Compressive Strength, psi
- v = Poisson's Ratio
- E = Modulus of Elasticity, psi
- D_0 = Outside Pipe Diameter, in.
- Dm = Mean Pipe Diameter, in.
- Di = Inside Pipe Diameter, in.
- t = Wall Thickness, in.
- c = Out of Roundness Factor, Approximately 0.66

Choice of Formula: By using formula 2 on thick wall pipe an excessively large pressure will be obtained. It is therefore necessary to calculate, for a given pipe size, the collapse pressure using both formulas; use the lower value as a guide to safe working pressure. See the table "Short Term Collapse Pressure" (next page) for short term collapse pressures at 73°F. For long-term loading conditions, use appropriate long-term data.

Vacuum Service

As implied by the collapse rating, thermoplastic pipe is suitable for vacuum or negative pressure conditions that are found in many piping applications.

Laboratory tests have been conducted on Schedule 80 PVC pipe to determine performance under vacuum at temperatures above recommended operating conditions. A 6" pipe showed slight deformation at 165°F and 20 inches of mercury. Above this temperature, failure occurred due to thread deformation.

Conclusion: All sizes of Schedule 80 PVC and CPVC thermoplastic pipe are suitable for vacuum service up to 140°F and 30 inches of mercury. In addition, CPVC may be used up to 200°F. Solvent cemented joints are required for vacuum applications.

Short Term Collapse Pressure in psi at 73°F

½"	¾"	1"	1¼"	1½"	2"	3"	4"	6"	8"	10"	12"
Schedule 40 PVC											
2095	1108	900	494	358	211	180	109	54	39	27	29
Schedule 80 PVC/CPVC											
2772	2403	2258	1389	927	632	521	335	215	147	126	117

Note: These are short term ratings; long term should be reduced by ⅓ to ½ of the short term ratings.

Pressure Rating – Secondary Pipe

Secondary pipe systems that are installed using the simultaneous joining method are hydrostatically pressure rated at 50 psi.

Vent any entrapped air in the secondary piping system when hydrostatically testing, or if a primary system failure would result in pneumatic pressurization of secondary piping system.

Secondary systems with joints made using the closure coupling joining method use components that are molded to be fully pressure rated. However, as a safety precaution, these secondary components should only be pressure tested to 5 psi when tested pneumatically. Closure coupling installations are therefore pressure rated to 5 psi.

Valve, flange, and union boxes are liquid tight to contain the components they house, but they are not pressure rated.

For more information on pressure ratings and pressure testing, see the "Pressure Testing" section.

Water Hammer

Surge pressures due to water hammer are a major factor contributing to pipe failure in liquid transmission systems. A column of moving fluid within a pipeline, owing to its mass and velocity, contains stored energy. Since liquids are effectively incompressible, this energy cannot be absorbed by the fluid when a valve is suddenly closed.

The result is a high momentary pressure surge called water hammer. The five factors that determine the severity of water hammer are:

1. Velocity
   (The primary factor in excessive water hammer; see discussion of "Velocity" and "Safety Factor" below)
2. Modulus of elasticity of pipe material
3. Inside diameter of pipe
4. Wall thickness of pipe
5. Valve closing time

Maximum pressure surges caused by water hammer can be calculated by using the equation below. This surge pressure should be added to the existing line pressure to arrive at a maximum operating pressure figure.

$$Ps = V\left(\frac{E\,t\,3960}{E\,t + 3 \times 10^5 Di}\right)^{1/2}$$

Where:
- Ps = Surge Pressure, in psi
- V = Liquid Velocity, in feet per second
- Di = Inside Pipe Diameter, inch
- E = Modulus of Elasticity of Pipe Material, psi
- t = Wall Thickness, inch

Calculated surge pressure, which assumes instantaneous valve closure, can be calculated for any material using the values for E (Modulus of Elasticity).

However, to keep water hammer pressures within reasonable limits, it is common practice to design valves for closure times considerably greater than 2L/c.

$$Tc > \frac{2L}{c}$$

Where:
- Tc = Valve Closure Time, second
- L = Length of Pipe Run, feet
- c = Sonic Velocity of the Pressure Wave = 4720 ft/second

Velocity

Thermoplastic piping has been successfully installed in systems with a water velocity in excess of 10 feet per second. Thermoplastic pipe is not subject to erosion caused by high velocities and turbulent flow and in this respect is superior to metal piping systems, particularly where corrosive or chemically aggressive fluids are involved. The accepted industry position is that while the maximum safe water velocity in a thermoplastic piping system depends on the specific details of the system and the operating conditions, five feet per second is considered safe. Higher velocities may be used in systems where the operating characteristics of the valves and pumps are known and sudden changes in flow velocity can be controlled. It is important that the total pressure in the system at any time (operating plus surge or water hammer) not exceed 150 percent of the pressure rating for the system.

Safety Factor

Since the duration of any pressure surges due to water hammer is extremely short—seconds, or more likely, fractions of a second—the calculations used in determining the Safety Factor, the maximum fiber stress due to internal pressure must be compared to some very short-term strength value. Referring to the "Regression Curve" chart on page 36, it shows that the failure stress for very short time periods is very high when compared to the Hydrostatic Design Stress.

Using this premise, the calculation of Safety Factor may be based, very conservatively, on the 20-second strength value given in the "Regression Curve" chart (page 36)—8470 psi for PVC Type I.

A sample calculation is shown below, based upon the listed criteria:

Pipe = 1¼" Schedule 80 PVC I
O.D. = 1.660; Wall = 0.191

HDS = 2000 psi

The calculated surge pressure for 1¼" Schedule 80 PVC pipe at a velocity of 1 ft/sec. is 26.2 psi/ft/sec. (see next page)

Water Velocity = 5 feet per second
Static Pressure in System = 300 psi
Total System Pressure = Total Static + Surge Pressure

$$\begin{aligned} Pt &= P + PS \\ &= 300 + 5 \times 26.2 \\ &= 431.0 \text{ psi} \end{aligned}$$

Maximum circumferential stress is calculated from a variation of the ISO Equation:

$$S = \frac{Pt\,(D^{O} - t)}{2t} = \frac{431\,(1.660 - 191)}{2 \times 191} = 1657.4$$

$$\text{Safety Factor} = \frac{\text{20-second strength}}{\text{Maximum stress}} = \frac{8470}{1657} = 5.11$$

Surge Pressure, Ps in psi at 73°F

water velocity (ft./sec.)	½"	¾"	1"	1¼"	1½"	2"	3"	4"	6"	8"	10"	12"
Schedule 40 PVC												
1	27.9	25.3	24.4	22.2	21.1	19.3	18.9	17.4	15.5	14.6	13.9	13.4
2	55.8	50.6	48.8	44.4	42.2	38.6	37.8	34.8	31.0	29.2	27.8	26.8
3	83.7	75.9	73.2	66.6	63.3	57.9	56.7	52.2	46.5	43.8	41.7	40.2
4	111.6	101.2	97.6	88.8	84.4	77.2	75.6	69.6	62.0	58.4	55.6	53.6
5	139.5	126.5	122.0	111.0	105.5	96.5	94.5	87.0	77.5	73.0	69.5	67.0
6	167.4	151.8	146.4	133.2	126.6	115.8	113.4	104.4	93.0	87.6	83.4	80.4
Schedule 80 PVC/CPVC												
1	32.9	29.9	28.7	26.2	25.0	23.2	22.4	20.9	19.4	18.3	17.3	17.6
2	65.6	59.8	57.4	52.4	50.0	46.4	44.8	41.8	38.8	36.6	35.6	35.2
3	98.7	89.7	86.1	78.6	75.0	69.6	67.2	62.7	58.2	59.9	53.4	52.8
4	131.6	119.6	114.8	104.8	107.0	92.8	89.6	83.6	77.6	73.2	71.2	70.4
5	164.5	149.5	143.5	131.0	125.0	116.3	112.0	104.5	97.0	91.5	89.0	88.0
6	197.4	179.4	172.2	157.2	150.0	133.2	134.4	125.4	116.4	109.8	106.8	105.6

The "Safety Factors vs. Service Factors" table (see below) gives the results of Safety Factor calculations based upon Service Factors of 0.5 and 0.4 for the 1¼" PVC I Schedule 80 pipe of the example shown on the previous page using the full pressure rating calculated from the listed Hydrostatic Design Stress. In each case, the Hydrostatic Design Basis = 4000 psi, and the water velocity = 5 feet per second.

Safety Factors vs. Service Factors — PVC Type I Thermoplastic Pipe

Pipe Class	Service Factor	HDS, psi	Pressure Rating psi	Surge Pressure at 5 ft./sec.	Maximum Pressure psi	Maximum Stress psi	Safety Factor
1¼" Sch. 80	0.5	2000	520	131.0	651.0	2503.5	3.38
1¼" Sch. 80	0.4	1600	416	131.0	547.0	2103.5	4.03

Pressure Rating values are for PVC I pipe, and for most sizes are calculated from the experimentally determined Long Term Strength of PVC I extrusion compounds. Because molding compounds may differ in Long Term Strength and elevated temperature properties from pipe compounds, piping systems consisting of extruded pipe and molded fittings may have lower pressure ratings than those shown here, particularly at the higher temperatures. Caution should be exercised in design of systems operating above 100°F.

Comparing Safety Factors for this 1¼" Schedule 80 pipe at different Service Factors, it is should be noted that changing from a Service Factor of 0.5 to a more conservative 0.4 increases the Safety Factor only by 16%.

Cyclic Fatigue in Vinyl Piping Systems

When discussing water hammer or pressure surge in a piping system, one should also be aware of a failure mode termed "Cyclic Fatigue." A piping system that has frequent and significant changes in flow conditions or pressure, creating a fluctuating surge, can have an effect on the structural integrity of a thermoplastic fitting. This condition has been observed in golf course irrigation systems that experience tens of thousands of water pressure surges over the course of a year. The resultant failure from cyclic fatigue is very similar in appearance to long-term static failure and it may be very difficult to ascertain the exact cause of such failures.

However, the design engineer should consider this phenomenon when designing a GF Piping System with frequent pressure changes, particularly if the surge pressure exceeds 50% of the systems working pressure. Based on some testing by Keller-Bliesener Engineering, the engineer may want to consider devaluing the fitting by 40% from the published pipe burst pressure. Keeping the flow velocity to 5 fps or less will also have an effect on pressure surges. Other considerations would be to use actuated valves that can be set to provide a slow opening or to install "soft start" pumps, as both of these will limit the water hammer and the resultant pressure surges.

Temperature-Pressure Relationship

Pressure ratings for thermoplastic pipe are generally determined using water at room temperature (73°F). As the system temperature increases, the thermoplastic pipe becomes more ductile, increases in impact strength and decreases in tensile strength. The pressure ratings of thermoplastic pipe must, therefore, be decreased accordingly.

The effects of temperature have been exhaustively studied and correction (derating) factors developed for each thermoplastic piping material. To determine the maximum operating pressure at any given temperature, multiply the pressure rating for the pipe size and type found in the following table by the temperature derating factor (f).

Solvent-Welded Pressure Rating vs. Service Temperature — PVC and CPVC

Nom. Size (inch)	D Outside Dia	t Wall	DR = D/t	P																	
				32–73°F		90°F		100°F		110°F		120°F		130°F		140°F		150°F	160°F	180°F	200°F
				PVC	CPVC	PVC	CPVC	PVC	CPVC	PVC	CPVC	PVC	CPVC	PVC	CPVC	PVC	CPVC	CPVC	CPVC	CPVC	CPVC
				f=1.00	f=1.00	f=0.75	f=0.92	f=0.62	f=0.85	f=0.50	f=0.77	f=0.40	f=0.70	f=0.30	f=0.62	f=0.22	f=0.55	f=0.47	f=0.40	f=0.25	f=0.18
				s=2000	s=2000	s=1500	s=1840	s=1240	s=1700	s=1000	s=1540	s=800	s=1400	s=600	s=1240	s=440	s=1000	s=940	s=800	s=500	s=400
½	0.84	0.15	5.71	848	848	636	780	526	721	424	653	339	594	254	526	187	466	399	339	212	153
¾	1.05	0.15	6.82	688	688	516	633	426	585	344	530	275	482	206	427	151	378	323	275	172	124
1	1.32	0.18	7.35	630	630	473	580	390	536	315	485	252	441	189	391	139	347	296	252	158	113
1¼	1.66	0.19	8.69	520	520	390	478	322	442	260	400	208	364	156	322	114	286	244	208	130	94
1½	1.90	0.20	9.50	471	471	353	433	292	400	236	363	188	330	141	292	104	259	221	188	118	85
2	2.38	0.22	10.89	404	404	303	372	251	343	202	311	162	283	121	250	89	222	190	162	101	73
2½	2.88	0.28	10.42	425	425	319	391	263	361	213	327	170	298	128	264	94	234	200	170	106	77
3	3.50	0.30	11.67	375	375	281	345	233	319	188	289	150	263	113	233	83	206	176	150	94	68
4	4.50	0.34	13.35	324	324	243	298	201	275	162	249	130	227	97	201	71	178	152	130	81	58
6	6.63	0.43	16.34	279	279	209	257	173	237	140	215	112	195	84	173	61	153	131	112	70	50
8	8.63	0.50	17.25	246	246	185	226	153	209	123	189	98	172	74	153	54	135	116	98	62	44
10	10.75	0.59	18.13	234	234	175	215	145	199	117	180	94	164	70	145	51	129	110	94	59	42
12	12.75	0.69	18.56	228	228	171	210	141	194	114	176	91	160	68	141	51	125	107	91	57	41

$$P = \frac{2St}{D-t} = \frac{2S}{DR-1} = P_{73°F}f$$

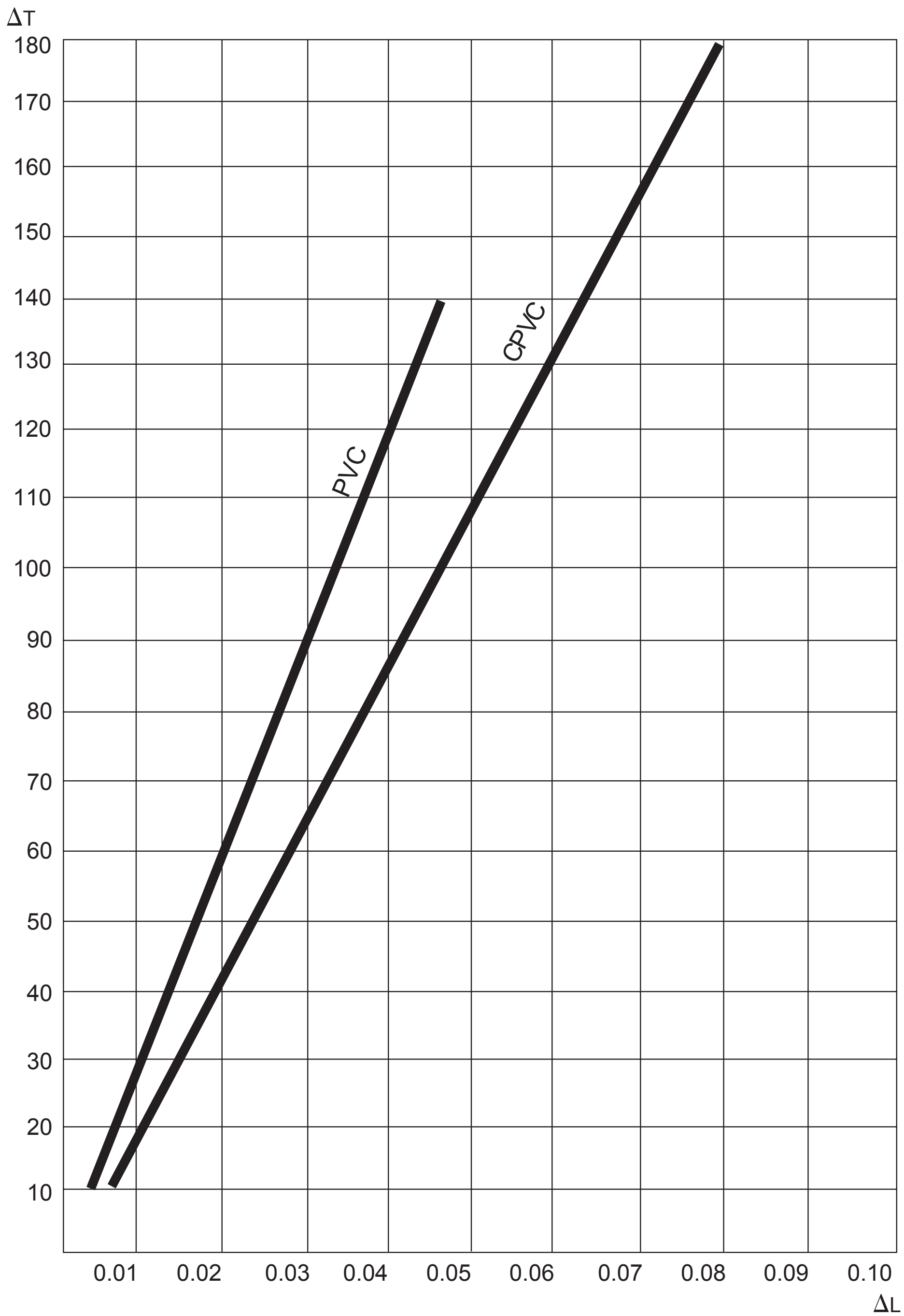
P = Pressure rating of pipe at service temperatures (psi)
S = Hydrostatic design stress (psi)
D = Outside diameter of pipe (inches)

1) Figures for pressure rating at 73°F are rounded off from actual calculated values. Pressure ratings for other temperatures are calculated from 73°F values.
2) Pressure rating values are for PVC (12454) and CPVC (24448) pipe and for most sizes are calculated from the experimentally determined long-term strength of PVC and CPVC extrusion compounds. Because molding compounds may differ in long-term strength and elevated temperature properties from pipe compounds, piping systems consisting of extruded pipe and molded fittings may have lower pressure ratings than those shown here, particularly at the higher temperatures. Caution should be exercised when designing PVC systems operating above 100°F and CPVC systems operating above 180°F.
3) The pressure ratings given are for solvent-cemented systems. When adding valves, flanges or other components, the system must be derated to the rating of the lowest component. (Pressure ratings: molded or cut threads are rated at 50% of solvent-cemented systems; flanges and unions are 150 psi; for valves, see manufacturer's recommendation.)
4) Not recommended for use below 32°F

Thermal Expansion and Contraction

Thermoplastics exhibit a relatively high coefficient of thermal expansion—up to ten times that of steel. Because of this, installers must consider expansion due to temperature change when designing plastic piping systems, particularly over long runs. One of the key features of Double-See is the ability to absorb a certain amount of thermal expansion within each fitting due to the unique flexible centralizer design. If expansion is greater than this amount, expansion loops—which are covered in the following pages—must be installed to compensate for temperature changes to the system. Common examples of temperature fluctuations in the system that may require such consideration are the difference between installation and working temperatures, and the difference between summer and winter temperature extremes.

Linear Expansion and Contraction



Change in Pipe Length (Inches/Foot)

Coefficient of Thermal Linear Expansion

PVC = 2.8×10^{-5} in/in/°F
CPVC = 3.4×10^{-5} in/in/°F

To Calculate:

ΔL = Change in pipe length due to thermal changes.

L = Straight runs of pipe with no changes in direction.

Y = Coefficient of thermal expansion (see above).

ΔT = maximum change in temperature between installation and operation (T MAX.–T. MIN.)

$\Delta L = Y \times L \times \Delta T$

Example:

- A system has 350 feet (4,200") of straight run (L) with no direction change.
- Pipe material is CPVC. Coefficient (Y) is 3.4×10^{-5} (0.000034").
- Pipe is installed at an ambient temperature of 60°F. Maximum anticipated operating temperature is 140°F. The difference (ΔT) is 80°F.

$\Delta L = 0.000034 \times 4200 \times 80$

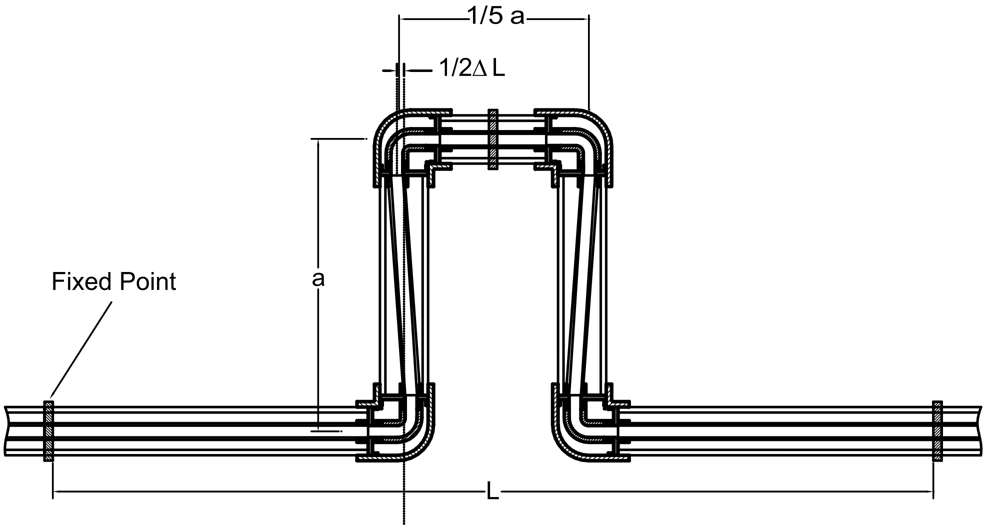
ΔL = 11.4" of linear expansion in 350 ft. in pipe.

PVC Thermal Expansion Calculation/Charts

The following formula yields the change in length of a PVC primary pipe caused by thermal expansion/contraction with temperature change.

Expansion Formula: $\Delta l = L \times \Delta T \times \partial$			
Expansion [in]	Length Run [in]	Change in Temperature	Expansion Coefficient
Δl	L	ΔT	∂
PVC: ∂ = 0.000028 in/in F			

The tables listed on the succeeding pages are derived from this formula and give the specific thermal expansion data for each size of the Double-See system. If two fittings can acceptably absorb the thermal expansion between them, the value for Δ L is shaded in. If, however, the calculated expansion of the primary pipe is too great to be absorbed by the inherent flex of the centralizers and fittings, the ΔL value is shown in white (un-shaded). Length and temperature combinations that fall in the white area of the charts require an expansion loop to compensate for the change in pipe length. This allows the primary pipe system to expand/contract without damaging the system. The value "a" (listed on the right of the expansion values in white) relates to the dimensions of each expansion loop, as pictured below:



Note that "L" is the distance between two fixed points. Install expansion loops in runs so they are centered between the fixed points on either end. Expansion loops may require their own, additional support when installed above-ground.

½ × 2 PVC

Distance Between Fittings (L) [ft]	Expansion [inches]																			
	ΔT [F]																			
	10°		20°		30°		40°		50°		60°		70°		80°		90°		100°	
	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a
10	0.03		0.07		0.10		0.13		0.17		0.20		0.24		0.27		0.30		0.34	
20	0.07		0.13		0.20		0.27		0.34		0.40		0.47		0.54		0.60		0.67	
30	0.10		0.20		0.30		0.40		0.50		0.60		0.71		0.81	17.86	0.91	18.94	1.01	19.97
40	0.13		0.27		0.40		0.54		0.67		0.81	17.86	0.94	19.29	1.08	20.62	1.21	21.87	1.34	23.06
50	0.17		0.34		0.50		0.67		0.84	18.23	1.01	19.97	1.18	21.57	1.34	23.06	1.51	24.46	1.68	25.78
60	0.20		0.40		0.60		0.81	17.86	1.01	19.97	1.21	21.87	1.41	23.63	1.61	25.26	1.81	26.79	2.02	28.24
70	0.24		0.47		0.71		0.94	19.29	1.18	21.57	1.41	23.63	1.65	25.52	1.88	27.28	2.12	28.94	2.35	30.50
80	0.27		0.54		0.81	17.86	1.08	20.62	1.34	23.06	1.61	25.26	1.88	27.28	2.15	29.16	2.42	30.93	2.69	32.61
90	0.30		0.60		0.91	18.94	1.21	21.87	1.51	24.46	1.81	26.79	2.12	28.94	2.42	30.93	2.72	32.81	3.02	34.59
100	0.34		0.67		1.01	19.97	1.34	23.06	1.68	25.78	2.02	28.24	2.35	30.50	2.69	32.61	3.02	34.59	3.36	36.46

Shaded area = expansion absorption between two ½"× 2" PVC fittings. No expansion loop required.

White area = expansion loop necessary; first number is expansion value (ΔL); second number is length of section "a" of expansion loop

Theoretical maximum distance per fitting 0.42"

0.425 × 2 = .85"

0.85 × 90% = 0.77" maximum movement (absorption of expansion) between two fittings

¾ × 3 PVC

Distance Between Fittings (L) [ft]	Expansion [inches]																			
	ΔT [F]																			
	10°		20°		30°		40°		50°		60°		70°		80°		90°		100°	
	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a
10	0.03		0.07		0.10		0.13		0.17		0.20		0.24		0.27		0.30		0.34	
20	0.07		0.13		0.20		0.27		0.34		0.40		0.47		0.54		0.60		0.67	
30	0.10		0.20		0.30		0.40		0.50		0.60		0.71		0.81		0.91		1.01	
40	0.13		0.27		0.40		0.54		0.67		0.81		0.94		1.08		1.21		1.34	
50	0.17		0.34		0.50		0.67		0.84		1.01		1.18		1.34		1.51		1.68	28.82
60	0.20		0.40		0.60		0.81		1.01		1.21		1.41		1.61	28.21	1.81	29.92	2.02	31.60
70	0.24		0.47		0.71		0.94		1.18		1.41		1.65	28.56	1.88	30.49	2.12	32.38	2.35	34.09
80	0.27		0.54		0.81		1.08		1.34		1.61	28.21	1.88	30.49	2.15	32.60	2.42	34.59	2.69	36.47
90	0.30		0.60		0.91		1.21		1.51		1.81	29.92	2.12	32.38	2.42	34.59	2.72	36.67	3.02	38.64
100	0.34		0.67		1.01		1.34		1.68	28.82	2.02	31.60	2.35	34.09	2.69	36.47	3.02	38.64	3.36	40.76

Shaded area = expansion absorption between two ¾" × 3" PVC fittings. No expansion loop required.

White area = expansion loop necessary; first number is expansion value (ΔL); second number is length of section "a" of expansion loop

Theoretical maximum distance per fitting 0.86"

0.86 × 2 = 1.72"

1.72 × 90% = 1.55" maximum movement (absorption of expansion) between two fittings

1 × 3 PVC

Distance Between Fittings (L) [ft]	Expansion [inches]																			
	ΔT [F]																			
	10°		20°		30°		40°		50°		60°		70°		80°		90°		100°	
	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a
10	0.03		0.07		0.10		0.13		0.17		0.20		0.24		0.27		0.30		0.34	
20	0.07		0.13		0.20		0.27		0.34		0.40		0.47		0.54		0.60		0.67	
30	0.10		0.20		0.30		0.40		0.50		0.60		0.71		0.81		0.91		1.01	
40	0.13		0.27		0.40		0.54		0.67		0.81		0.94		1.08		1.21		1.34	28.81
50	0.17		0.34		0.50		0.67		0.84		1.01		1.18		1.34	28.81	1.51	30.58	1.68	32.25
60	0.20		0.40		0.60		0.81		1.01		1.21		1.41	29.55	1.61	31.57	1.81	33.48	2.02	35.37
70	0.24		0.47		0.71		0.94		1.18		1.41	29.55	1.65	31.96	1.88	34.12	2.12	36.23	2.35	38.15
80	0.27		0.54		0.81		1.08		1.34	28.81	1.61	31.57	1.88	34.12	2.15	36.49	2.42	38.71	2.69	40.81
90	0.30		0.60		0.91		1.21		1.51	30.58	1.81	33.48	2.12	36.23	2.42	38.71	2.72	41.04	3.02	43.24
100	0.34		0.67		1.01		1.34	28.81	1.68	32.25	2.02	35.37	2.35	38.15	2.69	40.81	3.02	43.24	3.36	45.61

Shaded area = expansion absorption between two 1" × 3" PVC fittings. No expansion loop required.

White area = expansion loop necessary; first number is expansion value (ΔL); second number is length of section "a" of expansion loop

Theoretical maximum distance per fitting 0.70"

0.70 × 2 = 1.40"

1.40 × 90%= 1.26" maximum movement (absorption of expansion) between two fittings

1½ × 4 PVC

Distance Between Fittings (L) [ft]	Expansion [inches]																			
	ΔT [F]																			
	10°		20°		30°		40°		50°		60°		70°		80°		90°		100°	
	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a
10	0.03		0.07		0.10		0.13		0.17		0.20		0.24		0.27		0.30		0.34	
20	0.07		0.13		0.20		0.27		0.34		0.40		0.47		0.54		0.60		0.67	
30	0.10		0.20		0.30		0.40		0.50		0.60		0.71		0.81		0.91		1.01	
40	0.13		0.27		0.40		0.54		0.67		0.81		0.94		1.08		1.21		1.34	
50	0.17		0.34		0.50		0.67		0.84		1.01		1.18		1.34		1.51		1.68	
60	0.20		0.40		0.60		0.81		1.01		1.21		1.41		1.61		1.81		2.02	42.51
70	0.24		0.47		0.71		0.94		1.18		1.41		1.65		1.88	41.01	2.12	43.55	2.35	45.85
80	0.27		0.54		0.81		1.08		1.34		1.61		1.88	41.01	2.15	43.86	2.42	46.53	2.69	49.06
90	0.30		0.60		0.91		1.21		1.51		1.81		2.12	43.55	2.42	46.53	2.72	49.33	3.02	51.98
100	0.34		0.67		1.01		1.34		1.68		2.02	42.51	2.35	45.85	2.69	49.06	3.02	51.98	3.36	54.83

Shaded area = expansion absorption between two 1½" × 4" PVC fittings. No expansion loop required.

White area = expansion loop necessary; first number is expansion value (ΔL); second number is length of section "a" of expansion loop

Theoretical maximum distance per fitting 1.04"

1.04 × 2 = 2.08"

2.08 × 90% = 1.87" maximum movement (absorption of expansion) between two fittings

2 × 4 PVC

Distance Between Fittings (L) [ft]	Expansion [inches]																			
	ΔT [F]																			
	10°		20°		30°		40°		50°		60°		70°		80°		90°		100°	
	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a
10	0.03		0.07		0.10		0.13		0.17		0.20		0.24		0.27		0.30		0.34	
20	0.07		0.13		0.20		0.27		0.34		0.40		0.47		0.54		0.60		0.67	
30	0.10		0.20		0.30		0.40		0.50		0.60		0.71		0.81		0.91		1.01	
40	0.13		0.27		0.40		0.54		0.67		0.81		0.94		1.08		1.21		1.34	38.71
50	0.17		0.34		0.50		0.67		0.84		1.01		1.18		1.34	38.71	1.51	41.09	1.68	43.35
60	0.20		0.40		0.60		0.81		1.01		1.21	36.79	1.41	39.71	1.61	42.43	1.81	44.99	2.02	47.53
70	0.24		0.47		0.71		0.94		1.18	36.33	1.41	39.71	1.65	42.96	1.88	45.85	2.12	48.69	2.35	51.27
80	0.27		0.54		0.81		1.08		1.34	38.71	1.61	42.43	1.88	45.85	2.15	49.04	2.42	52.02	2.69	54.85
90	0.30		0.60		0.91		1.21	36.79	1.51	41.09	1.81	44.99	2.12	48.69	2.42	52.02	2.72	55.15	3.02	58.12
100	0.34		0.67		1.01		1.34	38.71	1.68	43.35	2.02	47.53	2.35	51.27	2.69	54.85	3.02	58.12	3.36	61.30

Shaded area = expansion absorption between two 2" × 4" PVC fittings. No expansion loop required.

White area = expansion loop necessary; first number is expansion value (ΔL); second number is length of section "a" of expansion loop

Theoretical maximum distance per fitting 0.635"

0.635 × 2 = 1.27"

1.27 × 90% = 1.14" maximum movement (absorption of expansion) between two fittings

3 × 6 PVC

Distance Between Fittings (L) [ft]	Expansion [inches]																			
	ΔT [F]																			
	10°		20°		30°		40°		50°		60°		70°		80°		90°		100°	
	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a
10	0.03		0.07		0.10		0.13		0.17		0.20		0.24		0.27		0.30		0.34	
20	0.07		0.13		0.20		0.27		0.34		0.40		0.47		0.54		0.60		0.67	
30	0.10		0.20		0.30		0.40		0.50		0.60		0.71		0.81		0.91		1.01	
40	0.13		0.27		0.40		0.54		0.67		0.81		0.94		1.08		1.21		1.34	
50	0.17		0.34		0.50		0.67		0.84		1.01		1.18		1.34		1.51		1.68	
60	0.20		0.40		0.60		0.81		1.01		1.21		1.41		1.61		1.81	54.62	2.02	57.70
70	0.24		0.47		0.71		0.94		1.18		1.41		1.65		1.88	55.66	2.12	59.11	2.35	62.23
80	0.27		0.54		0.81		1.08		1.34		1.61		1.88	55.66	2.15	59.53	2.42	63.15	2.69	66.58
90	0.30		0.60		0.91		1.21		1.51		1.81	54.62	2.12	59.11	2.42	63.15	2.72	66.95	3.02	70.55
100	0.34		0.67		1.01		1.34		1.68		2.02	57.70	2.35	62.23	2.69	66.58	3.02	70.55	3.36	74.42

Shaded area = expansion absorption between two 3" × 6" PVC fittings. No expansion loop required.

White area = expansion loop necessary; first number is expansion value (ΔL); second number is length of section "a" of expansion loop

Theoretical maximum distance per fitting 0.965"

0.965 × 2 = 1.93"

1.93 × 90% = 1.74" maximum movement (absorption of expansion) between two fittings

4 × 8 PVC

Distance Between Fittings (L) [ft]	Expansion [inches]																			
	ΔT [F]																			
	10°		20°		30°		40°		50°		60°		70°		80°		90°		100°	
	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a
10	0.03		0.07		0.10		0.13		0.17		0.20		0.24		0.27		0.30		0.34	
20	0.07		0.13		0.20		0.27		0.34		0.40		0.47		0.54		0.60		0.67	
30	0.10		0.20		0.30		0.40		0.50		0.60		0.71		0.81		0.91		1.01	
40	0.13		0.27		0.40		0.54		0.67		0.81		0.94		1.08		1.21		1.34	
50	0.17		0.34		0.50		0.67		0.84		1.01		1.18		1.34		1.51		1.68	
60	0.20		0.40		0.60		0.81		1.01		1.21		1.41		1.61		1.81		2.02	
70	0.24		0.47		0.71		0.94		1.18		1.41		1.65		1.88		2.12		2.35	
80	0.27		0.54		0.81		1.08		1.34		1.61		1.88		2.15		2.42		2.69	75.50
90	0.30		0.60		0.91		1.21		1.51		1.81		2.12		2.42		2.72	75.92	3.02	80.00
100	0.34		0.67		1.01		1.34		1.68		2.02		2.35		2.69	75.50	3.02	80.00	3.36	84.38

Shaded area = expansion absorption between two 4" × 8" PVC fittings. No expansion loop required.

White area = expansion loop necessary; first number is expansion value (ΔL); second number is length of section "a" of expansion loop

Theoretical maximum distance per fitting 1.36"

1.36 × 2 = 2.72"

2.72 × 90% = 2.45" maximum movement (absorption of expansion) between two fittings

6 × 10 PVC

Distance Between Fittings (L) [ft]	Expansion [inches]																			
	ΔT [F]																			
	10°		20°		30°		40°		50°		60°		70°		80°		90°		100°	
	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a
10	0.03		0.07		0.10		0.13		0.17		0.20		0.24		0.27		0.30		0.34	
20	0.07		0.13		0.20		0.27		0.34		0.40		0.47		0.54		0.60		0.67	
30	0.10		0.20		0.30		0.40		0.50		0.60		0.71		0.81		0.91		1.01	
40	0.13		0.27		0.40		0.54		0.67		0.81		0.94		1.08		1.21		1.34	
50	0.17		0.34		0.50		0.67		0.84		1.01		1.18		1.34		1.51		1.68	
60	0.20		0.40		0.60		0.81		1.01		1.21		1.41		1.61		1.81		2.02	
70	0.24		0.47		0.71		0.94		1.18		1.41		1.65		1.88		2.12		2.35	85.62
80	0.27		0.54		0.81		1.08		1.34		1.61		1.88		2.15		2.42	86.89	2.69	91.61
90	0.30		0.60		0.91		1.21		1.51		1.81		2.12		2.42	86.89	2.72	92.12	3.02	97.06
100	0.34		0.67		1.01		1.34		1.68		2.02		2.35	85.62	2.69	91.61	3.02	97.06	3.36	102.38

Shaded area = expansion absorption between two 1½" × 4" PVC fittings. No expansion loop required.

White area = expansion loop necessary; first number is expansion value (ΔL); second number is length of section "a" of expansion loop

Theoretical maximum distance per fitting 1.23"

1.23 × 2 = 2.46"

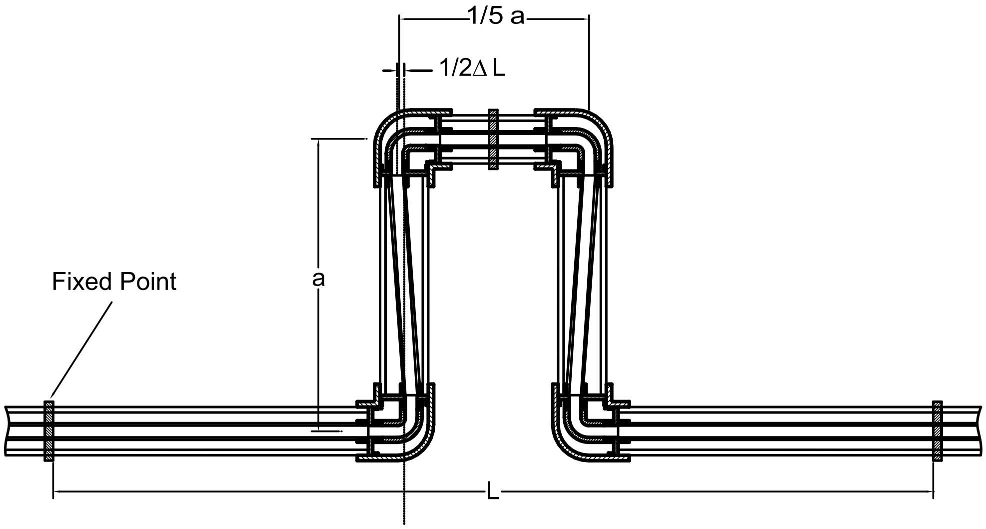
2.46 × 90% = 2.21" maximum movement (absorption of expansion) between two fittings

CPVC Thermal Expansion Calculation/Charts

The following formula yields the change in length of a CPVC primary pipe caused by thermal expansion/ contraction with temperature change.

Expansion Formula: $\Delta l = L \times \Delta T \times \partial$			
Expansion [in]	Length Run [in]	Change in Temperature	Expansion Coefficient
Δl	L	ΔT	∂
CPVC: ∂ = 0.000034 in/in F			

The tables listed on the succeeding pages are derived from this formula and give the specific thermal expansion data for each size of the Double-See system. If two fittings can acceptably absorb the thermal expansion between them, the value for Δ L is shaded in. If, however, the calculated expansion of the primary pipe is too great to be absorbed by the inherent flex of the centralizers and fittings, the ΔL value is shown in white (un-shaded). Length and temperature combinations that fall in the white area of the charts require an expansion loop to compensate for the change in pipe length. This allows the primary pipe system to expand/contract without damaging the system. The value "a" (listed on the right of the expansion values in white) relates to the dimensions of each expansion loop, as pictured below:



Note that "L" is the distance between two fixed points. Install expansion loops in runs so they are centered between the fixed points on either end. Expansion loops may require their own, additional support when installed above-ground.

½ × 2 CPVC

Distance Between Fittings (L) [ft]	Expansion [inches]																			
	ΔT [F]																			
	10°		20°		30°		40°		50°		60°		70°		80°		90°		100°	
	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a
10	0.04		0.08		0.12		0.16		0.20		0.24		0.29		0.33		0.37		0.41	
20	0.08		0.16		0.24		0.33		0.41		0.49		0.57		0.65		0.73		0.82	17.97
30	0.12		0.24		0.37		0.49		0.61		0.73		0.86	18.41	0.98	19.68	1.10	20.87	1.22	22.00
40	0.16		0.33		0.49		0.65		0.82	17.97	0.98	19.68	1.14	21.26	1.31	22.73	1.47	24.10	1.63	25.41
50	0.20		0.41		0.61		0.82	17.97	1.02	20.09	1.22	22.00	1.43	23.77	1.63	25.41	1.84	26.95	2.04	28.41
60	0.24		0.49		0.73		0.98	19.68	1.22	22.00	1.47	24.10	1.71	26.03	1.96	27.83	2.20	29.52	2.45	31.12
70	0.29		0.57		0.86	18.41	1.14	21.26	1.43	23.77	1.71	26.03	2.00	28.12	2.28	30.06	2.57	31.89	2.86	33.61
80	0.33		0.65		0.98	19.68	1.31	22.73	1.63	25.41	1.96	27.83	2.28	30.06	2.61	32.14	2.94	34.09	3.26	35.93
90	0.37		0.73		1.10	20.87	1.47	24.10	1.84	26.95	2.20	29.52	2.57	31.89	2.94	34.09	3.30	36.16	3.67	38.11
100	0.41		0.82	17.97	1.22	22.00	1.63	25.41	2.04	28.41	2.45	31.12	2.86	33.61	3.26	35.93	3.67	38.11	4.08	40.17

Shaded area = expansion absorption between two ½" × 2" CPVC fittings. No expansion loop required.

White area = expansion loop necessary; first number is expansion value (ΔL); second number is length of section "a" of expansion loop

Theoretical maximum distance per fitting 0.42"

0.425 × 2 = .85"

0.85 × 90% = 0.77" maximum movement (absorption of expansion) between two fittings

¾ × 3 CPVC

Distance Between Fittings (L) [ft]	Expansion [inches]																			
	ΔT [F]																			
	10°		20°		30°		40°		50°		60°		70°		80°		90°		100°	
	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a
10	0.04		0.08		0.12		0.16		0.20		0.24		0.29		0.33		0.37		0.41	
20	0.08		0.16		0.24		0.33		0.41		0.49		0.57		0.65		0.73		0.82	
30	0.12		0.24		0.37		0.49		0.61		0.73		0.86		0.98		1.10		1.22	
40	0.16		0.33		0.49		0.65		0.82		0.98		1.14		1.31		1.47		1.63	28.39
50	0.20		0.41		0.61		0.82		1.02		1.22		1.43		1.63	28.39	1.84	30.16	2.04	31.76
60	0.24		0.49		0.73		0.98		1.22		1.47		1.71	29.08	1.96	31.13	2.20	32.98	2.45	34.80
70	0.29		0.57		0.86		1.14		1.43		1.71	29.08	2.00	31.45	2.28	33.58	2.57	35.65	2.86	37.60
80	0.33		0.65		0.98		1.31		1.63	28.39	1.96	31.13	2.28	33.58	2.61	35.92	2.94	38.13	3.26	40.15
90	0.37		0.73		1.10		1.47		1.84	30.16	2.20	32.98	2.57	35.65	2.94	38.13	3.30	40.39	3.67	42.60
100	0.41		0.82		1.22		1.63	28.39	2.04	31.76	2.45	34.80	2.86	37.60	3.26	40.15	3.67	42.60	4.08	44.91

Shaded area = expansion absorption between two ¾" × 3" CPVC fittings. No expansion loop required.

White area = expansion loop necessary; first number is expansion value (ΔL); second number is length of section "a" of expansion loop

Theoretical maximum distance per fitting 0.86"

0.86 × 2 = 1.72"

1.72 × 90% = 1.55" maximum movement (absorption of expansion) between two fittings

1 × 3 CPVC

Distance Between Fittings (L) [ft]	Expansion [inches]																			
	ΔT [F]																			
	10°		20°		30°		40°		50°		60°		70°		80°		90°		100°	
	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a
10	0.04		0.08		0.12		0.16		0.20		0.24		0.29		0.33		0.37		0.41	
20	0.08		0.16		0.24		0.33		0.41		0.49		0.57		0.65		0.73		0.82	
30	0.12		0.24		0.37		0.49		0.61		0.73		0.86		0.98		1.10		1.22	
40	0.16		0.33		0.49		0.65		0.82		0.98		1.14		1.31		1.47	30.17	1.63	31.77
50	0.20		0.41		0.61		0.82		1.02		1.22		1.43	29.76	1.63	31.77	1.84	33.75	2.04	35.54
60	0.24		0.49		0.73		0.98		1.22		1.47	30.17	1.71	32.54	1.96	34.84	2.20	36.91	2.45	38.95
70	0.29		0.57		0.86		1.14		1.43	29.76	1.71	32.54	2.00	35.19	2.28	37.57	2.57	39.89	2.86	42.08
80	0.33		0.65		0.98		1.31	28.48	1.63	31.77	1.96	34.84	2.28	37.57	2.61	40.20	2.94	42.67	3.26	44.93
90	0.37		0.73		1.10		1.47	30.17	1.84	33.75	2.20	36.91	2.57	39.89	2.94	42.67	3.30	45.20	3.67	47.67
100	0.41		0.82		1.22		1.63	31.77	2.04	35.54	2.45	38.95	2.86	42.08	3.26	44.93	3.67	47.67	4.08	50.26

Shaded area = expansion absorption between two 1" × 3" CPVC fittings. No expansion loop required.

White area = expansion loop necessary; first number is expansion value (ΔL); second number is length of section "a" of expansion loop

Theoretical maximum distance per fitting 0.70"

0.70 × 2 = 1.40"

1.40 × 90%= 1.26" maximum movement (absorption of expansion) between two fittings

1½ × 4 CPVC

Distance Between Fittings (L) [ft]	Expansion [inches]																			
	ΔT [F]																			
	10°		20°		30°		40°		50°		60°		70°		80°		90°		100°	
	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a
10	0.04		0.08		0.12		0.16		0.20		0.24		0.29		0.33		0.37		0.41	
20	0.08		0.16		0.24		0.33		0.41		0.49		0.57		0.65		0.73		0.82	
30	0.12		0.24		0.37		0.49		0.61		0.73		0.86		0.98		1.10		1.22	
40	0.16		0.33		0.49		0.65		0.82		0.98		1.14		1.31		1.47		1.63	
50	0.20		0.41		0.61		0.82		1.02		1.22		1.43		1.63		1.84	40.57	2.04	42.72
60	0.24		0.49		0.73		0.98		1.22		1.47		1.71		1.96	41.88	2.20	44.37	2.45	46.82
70	0.29		0.57		0.86		1.14		1.43		1.71		2.00	42.30	2.28	45.17	2.57	47.95	2.86	50.58
80	0.33		0.65		0.98		1.31		1.63		1.96	41.88	2.28	45.17	2.61	48.32	2.94	51.29	3.26	54.01
90	0.37		0.73		1.10		1.47		1.84	40.57	2.20	44.37	2.57	47.95	2.94	51.29	3.30	54.34	3.67	57.30
100	0.41		0.82		1.22		1.63		2.04	42.72	2.45	46.82	2.86	50.58	3.26	54.01	3.67	57.30	4.08	60.42

Shaded area = expansion absorption between two 1½" × 4" CPVC fittings. No expansion loop required.

White area = expansion loop necessary; first number is expansion value (ΔL); second number is length of section "a" of expansion loop

Theoretical maximum distance per fitting 1.04"

1.04 × 2 = 2.08"

2.08 × 90% = 1.87" maximum movement (absorption of expansion) between two fittings

2 × 4 CPVC

Distance Between Fittings (L) [ft]	Expansion [inches]																			
	ΔT [F]																			
	10°		20°		30°		40°		50°		60°		70°		80°		90°		100°	
	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a
10	0.04		0.08		0.12		0.16		0.20		0.24		0.29		0.33		0.37		0.41	
20	0.08		0.16		0.24		0.33		0.41		0.49		0.57		0.65		0.73		0.82	
30	0.12		0.24		0.37		0.49		0.61		0.73		0.86		0.98		1.10		1.22	37.00
40	0.16		0.33		0.49		0.65		0.82		0.98		1.14		1.31	38.21	1.47	40.53	1.63	42.72
50	0.20		0.41		0.61		0.82		1.02		1.22	37.00	1.43	39.96	1.63	42.72	1.84	45.31	2.04	47.76
60	0.24		0.49		0.73		0.98		1.22	37.00	1.47	40.53	1.71	43.78	1.96	46.80	2.20	49.64	2.45	52.32
70	0.29		0.57		0.86		1.14		1.43	39.96	1.71	43.78	2.00	47.28	2.28	50.55	2.57	53.62	2.86	56.52
80	0.33		0.65		0.98		1.31	38.21	1.63	42.72	1.96	46.80	2.28	50.55	2.61	54.04	2.94	57.32	3.26	60.42
90	0.37		0.73		1.10		1.47	40.53	1.84	45.31	2.20	49.64	2.57	53.62	2.94	57.32	3.30	60.79	3.67	64.08
100	0.41		0.82		1.22	37.00	1.63	42.72	2.04	47.76	2.45	52.32	2.86	56.52	3.26	60.42	3.67	64.08	4.08	67.55

Shaded area = expansion absorption between two 2" × 4" CPVC fittings. No expansion loop required.

White area = expansion loop necessary; first number is expansion value (ΔL); second number is length of section "a" of expansion loop

Theoretical maximum distance per fitting 0.635"

0.635 × 2 = 1.27"

1.27 × 90% = 1.14" maximum movement (absorption of expansion) between two fittings

3 × 6 CPVC

Distance Between Fittings (L) [ft]	Expansion [inches]																			
	ΔT [F]																			
	10°		20°		30°		40°		50°		60°		70°		80°		90°		100°	
	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a
10	0.04		0.08		0.12		0.16		0.20		0.24		0.29		0.33		0.37		0.41	
20	0.08		0.16		0.24		0.33		0.41		0.49		0.57		0.65		0.73		0.82	
30	0.12		0.24		0.37		0.49		0.61		0.73		0.86		0.98		1.10		1.22	
40	0.16		0.33		0.49		0.65		0.82		0.98		1.14		1.31		1.47		1.63	
50	0.20		0.41		0.61		0.82		1.02		1.22		1.43		1.63		1.84	55.07	2.04	57.98
60	0.24		0.49		0.73		0.98		1.22		1.47		1.71		1.96	56.84	2.20	60.22	2.45	63.54
70	0.29		0.57		0.86		1.14		1.43		1.71		2.00	57.41	2.28	61.30	2.57	65.08	2.86	68.66
80	0.33		0.65		0.98		1.31		1.63		1.96	56.84	2.28	61.30	2.61	65.59	2.94	69.61	3.26	73.30
90	0.37		0.73		1.10		1.47		1.84	55.07	2.20	60.22	2.57	65.08	2.94	69.61	3.30	73.75	3.67	77.77
100	0.41		0.82		1.22		1.63		2.04	57.98	2.45	63.54	2.86	68.66	3.26	73.30	3.67	77.77	4.08	82.00

Shaded area = expansion absorption between two 3" × 6" CPVC fittings. No expansion loop required.

White area = expansion loop necessary; first number is expansion value (ΔL); second number is length of section "a" of expansion loop

Theoretical maximum distance per fitting 0.965"

0.965 × 2 = 1.93"

1.93 × 90% = 1.74" maximum movement (absorption of expansion) between two fittings

4 × 8 CPVC

Distance Between Fittings (L) [ft]	Expansion [inches]																			
	ΔT [F]																			
	10°		20°		30°		40°		50°		60°		70°		80°		90°		100°	
	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a
10	0.04		0.08		0.12		0.16		0.20		0.24		0.29		0.33		0.37		0.41	
20	0.08		0.16		0.24		0.33		0.41		0.49		0.57		0.65		0.73		0.82	
30	0.12		0.24		0.37		0.49		0.61		0.73		0.86		0.98		1.10		1.22	
40	0.16		0.33		0.49		0.65		0.82		0.98		1.14		1.31		1.47		1.63	
50	0.20		0.41		0.61		0.82		1.02		1.22		1.43		1.63		1.84		2.04	
60	0.24		0.49		0.73		0.98		1.22		1.47		1.71		1.96		2.20		2.45	
70	0.29		0.57		0.86		1.14		1.43		1.71		2.00		2.28		2.57	73.80	2.86	77.85
80	0.33		0.65		0.98		1.31		1.63		1.96		2.28		2.61	74.37	2.94	78.93	3.26	83.11
90	0.37		0.73		1.10		1.47		1.84		2.20		2.57	73.80	2.94	78.93	3.30	83.62	3.67	88.19
100	0.41		0.82		1.22		1.63		2.04		2.45		2.86	77.85	3.26	83.11	3.67	88.19	4.08	92.98

Shaded area = expansion absorption between two 4" × 8" CPVC fittings. No expansion loop required.

White area = expansion loop necessary; first number is expansion value (ΔL); second number is length of section "a" of expansion loop

Theoretical maximum distance per fitting 1.36"

1.36 × 2 = 2.72"

2.72 × 90% = 2.45" maximum movement (absorption of expansion) between two fittings

6 × 10 CPVC

Distance Between Fittings (L) [ft]	Expansion [inches]																			
	ΔT [F]																			
	10°		20°		30°		40°		50°		60°		70°		80°		90°		100°	
	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a	ΔL	a
10	0.04		0.08		0.12		0.16		0.20		0.24		0.29		0.33		0.37		0.41	
20	0.08		0.16		0.24		0.33		0.41		0.49		0.57		0.65		0.73		0.82	
30	0.12		0.24		0.37		0.49		0.61		0.73		0.86		0.98		1.10		1.22	
40	0.16		0.33		0.49		0.65		0.82		0.98		1.14		1.31		1.47		1.63	
50	0.20		0.41		0.61		0.82		1.02		1.22		1.43		1.63		1.84		2.04	
60	0.24		0.49		0.73		0.98		1.22		1.47		1.71		1.96		2.20		2.45	87.43
70	0.29		0.57		0.86		1.14		1.43		1.71		2.00		2.28	84.34	2.57	89.54	2.86	94.46
80	0.33		0.65		0.98		1.31		1.63		1.96		2.28	84.34	2.61	90.23	2.94	95.77	3.26	100.85
90	0.37		0.73		1.10		1.47		1.84		2.20		2.57	89.54	2.94	95.77	3.30	101.46	3.67	107.00
100	0.41		0.82		1.22		1.63		2.04		2.45	87.43	2.86	94.46	3.26	100.85	3.67	107.00	4.08	112.82

Shaded area = expansion absorption between two 1½" × 4" CPVC fittings. No expansion loop required.

White area = expansion loop necessary; first number is expansion value (ΔL); second number is length of section "a" of expansion loop

Theoretical maximum distance per fitting 1.23"

1.23 × 2 = 2.46"

2.46 × 90% = 2.21" maximum movement (absorption of expansion) between two fittings

Installation Instructions

Storage and Handling

GF thermoplastics have excellent resistance to weathering and can be stored outside for extended periods. However, to prevent excessive temperature buildup that could lead to warping, GF recommends covering any plastic pipe stored outside with a light tarpaulin. Otherwise, keep plastic pipe under cover in a well ventilated warehouse or shed. Protect stored pipe from direct exposure to UV rays (direct sunlight) and store pipe in a location away from steam lines or other heat sources.

Store piping on racks that provide close or continuous support to prevent sagging or "draping," particularly with longer sections of pipe. Make sure to remove any sharp edges or burrs from the racks. To prevent excessive deflection, loose stacks of pipe should not exceed a height of three feet. Bundled pipe can be stacked twice as high.

Keep fittings and flanges in their original packaging or in separate bins until they are needed for installation. Do not mix them with metal piping components.

Since plastic pipe has lower impact strength and resistance to mechanical abuse than steel, it requires somewhat more care in handling, as scratches, splits or gouges sustained during handling can compromise structural integrity and reduce the overall pressure rating. For example, avoid pulling a length of pipe off a truck bed and letting the free end plummet to the ground. Do not drag the pipe over rough ground, drop heavy objects on it, or using any kind of chains to move or store it.

Fortunately, in the event that careless handling leads to damage, vinyl piping allows installers to easily cut out and replace a damaged section of pipe, even after initial installation of the system.

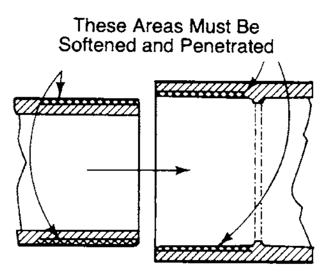
Solvent Welding PVC and CPVC: Basic Principles

Solvent cemented connections in thermoplastic pipe and fittings are the last vital link in a plastic pipe installation. Each solvent cemented joint dictates the success or failure of the entire system. Thus, solvent cementing PVC and CPVC piping requires the same professional care and attention given to other components of the system.

GF values teaching a basic knowledge of solvent cementing principles before jumping into specific installation procedures. There are many publications of step-by step procedures for solvent cementing, but we have found that a little general insight helps installers choose the appropriate cementing techniques for various combinations of applications, temperature conditions, and parts. With this in mind, the following concepts are crucial to understanding how to make good joints consistently:

1. The joining surfaces must be dissolved and made semi-fluid.
2. Sufficient cement must be applied to fill the gap between pipe and fitting.
3. Assembly of pipe and fittings must be made while the surfaces are still wet and fluid.
4. Joint strength develops as the cement dries. In the tight part of the joint (back of the socket) the surfaces will tend to fuse together; in the loose part, the cement will bond to both surfaces.

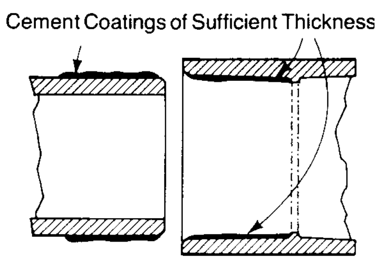
Penetration and dissolving can be achieved by a suitable primer, or by the use of both primer and cement. A suitable primer will penetrate and dissolve the plastic more quickly than cement alone. The use of a primer provides a safety factor for the installer for he can know, under various temperature conditions, when he has achieved sufficient softening.



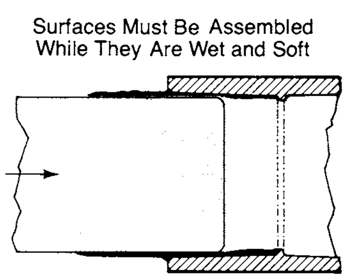
A suitable primer is critical to adequately penetrating and dissolving the plastic, as it can achieve this more thoroughly than cement alone. Primer also helps installers gauge if the pipe is sufficiently softened for joining, particularly in unfamiliar temperature conditions.

Installers should apply enough cement so that it more than sufficiently fills the loose part of the joint. The cement will not only fill the gap, but it will also help to penetrate the surface and keep the plastic wet while the joint is being assembled.

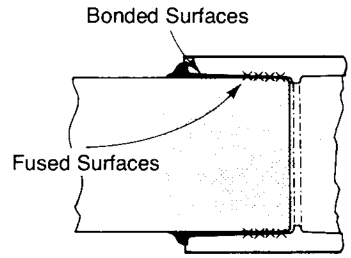
More than sufficient cement to fill the loose part of the joint must be applied. Besides filling the gap, adequate cement layers will penetrate the surface and also remain wet until the joint is assembled. This is particularly important during simultaneous joining, as the fittings may be incredibly difficult to assemble without fluid joints.



If the cement coatings on the pipe and fittings are wet and fluid when assembly takes place, they will tend to flow together and become one cement layer. Also, if the cement is wet, the surfaces beneath them will still be soft; these softened surfaces in the tight part of the joint will tend to fuse together, forming a stronger joint than just bonding alone would.



As the solvent dissipates, the cement layer and the dissolved surfaces will harden, and the joint will subsequently gain strength. A good joint will actually take the required working pressure long before the joint is fully dry and final strength will develop more quickly than in the looser (bonded) part of the joint.

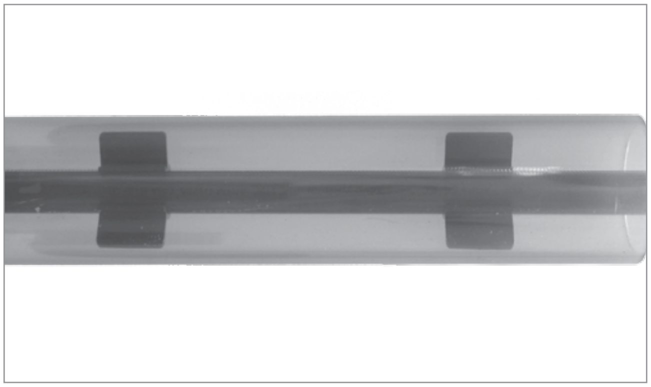


Note: Factory-made solvent cement joints are made with IPS brand 724 cement for maximum chemical resistance.

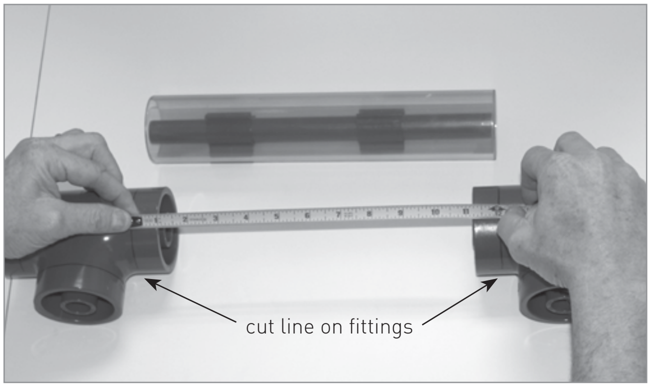
Double-See Detailed Installation Procedures – Simultaneous Joining Method

Before solvent cementing any joints, read through the previous section "Solvent Welding" and read all of the following instructions.

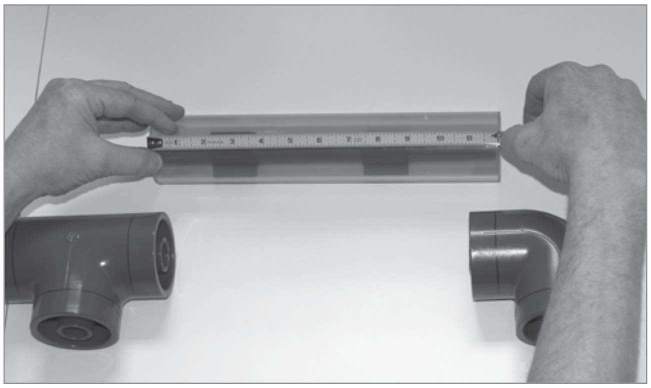
1. Pipe centralizers are pre-assembled to the primary pipe at pre-determined intervals based on pipe size.
   → **Ensure there is a centralizer on the primary pipe close to pipe end so that it remains centered during assembly.**
2. Position primary pipe with attached centralizers within secondary pipe, making sure ends are flush.



3. Deburr and bevel ends of all pipe segments; align the pipe segment between desired fittings; test dry fit of all joints; clean/dry all jointing surfaces; mark depth-of-entry (socket depth) with a permanent marker for reference.
   → Bevel on the primary pipe is critical for simultaneous joints. For sizes under 2", bevel ⅛"–3⁄16". For sizes 2" and above, bevel 3⁄16"–¼". The bevel angle should be approximately 15°.

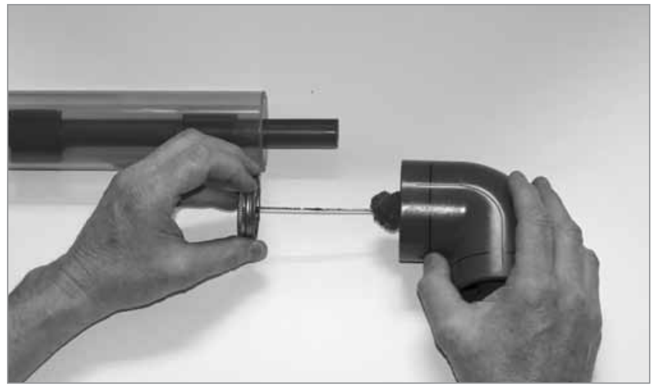


4. Cut primary and secondary pipes to the same length for the desired segment (measure using pipe cut length guidance marks on fittings).



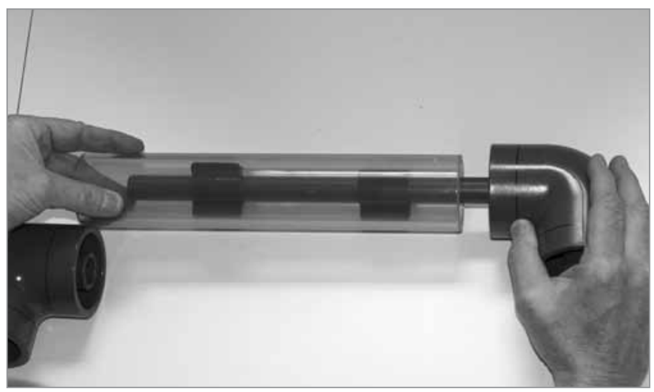
⚠ **Very important: Position pipe centralizer near end of pipe to ensure pipes are centrally aligned during joining.**

5. Prime the first end of the primary pipe and the associated socket of fitting 1.



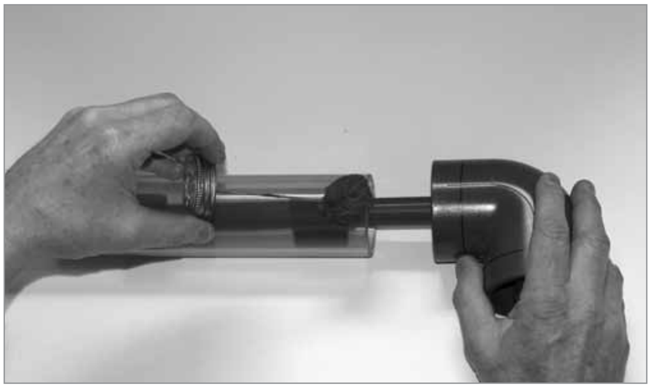
6. While primer is still wet, apply cement over the primer on the primary pipe, in the socket, and then and again on the pipe.

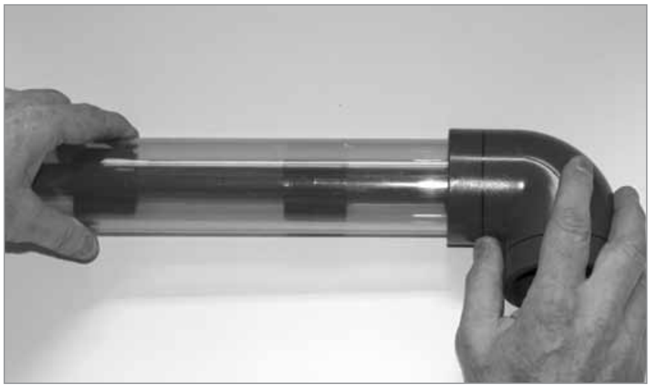
7. Insert primary pipe into socket until pipe bottoms out, rotating the pipe ¼ turn during insertion, and hold joint for as long as necessary until joint holds to ensure pipe is fully inserted (may take up to a few minutes).



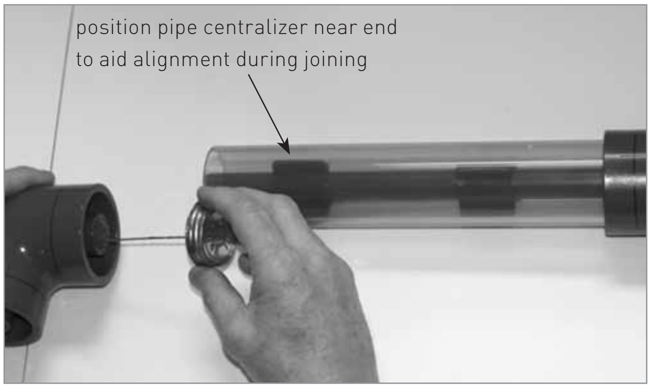
8. While cement is still soft, remove excess cement from around the joint.

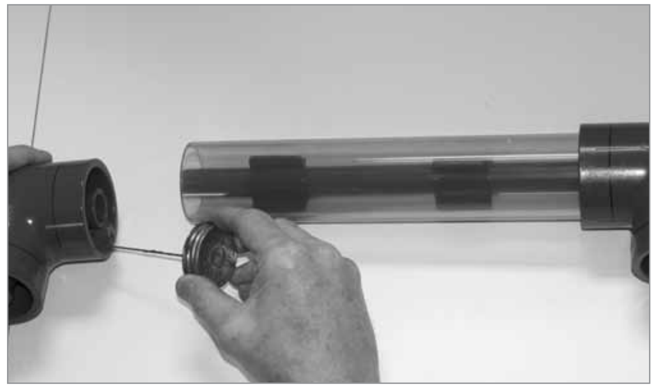
9. Repeat steps 5 through 8 for the same end of the secondary pipe; cement it into the associated socket of the same fitting (fitting 1).

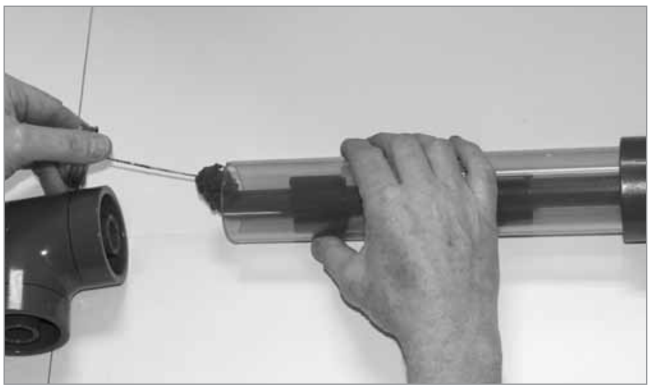


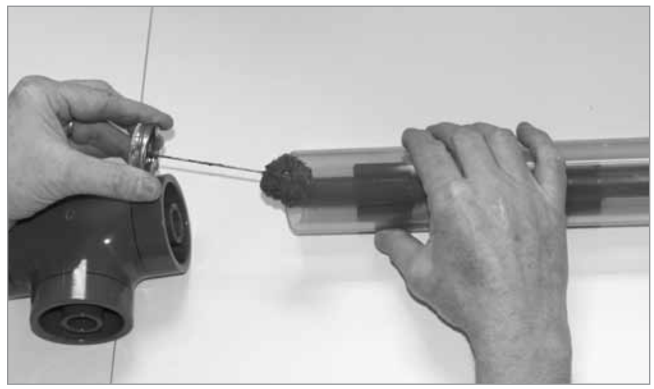


10. Repeat steps 5 through 8 above except both primary and secondary joints must be primed and cemented at the same time. It is essential that all surfaces are wet before joining. Two workers are recommended.









It is important to note that this method does not comply with B31.3 part 345.3.1 and may lead to more difficult repairs and adjustments of the primary pipe system if it is initially installed with a leaking connection.

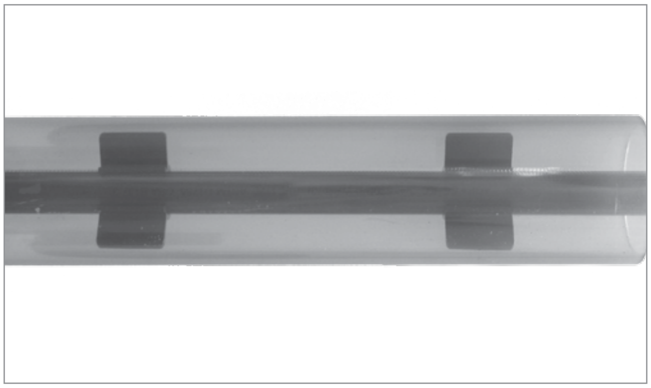
However, if the contractor deems this to be an appropriate method, based on spatial or other limitations, simultaneous joining is a legitimate option that is frequently used in other double containment systems on the market. This method may make installation substantially more difficult than installation with a closure coupling, especially for large diameter pipes. Nonetheless, it may reduce installation time if executed properly.

A closure coupling fitting can be combined with simultaneous joining when making final connections.

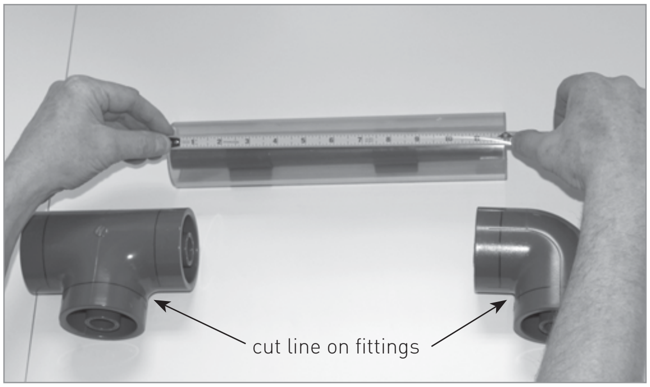
Double-See Detailed Installation Procedures – Closure Coupling Joining Method to Expose Primary Joints for Pressure Testing

Before solvent cementing any joints, read through the previous section "Solvent Welding" and read all of the following instructions.

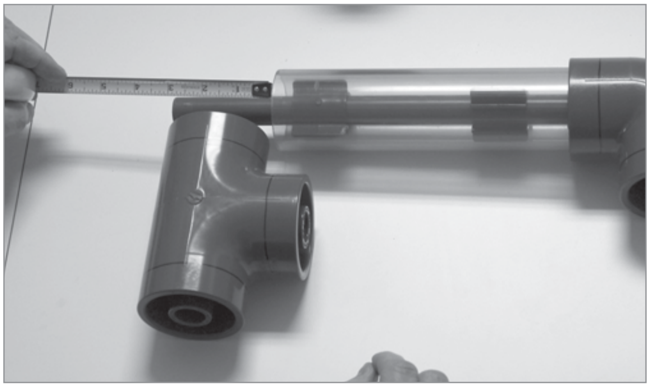
1. Pipe centralizers are pre-assembled to the primary pipe at pre-determined intervals based on pipe size.
2. Position primary pipe with attached centralizers within secondary pipe, making sure ends are flush.



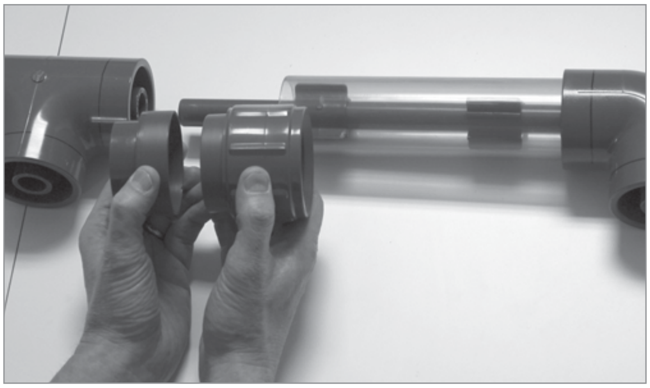
3. Cut primary and secondary pipes to the same length for the desired segment (measure using cut length guidance marks on fittings).



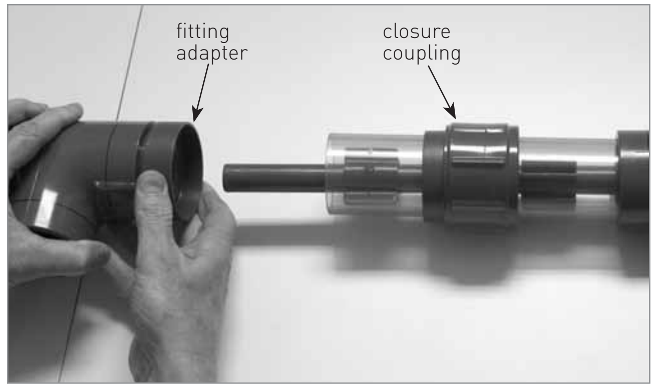
4. When using the closure coupling, it is necessary to trim the secondary pipe slightly less than one pipe diameter to allow space for the closure coupling. (Trim length is slightly less than the diameter of the secondary pipe and shown in chart on page 43.)



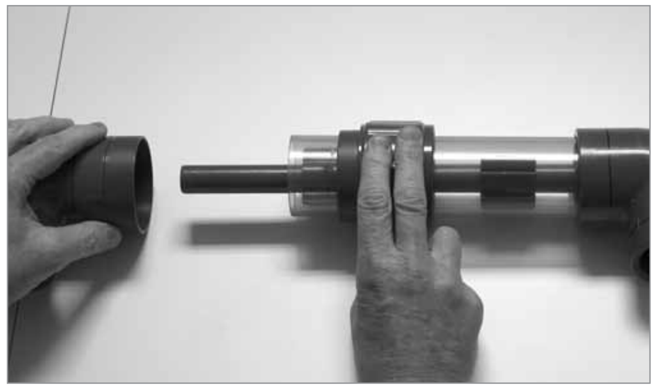
5. The closure coupling consists of two pieces.



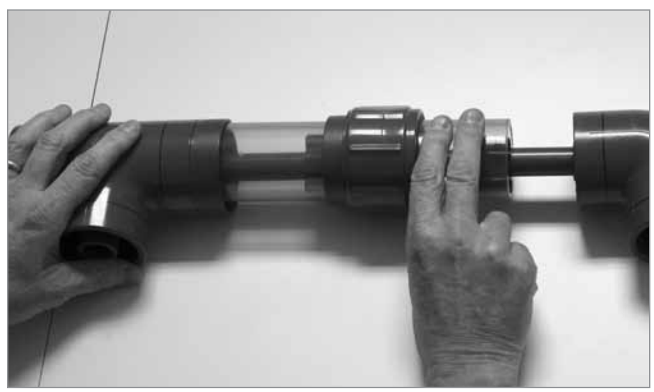
6. The fitting adapter fits inside the secondary fitting socket and the closure coupling which joins the pipe to the secondary fitting adapter. Only one closure coupling is needed between every two joints.



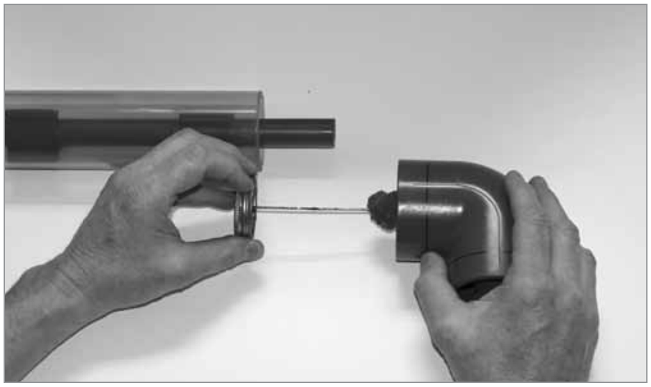
7. Before assembly, slip the closure coupling on the pipe and insert the fitting adapter (without glue) onto the fitting.

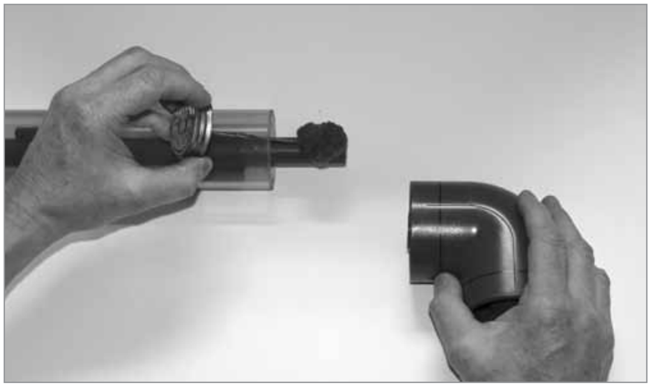


8. Dry fit the components to ensure everything will assemble correctly. Slide the secondary pipe back to allow room, apply primer, and glue the primary pipe and socket onto the non-closure coupling side.

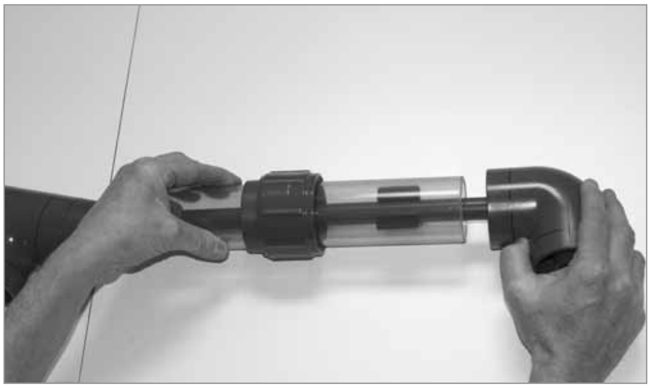


9. Apply primer and cement to the primary pipe and fitting socket.

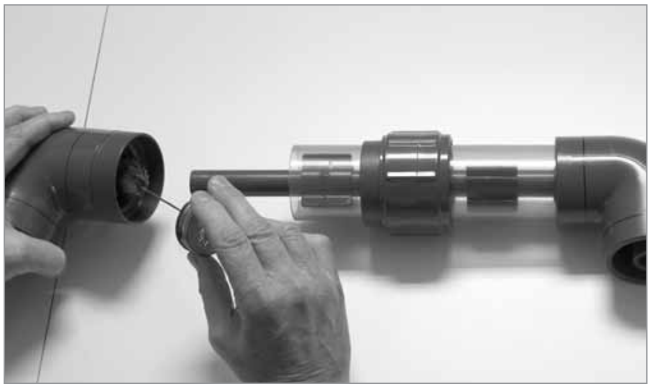


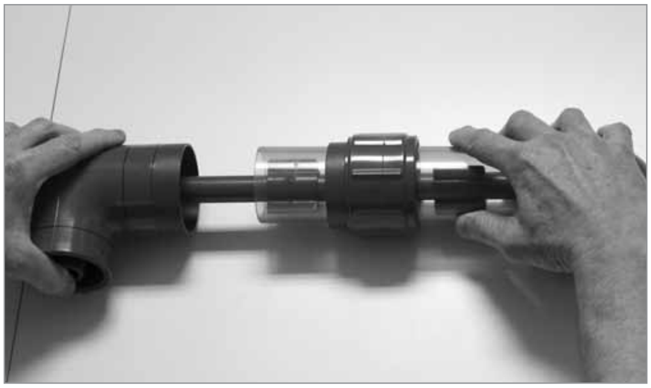


10. Insert the primary pipe into the fitting, rotating a ¼ turn.

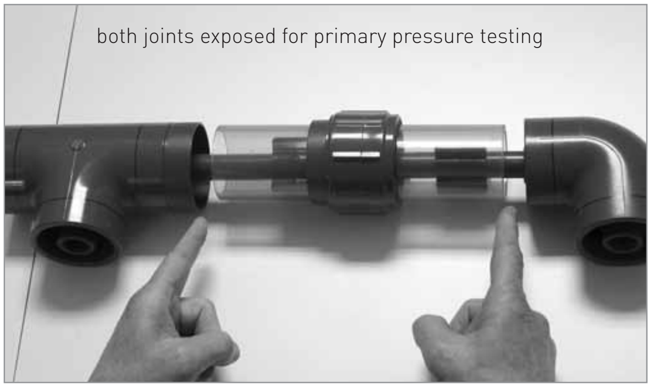


11. Slide the secondary pipe back into the unglued socket of the fitting to allow room on the other side. Apply primer and glue to the primary pipe and fitting (taking care not to get glue on the adapter fitting) and insert fitting onto pipe socket.

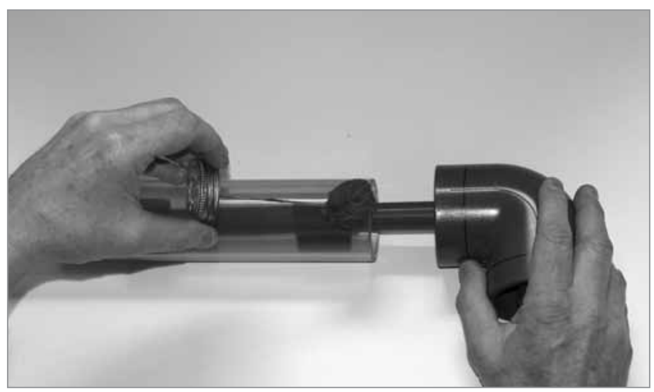




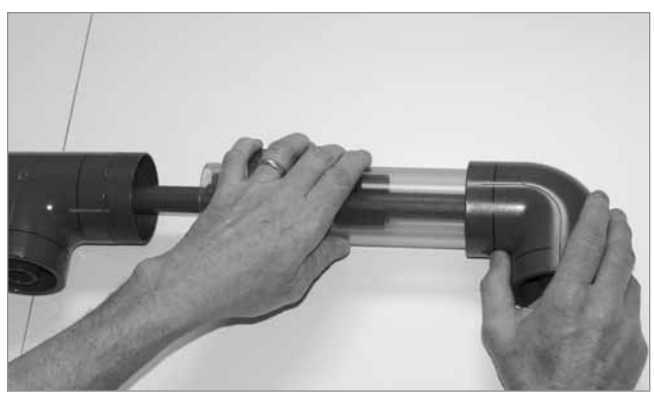
12. The secondary pipe can now be slid out of the secondary socket to expose the primary glued joints on both sides. If installing to comply with an ANSI B31.3 sytem, all joints should be installed using this method so that all primary joints can be exposed during pressure testing.



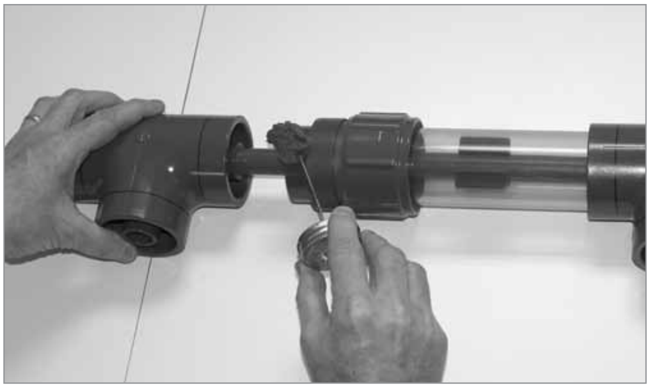
13. After pressure testing, the secondary pipe can now be cemented. Slide the secondary pipe to one side and apply primer and cement to the socket and pipe.



14. Insert the secondary pipe into the socket with a ¼ turn.

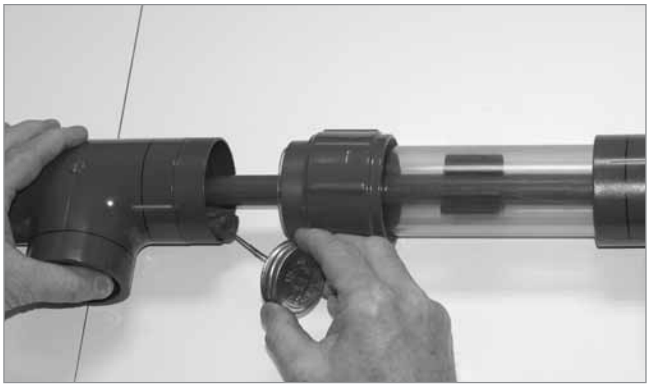


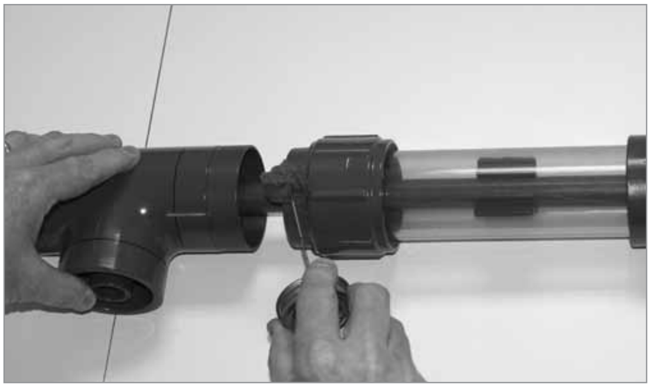
15. Slide the adapter fitting onto the closure coupling to allow maximum working space and apply primer and cement to the adapter spigot and fitting socket.



16. Slide the adapter fitting into the socket with a ¼ turn.

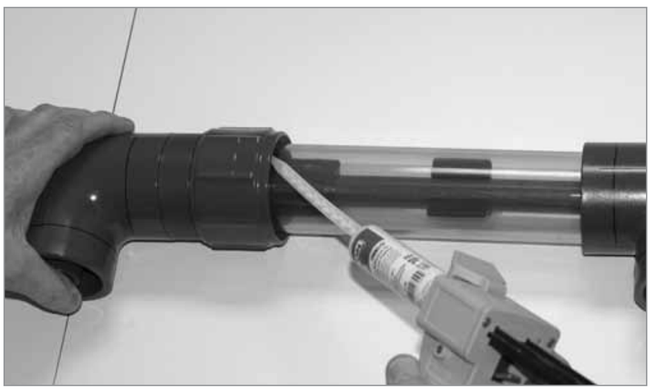
17. Apply primer and cement to the adapter socket and coupling spigot.

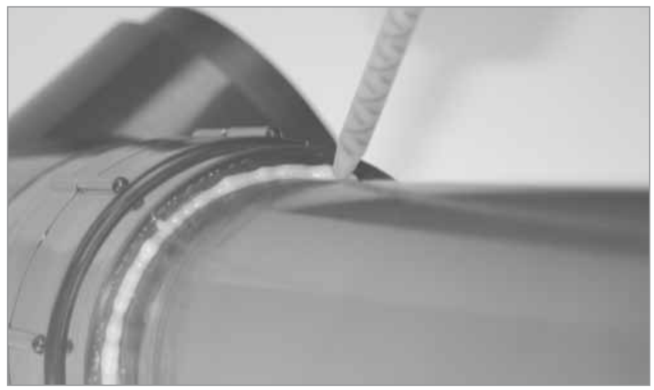




18. Slide the coupling onto the adapter until fitting bottoms out and no gap is present. Do not disturb joint until cement has set up.

19. Seal the coupling by applying a special two-part adhesive on the pipe side of the coupling. This side of the coupling has a large bevel area to receive the adhesive, when applied with the mixing tip. Apply adhesive around the entire coupling, using the applicator tip, to completely fill the gap. Allow adhesive to cure 1–2 hours before pressure testing.





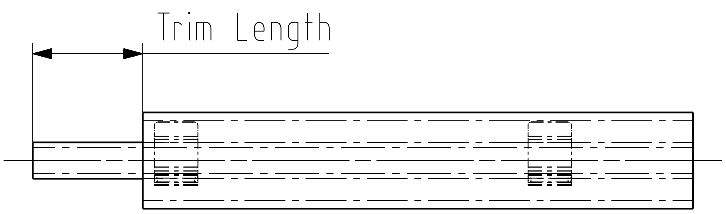
20. The system shall be tested in accordance with local plumbing codes and manufacturers' recommendations. If the secondary pipe cannot be tested hydrostatically, a maximum of 5 PSI pneumatic air or nitrogen test may be performed. A pressure regulator and pressure relief device must be used to prevent over-pressurization of the secondary system. Pressure testing of the secondary pipe may be done hydrostatically up to a max of 50 PSI and in accordance with local codes.

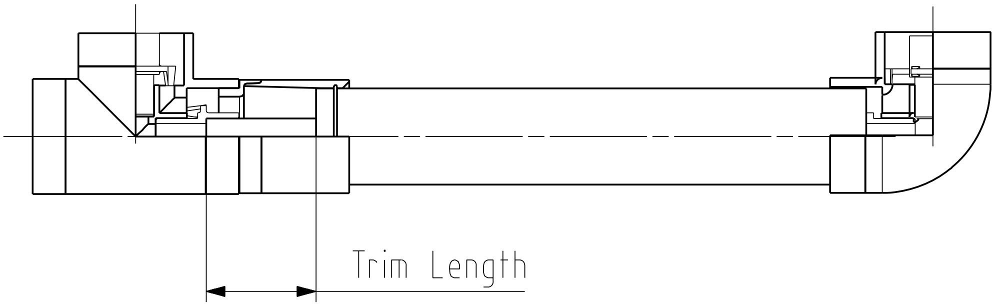
+GF+

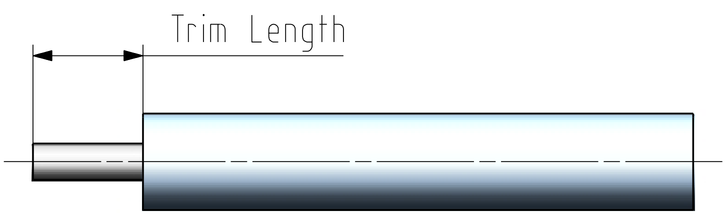
Trim and Glue Length Guidelines
→ for Closure Coupling Method

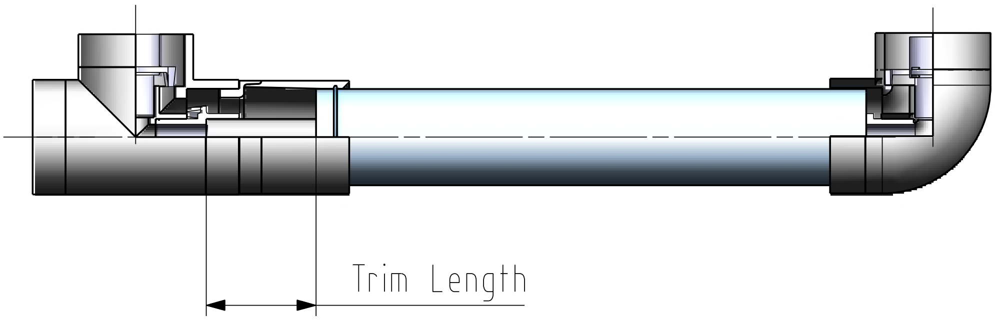
Use the following diagrams and table as general guidelines for cutting the secondary pipe and gluing the closure coupling during closure coupling installation. Treat the glue length as the minimum distance that primer and cement should be applied to the secondary pipe from its end. Use orange cement (or similar bright color that stands out from pipe) for PVC and CPVC systems.

Size (inch)	Trim Length (inch)
½ × 2	2⅞
¾ × 3	3¾
1 × 3	3⅞
1½ × 4	4½
2 × 4	4¾
3 × 6	8¼
4 × 8	9⅜
6 × 10	11









Temperature Considerations

Joining Plastic Pipe in Hot Weather

There are many occasions when solvent cementing plastic pipe in 95°F temperatures and over cannot be avoided. If surface temperatures exceed 110°F, we recommend contacting the solvent cement manufacturer.

Solvent cements for plastic pipe contain high-strength solvents which evaporate faster at elevated temperatures. This is especially amplified when there is a hot wind blowing. If the pipe is stored in direct sunlight, surface temperatures may be 20°F to 30°F above air temperature. Solvents attack these hot surfaces faster and deeper, especially inside a joint. Thus it is very important to avoid puddling inside socket and to wipe off excess cement outside.

By following our standard instructions and using a little extra care, as outlined below, successful solvent cemented joints can be made in even the most extreme hot weather conditions.

Tips to Follow When Solvent Cementing in High Temperatures

1. Store solvent cements and primers in a cool or shaded area prior to use.
2. If possible, store fitting and the pipe, or at least the ends to be solvent welded, in shady area before cementing.
3. Cool surfaces to be joined by wiping with a damp rag. Be sure that surfaces dry prior to applying solvent cement.
4. Try to do the solvent cementing in cooler morning hours.
5. Make sure that both surfaces to be joined are still wet with cement when putting them together. With large size pipe, more people on the crew may be necessary.
6. Use of heavier, high viscosity cements will provide a little more working time.

Note that in hot climates, there can be a greater expansion/contraction factor.

Good Joints Can Be Made at Sub-Zero Temperatures

By following standard instructions and using a little extra care and patience, successful solvent cemented joints can be made at temperatures even as low as –15°F. In cold weather, solvents penetrate and soften the surfaces more slowly than in warm weather, and the plastic is more resistant to solvent attack. Therefore, it becomes more important to pre-soften surfaces with a primer. Because of slower evaporation, cemented joints take longer to cure. Cure schedules already allow a wide margin for safety, so for colder weather, simply allow more time.

Tips to Follow in Solvent Cementing During Cold Weather

1. Prefabricate as much of the system as possible in a heated working area.
2. Store cements and primers in a warmer area when not in use and make sure they remain fluid.
3. Take special care to remove moisture including ice and snow.
4. Use a primer to soften the joining surfaces before applying cement.
5. Allow a longer cure period before the system is used.
6. Read and follow all of our directions carefully before installation.

Regular cements are formulated to have well balanced drying characteristics and to have good stability in sub-freezing temperatures. Some manufacturers offer special cements for cold weather because their regular cements do not have that same stability. For all practical purposes, good solvent cemented joints are achievable in very cold conditions with existing products, provided the installer takes proper care and uses a little common sense.

Guideline on Cement Usage

Pipe Size	½ × 2	¾ × 3	1 × 3	1½ × 4	2 × 4	3 × 6	4 × 8	6 × 10
No. of Joints	50	33	30	22	20	8	4	1–2

Note: This information is provided as a general guideline. Recommendation is for the number of joints per quart. A tee will have 3 joints, an ell will have 2 joints, etc. Our recommendation for primer is to plan for a quart to supply 150% of the number of joints as for cement.

Centralizer Placement

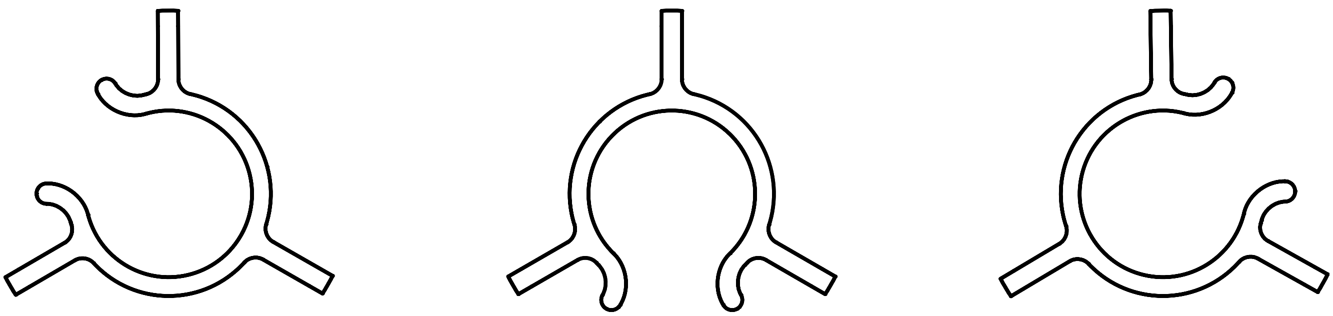
GF's centralizers are designed to support the primary pipe within the secondary pipe and keep it centered in the interstitial space. They are molded out of either PVC or CPVC and should be chosen based on the material of the primary pipe. Each centralizer is engineered with slight clearance between the end of each arm and the interior wall of the secondary pipe so that the outward flex and material expansion of centralizers (due to conduction of thermal energy after temperature increase of the primary pipe) will not cause the arms to exert an outward mechanical force on the secondary pipe.

Our centralizers are relatively lightweight and offer enough space around them for unobstructed fluid flow and access for leak detection system installation.

Centralizers should be placed at intervals established in the table below, but must be located near pipe end if doing simultaneous joining.

Installers may either slide or clip the centralizers onto the primary pipe. It is easiest to do this before placing the primary pipe within the secondary pipe.

For horizontal runs, centralizers should be oriented with one arm vertical as pictured below to ensure even distribution of the primary pipe's load:



Recommended Centralizer Support Spacing* (in feet)

Nom. Pipe Size (In.)	PVC Pipe					CPVC Pipe					
	Schedule 80 Temp.°F					Schedule 80 Temp.°F					
	60	80	100	120	140	60	80	100	120	140	180
½ × 2	5	4½	4½	3	2½	5½	5½	5	4½	4½	2½
¾ × 3	5½	5	4½	3	2½	5½	5½	5½	5	4½	2½
1 × 3	6	5½	5	3½	3	6	6	6	5½	5	3
1½ × 4	6½	6	5½	3½	3½	7	7	6½	6	5½	3½
2 × 4	7	6½	6	4	3½	7	7	7	6½	6	3½
3 × 6	8	7½	7	4½	4	8	8	8	7½	7	4
4 × 8	9	8½	7½	5	4½	9	9	9	8½	7½	4½
6 × 10	10	9½	9	6	5	10	10	9½	9	8	5

*Chart based on spacing for continuous spans and for uninsulated lines conveying fluids of specific gravity up to 1.00.

Above Ground Installation

Support Spacing

Thermoplastic piping systems that are installed above-ground must be properly supported to avoid unnecessary stresses and possible sagging.

Horizontal runs require the use of hangers, spaced approximately as indicated in the table below. Vertical lines must also be supported at intervals so that the fittings at the lower end of a riser or column are not overloaded.

Continuous support can be accomplished by the use of smooth structural angle or channel.

Protective shields should be installed where the pipe may be exposed to impact damage.

Tables are based on the maximum deflection of a uniformly loaded, continuously supported system. Following these recommendations should ensure that the secondary pipe is held rigid enough to prevent snaking and supported enough so that it will not fall if completely filled in the event of a complete primary pipe failure. The secondary pipe should be held rigid so that the centralizers in fittings can absorb the maximum calculated deflection due to temperature changes in the primary pipe.

All specialized components such as valve/flange/union boxes, in-line double contained valves, expansion loops, leak detection tees, etc. may require additional support.

Sunlight and Plastics

Plastic pipe and fittings are used extensively outdoors and are resistant to weathering, but may have some surface degradation from intense and prolonged exposure to the ultraviolet (UV) rays in sunlight. This degradation is a surface effect and it reduces the impact rating, but it has no affect on the temperature capability, chemical resistance, or pressure rating of the pipe. This reduced impact rating can be eliminated by removing the affected surface area, and can be prevented by covering areas exposed to direct sunlight with a good bonding exterior latex paint.

The latex paint must be applied thick enough to create an opaque covering (probably several coats). If the pipe and fittings are prepared properly for painting (cleaning and very light sanding), a good grade of exterior latex should last for many years. We suggest using white or light colored pigment, as such colors offer a more reflective surface.

Closure Coupling and Sunlight

This is particularly important for our transparent closure couplings. Installers should take care to cover these appropriately when anticipating direct sunlight exposure. Without such protection, the plastic will change color and lose transparency. Depending on the location, it may be possible to leave part of the closure coupling exposed without risk of sunlight exposure; this is recommended where possible, because the uncovered side of the coupling would still allow for some level of visual leak detection in the system.

Recommended Secondary Support Spacing* (in feet)

Nom. Pipe Size (In.)	PVC Pipe										CPVC Pipe					
	Clear Schedule 40 Temp.°F					Schedule 80 Temp.°F					Schedule 80 Temp.°F					
	60	80	100	120	140	60	80	100	120	140	60	80	100	120	140	180
½ × 2	7½	7	6½	4½	4	9	8	7½	5	4½	9	9	9	8	7½	4½
¾ × 3	9	9	7½	5	4½	10	9½	9	5½	5	10	10	10	9½	9	5
1 × 3	9	9	7½	5	4½	10	9½	9	5½	5	10	10	10	9½	9	5
1½ × 4	9½	9	8	5½	5	11½	10½	9½	6½	5½	11½	11½	11½	10½	9½	5½
2 × 4	9½	9	8	5½	5	11½	10½	9½	6½	5½	11½	11½	11½	10½	9½	5½
3 × 6	10½	10	9½	6½	5½	12½	12	11½	7½	6½	12½	12	12	11½	10	6½
4 × 8						14	13	12	8	7	14	14	13	12½	11½	7
6 × 10						15	14	12½	9	7½	14½	14½	14	13	12	7½

*Chart based on spacing for continuous spans and for uninsulated lines conveying fluids of specific gravity up to 1.00.

Below Ground Installation

1. Depth: When installing underground piping systems, trench depth is determined by the intended service and by local conditions (and by local, state and national codes where applicable that may require a greater trench depth and cover than are technically necessary).

Underground pipes are subjected to external loads caused by the weight of the backfill material and by loads applied at the surface of the fill. These can range from static to dynamic loads.

Static loads comprise the weight of the soil above the top of the pipe plus any additional material that might by stacked above ground. An important point is that the load on a flexible pipe will be less than on a rigid pipe buried in the same manner. This is because the flexible conduit transfers part of the load to the surrounding soil and not the reverse. Soil loads are minimal with narrow trenches until a pipe depth of 10 feet is attained.

Dynamic loads are loads due to moving vehicles such as trucks, trains and other heavy equipment. For shallow burial conditions, dynamic (live) loads should be considered and added to static loads, but at depths greater than 10 feet, live loads have very little effect.

For static and dynamic soil loading tables, refer to specific materials sections on PVC and CPVC.

Pipe intended for potable water service should be buried at least 12 inches below the maximum expected frost penetration.

2. Bedding: The bottom of the trench should provide a firm, continuous bearing surface along the entire length of the pipe run. It should be relatively smooth and free of rocks. Where hardpan, ledge rock or boulders are present, it is recommended that the trench bottom be cushioned with at least four (4) inches of sand or compacted fine-grained soils.

Backfilling

Before making the final connections and backfilling, the pipeline should be cooled to near the temperature of the soil. During hot weather, for example, backfilling should be done early in the morning, when the solvent-cemented joints are completely dried and the line is fully contracted.

Assuming that the pipe is uniformly and continuously supported over its entire length on firm, stable material, it should first be covered with 6 to 8 inches of soil that is free of debris and rocks larger than one-half inch in diameter. This initial layer should be compacted by hand or, preferably, by mechanical tamper so that it acts as a protective cushion against the final backfill. Any large, sharp rocks that could penetrate the tampered layer around the pipe should be removed from the final backfill.

Heavy Traffic: When plastic pipe is installed beneath streets, railroads or other surfaces that are subjected to heavy traffic and resulting shock and vibration, it should be run within a protective metal or concrete casing.

Locating Buried Pipe: The location of plastic pipelines should be accurately recorded at the time of installation. Since pipe is a non-conductor, it does not respond to the electronic devices normally used to locate metal pipelines. However, a copper or galvanized wire can be spiraled around, taped to or laid alongside or just above the pipe during installation to permit the use of a locating device.

Note: For additional information, see ASTM D-2774, "Underground Installation of Thermoplastic Piping."

Anchors, Valves, and Other Connections

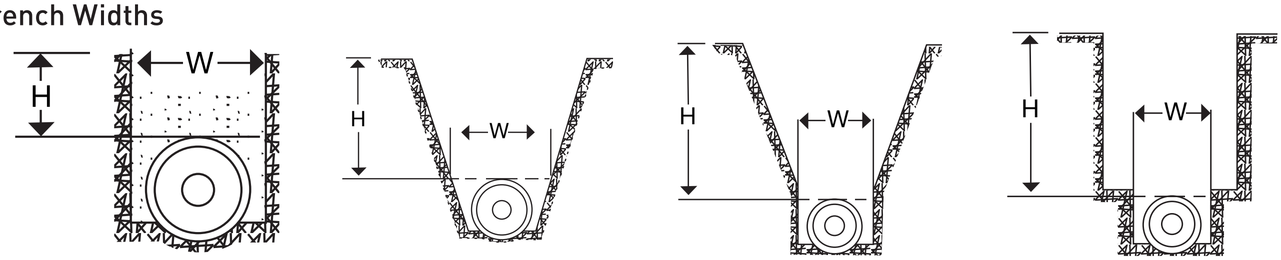
Plastic pipe is not designed to provide structural strength beyond sustaining internal pressures up to its designed hydrostatic pressure rating and normal soil loads. Anchors, valves and other connections must be independently supported to prevent added shearing and bending stresses on the pipe.

The above piping design rule applies also where pipe is brought out of the ground. Above-ground valves or other connections must be supported independently. If pipe is exposed to external damage, it should be protected with a separate, rigidly supported metal pipe sleeve at the danger areas. Thermoplastic pipe should not be brought above ground where it is exposed to high temperatures. Elevated temperatures can lower the pipe's pressure rating below design levels.

Soil Loads for PVC and CPVC Schedule 80 Pipe

Secondary Nom. Size	Wc'=Load Resistance of Pipe (lb./ft.)		H=Height of fill above pipe	Wc = Soil Loads at Various Trench Widths at Top of Pipe (lb./ft.)			
	Schedule 80 Pipe						
	E'=200	E'=700	(ft.)	2ft.	3ft.	4ft.	5ft.
2	1161	1400	10	132	156	170	190
			20	172	227	265	291
			30	180	259	317	392
			40	—	267	337	398
3	1416	1772	10	196	231	252	280
			20	256	336	392	429
			30	266	266	384	469
			40	—	394	497	586
4	1266	1735	10	252	297	324	360
			20	328	432	540	551
			30	342	493	603	743
			40	—	506	639	754
6	1323	2028	10	371	437	477	530
			20	484	636	742	812
			30	503	725	888	1093
			40	—	745	941	1110
8	1319	2250	10	483	569	621	690
			20	630	828	966	1057
			30	656	945	1156	1423
			40	—	970	1225	1415
10	1481	2649	10	602	710	774	860
			20	785	1032	1204	1317
			30	817	1177	1405	1774
			40	—	1209	1527	1801

Trench Widths



Note: W = Trench width at top of pipe.

+GF+

Flanges and Unions

Flanges

Flanges prove useful wherever the pipe system may need to be dismantled or at transitions from PVC/CPVC to other materials.

GF Piping Systems offers a complete range of flange boxes for our Double-See line. For more information on these containment boxes, see the flange/union box section on page 73.

While flanges are easy to install, specific knowledge is required to ensure proper assembly. For detailed instructions on PVC/CPVC flange installation (tools, alignment, gasket placement, fasteners, bolt torque, documentation, etc.), consult the GF PVC and CPVC Technical Manual. (www.gfpiping.com)

Unions

Similar to flanges, unions can be implemented where the pipe system must be mobile or may need to be dismantled. GF true union ball valves, such as the Type 546 and Type 375 ball valves used in the Double-See system, feature union type connections.

GF Piping Systems offers a complete range of union boxes for Double-See. For more information on these containment boxes, see the flange/union box section on page 73.

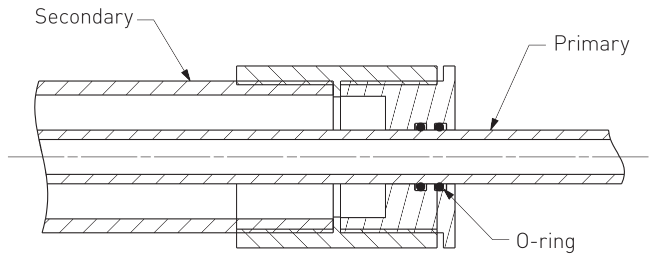
Union installation is not required for any of our pre-fabricated valve tees or valve boxes, as they are fitted with customized parts to extend each primary pipe socket from the valve out to a socket that is flush with the mouth of the secondary fitting. However, union installation may be relevant in the event of a future valve replacement.

For detailed instructions on union installation (alignment, tightening, sealing, etc.), consult the GF PVC and CPVC Technical Manual. (www.gfpiping.com)

Termination and Test Fittings

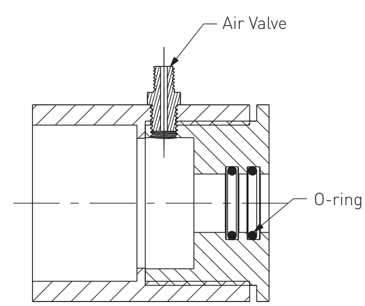
Termination Fittings

Termination fittings allow for the secondary containment pipe to be discontinued before the end of the primary pipe. Our termination fittings come pre-fabricated from custom molded components and high-strength o-rings. Always deburr and bevel ends of primary pipe before sliding termination fitting over it. Do NOT expose o-rings to primer or cement, as this may destroy them. O-ring lubricant may be necessary to install fitting. Cement secondary pipe into fitting per instructions for installation of secondary pipe into non-machined (standard) fitting.



Test Fittings

Our test fitting comes with a pre-installed air valve for pneumatically pressure testing the secondary pipe system. Installation of test fittings is consistent with that of termination fittings. Take care not to cover inlet from the air valve to the interstitial space with cement during installation, as this may block proper fluid flow during pressure testing.

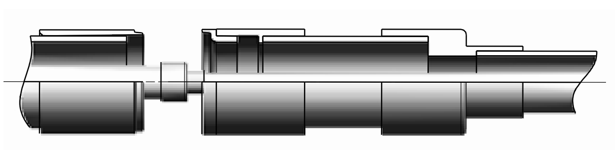


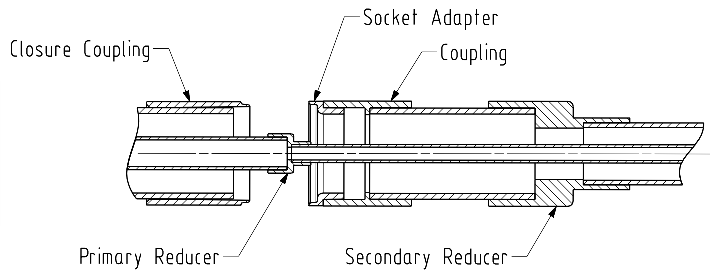
Reducers

GF Piping Systems offers a full range of reducing and increasing options in the Double-See vinyl double containment system. Installation requires some layout consideration beforehand to ensure joints can be properly inspected and primary pipes are not impeded by secondary reducers.

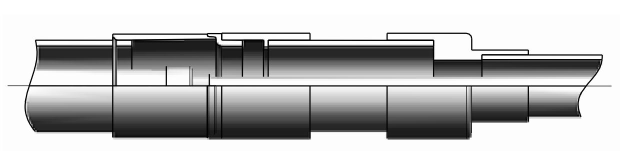
To accomplish this, installers must position the reducers so that the primary pipe is reduced while the secondary system is still at its larger diameter and there is an appropriate distance between the two reducers. For installation with a closure coupling, the primary pipe should be reduced in the gap between the secondary pipe and the machined coupling (the gap that the closure coupling bridges); this will expose the primary reducer during pressure testing. Examples of these different approaches are pictured below:

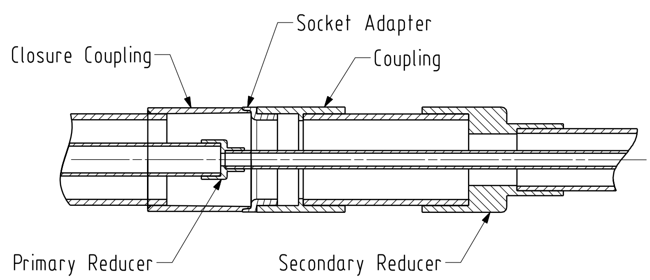
Using a closure coupling (exposed joint)



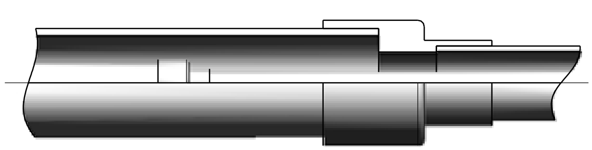


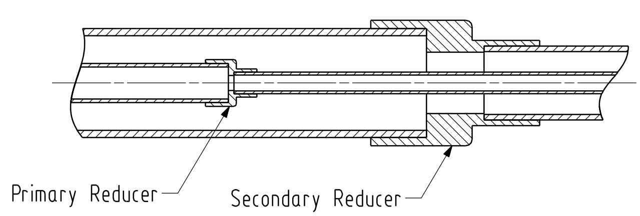
Using a closure coupling (sealed)





Without using a closure coupling





Double Contained Valves

GF Piping Systems offers a wide range of solutions for double containment valve applications. All containment vessels are sold with the valves pre-installed with full support and custom-fabricated connections for simplicity and convenience during installation. A number of variations concerning pressure rating, handle positioning, manual/actuation, and a full range of sizes and materials are available.

Valves must be supported independently of standard support spacing to prevent stressing attached pipes. See "Above Ground Installation" for details.

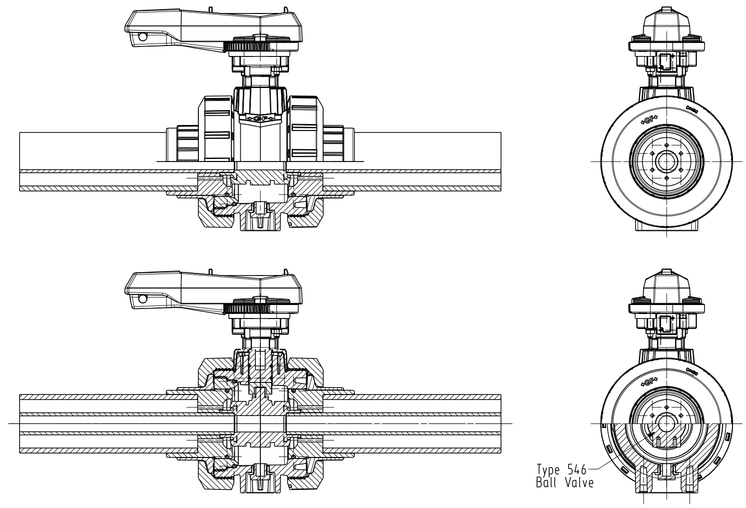
For questions and customized products, contact GF Piping Systems.

Product Offerings

Pressure Rated

Double Contained Manual Ball Valve

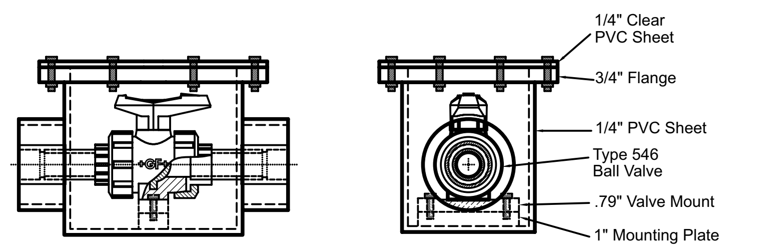
- Unique variation of Type 546 ball valve: Turning outside handle actuates ball valve in primary line.
- State-of-the-art fully pressure rated, compact design.
- ½"–2"
- Rated to 150 psi



Not Pressure Rated

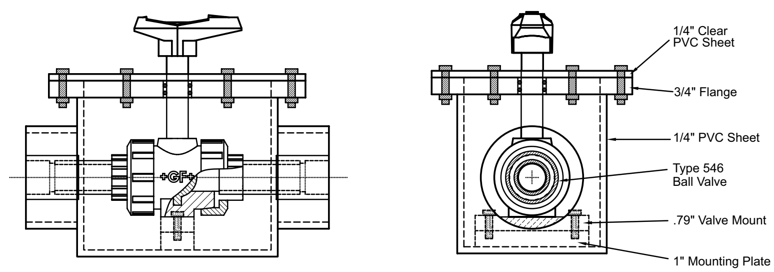
Manual Valve Box

- Type 546 ball valve
- Handle inside box
- Flanged lid for access
- Clear lid for visual inspection
- ½"–4"



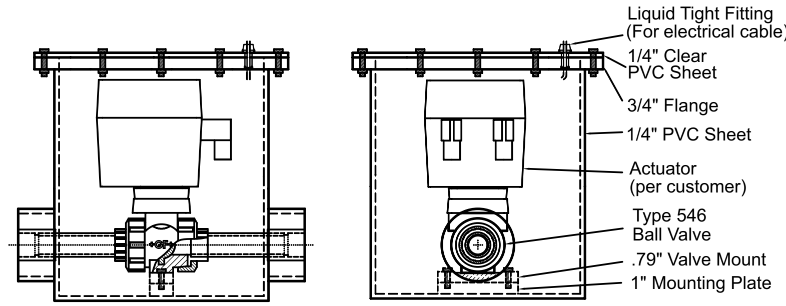
Manual Valve Box – External Handle

- Type 546 ball valve
- External Handle (custom extension)
- Flanged lid for access
- Clear lid for visual inspection
- ½"–4"



Actuated Valve Box

- Type 546 ball valve
- Type 107 actuator
- Actuator inside box
- Flanged lid for access
- Clear lid for visual inspection
- ½"–2"



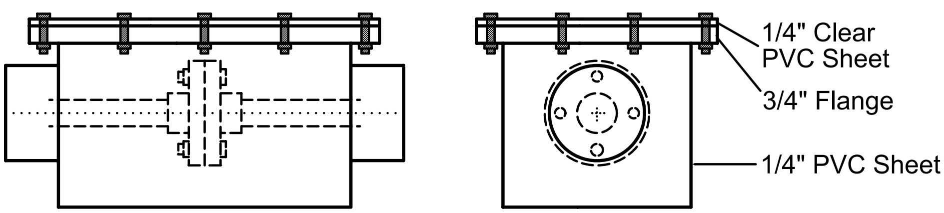
Flange/Union Boxes

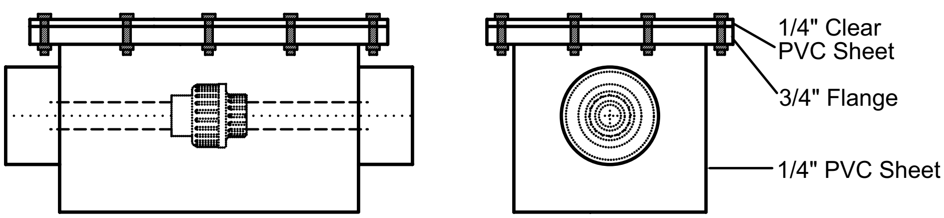
GF Piping Systems offers a wide range of boxes engineered to contain mechanical joints such as flanges and unions. These may be particularly useful for applications requiring system mobility, temporary systems, and at points of transition to other materials.

Flange/union boxes feature the same sturdy, leak-proof construction as our line of valve boxes, and like the valve boxes, they are not pressure rated.

These boxes do not include flanges, unions, or primary pipe connections. For dimensional data and part information, see flange and union pages in the part listings.

Flange/union boxes must be supported independently of standard support spacing to prevent stressing attached pipes.

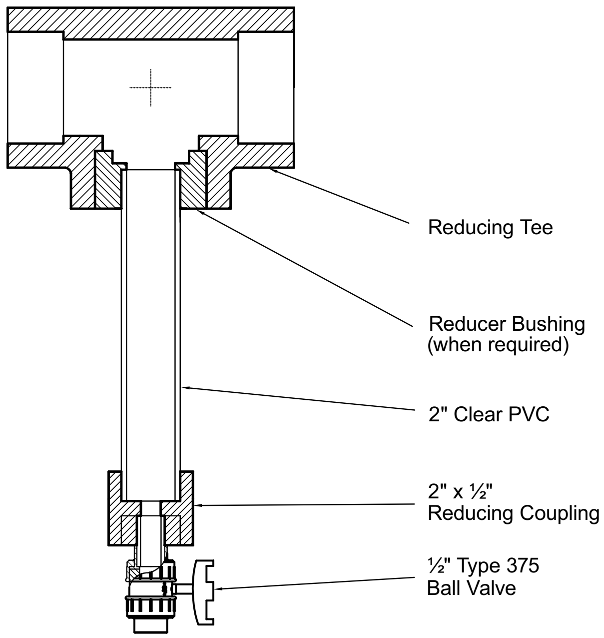




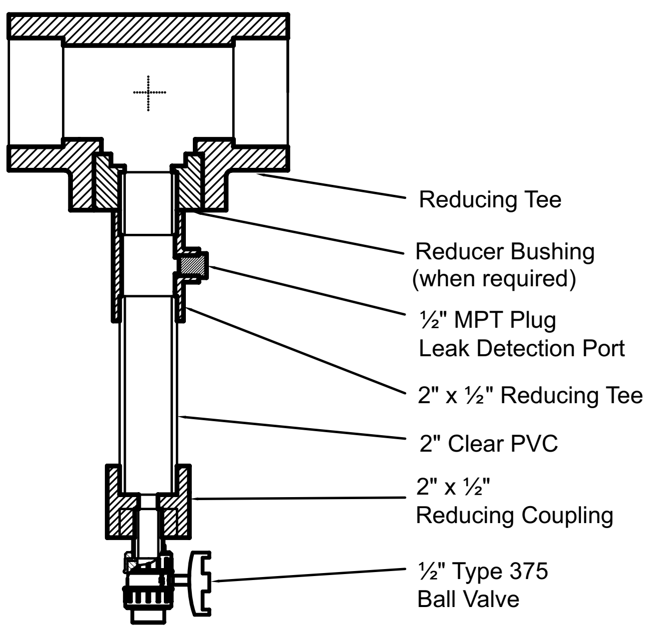
Leak Detection Tees

GF Piping Systems offers two variations of leak detection tees. Both also serve as low-point drains and high-point vents for the secondary pipe system.

Visual Leak Detection



Visual Leak Detection
Level Sensor Port



Repair a Break in a Pipe or Replace a Leaky Fitting

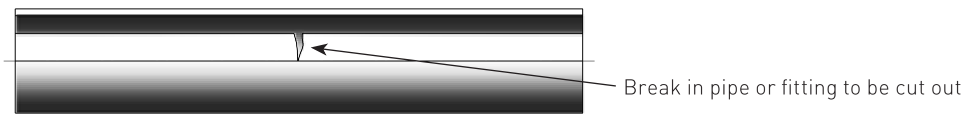
The lifespan of PVC and CPVC piping systems frequently exceeds 50 years of service. However, this does not mean that these systems are completely invincible. From poorly installed joints to long term external and environmental stresses, a number of circumstances may lead to system leaks over time. Though failures are not common, if a PVC/CPVC pipe system is properly installed, joints and components may eventually need repair.

The following instructions serve as general guidelines for repairing the Double-See system should there be a failure for whatever reason. Because every pipe system is unique, this is not the only method of repair. As such, this procedure may not be suitable for every scenario. If in doubt, consult Georg Fischer before performing a system repair.

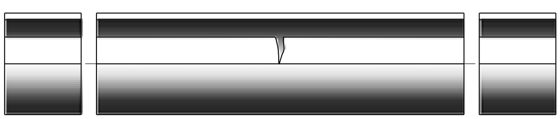
Procedure

You will need the following parts: two (2) primary pipe couplings, one (1) closure coupling kit, two (2) secondary couplings, and segments of replacement primary and secondary pipe.

1. Once a leak is detected, locate the source. Shut off the flow of fluid in the primary pipe and empty the contents of the system (or isolated section containing the leak). If pipes carry hazardous media, make sure to completely flush the system.



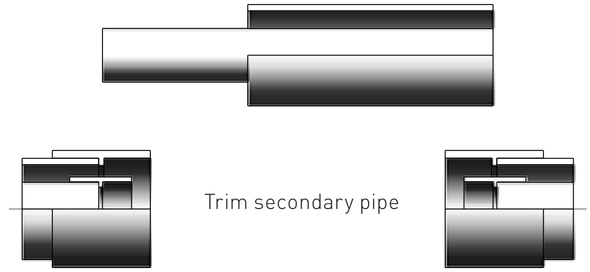
2. Mark the spot of the leak and cut out a section of pipe (primary and secondary) or fitting to be replaced, removing the leaking segment. [Note: if a fitting is leaking, cut the pipe past the fitting, not the fitting itself]. Make sure that the new gap in the pipe is at least as long as 3 closure couplings. Make sure cut ends of primary and secondary pipes are flush.

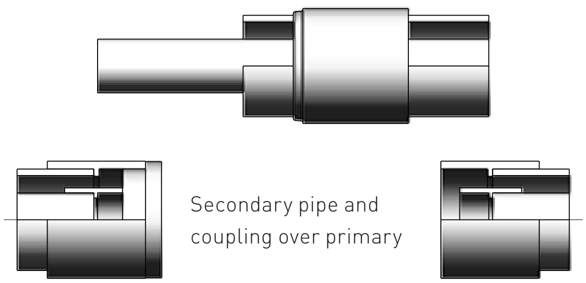


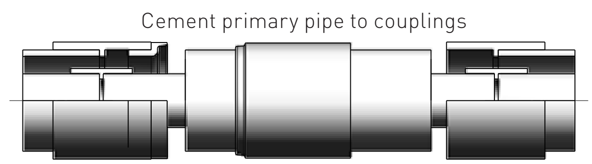
3. Dry all surfaces of exposed pipe ends. Solvent cement primary pipe couplings to the exposed primary pipes. (Details on solvent cementing are explained in the Installation Instructions section).

4. Solvent cement secondary couplings onto the secondary pipe ends.

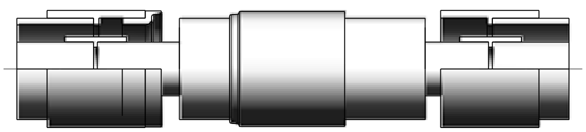
5. Cut replacement pipe sections; trim secondary to appropriate length for closure coupling installation (trim lengths defined in table on page 43). Place secondary pipe and closure coupling over primary pipe (ensure closure coupling is oriented properly). Solvent cement primary pipe into the primary couplings.



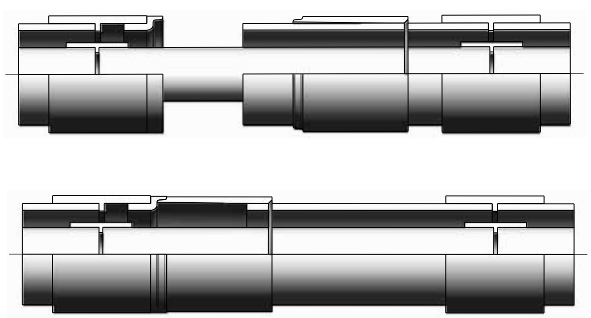




6. Pressure test the system with new primary joints exposed.



7. Cement secondary pipe into secondary coupling, and cement closure coupling and socket adapter to secondary pipe.



Pressure Testing

Primary Pipe

The internal pressure test should be completed only after the last cemented joint has sufficient cure time for the working conditions. One of the key advantages of the Double-See system is the ability to inspect the primary piping joint before the secondary piping system is joined (and comply with ASME Standard for Pressure Piping system Section B31.3 part 345.1). The primary pipe can be tested in its entirety or in sections depending on the size of the project, job site conditions or requirements of the owner, building codes, or local authorities.

The internal pipe should be tested hydrostatically, slowly filling the system from the lowest point and taking care to remove any entrapped air by opening vents at high points. It is a good idea to allow the system to purge out any debris that may have accumulated during installation. Once all entrapped air is removed the system should be closed off, connect a pressure gauge and slowly build pressure in 25 PSI increments, checking for any leaks through the open space at each joint or loss of gauge pressure. If no leaks or loss of pressure is detected at the lower pressure, the system should be brought to final test pressure according to local code requirements or to 150% of maximum operating pressure (not rated pressure) for 1 hour. Note: a loss of 2–3% of gauge pressure is normal due to pipe relaxation or temperature change.

Secondary Pipe

Once the primary pipe has been successfully tested, the secondary pipe joints can be cemented closed following the procedures outlined in this manual. After sufficient cure time, the secondary system can be tested either hydrostatically (150 PSI or less depending on joining method) or pneumatically using low pressure (not more than 5 PSI) air or inert gas. Warning: Georg Fischer does NOT recommend any vinyl piping system be tested with compressed gas greater than 5 PSI. Severe bodily harm can result from over pressurization of PVC or CPVC piping systems.

CARE MUST BE TAKEN TO ISOLATE NON-PRESSURE RATED VALVE BOXES FROM ANY TEST PRESSURE. Non-pressure rated valve boxes will be severely damaged if exposed to any test pressure.

Pressure-rated Double-See valves from GF Piping Systems, however, can be safely tested with water or air per limits stated above.

It is recommended that secondary piping systems tested with 5 PSI gas be fitted with a pressure-limiting device such as a rubber test fitting or pressure relief valve set for not more than 8 PSI at the opposite end of the where test gas is introduced. Once the secondary system is properly prepared, apply pressure and check for gauge pressure loss and/or apply a soap solution to joints.

Standards

Standards allow an engineer to develop a specification which will provide accepted material and product performance. Having strong industry standards provides the market with the necessary criteria to determine the suitability of a specific material and/or product for a specific application. Within the plastics industry the primary source of these standards is ASTM which are usually the basis of most specifications.

Manufacturers may also subscribe to other standards, such as IAPMO, NSF, ANSI, ASME and UL. For the purposes of this manual we will restrict our listing of standards to those that are relevant to Schedule 80 PVC and CPVC.

ASTM (American Society for Testing and Materials)

D-1784: "Standard Specification for Rigid Poly(vinyl Chloride) (PVC) and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds"

This specification covers the compound materials physical requirements for PVC and CPVC pipe, valves and fittings based on several physical and chemical properties.

D-1785: "Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120"

This specification covers poly(vinyl chloride) (PVC) pipe made in Schedule 40, 80 and 120 sizes and pressure-rated for water. Included are criteria for classifying PVC plastic pipe materials and PVC plastic pipe, a system of nomenclature for PVC plastic pipe and requirements and test methods for materials, workmanship, dimensions, sustained pressure, burst pressure, flattening, and extrusion quality.

D-2466: "Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40"

This specification covers poly(vinyl chloride) (PVC) Schedule 40 pipe fittings. Included are requirements for material, workmanship, dimensions, and bust pressure.

D-2467: "Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80"

This specification covers poly(vinyl chloride) (PVC) Schedule 80 pipe fittings. Included are requirements for materials, workmanship, dimensions, and burst pressure.

D-2672: "Standard Specification for Joints for IPS PVC Pipe using Solvent Cement"

This specification covers the socket produced for solvent cements joints on both pressure and non-pressure IPS pipe. It also covers the testing of the joints on both pressure and non-pressure pipe, and includes requirements for socket dimensions, burst pressure, and joint tightness tests of the solvent cemented joints. The tests described are not intended for routine quality control, but rather to evaluate the performance characteristics of the joint.

D-2855: "Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings"

This recommended practice describes, in detail, procedures for making solvent cemented joints. Preparation of the surfaces, applying the cement, making the assembly, handling after assembly, testing and a schedule of drying times related to temperature and pipe sizes are covered.

F-1498: "Standard Specification for Taper Pipe Threads 60° for Thermoplastic Pipe and Fittings"

This specification established requirements for dimensions and gauging of taper pipe threads used on threaded plastic pipe and fittings.

F-402: "Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings"

This recommended practice covers procedures for the safe handling of solvent cements containing solvents which may be flammable, toxic or irritants. It recommends precautions and safeguards against the hazards of fire.

F-437: "Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80"

This specification covers chlorinated poly(vinyl chloride) (CPVC) threaded Schedule 80 pipe fittings. Included are requirements for materials, workmanship, dimensions, and burst pressure.

F-439: "Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80"

This specification covers chlorinated poly(vinyl chloride) (CPVC) Schedule 80 pipe fittings. Included are requirements for materials, workmanship, dimensions, and burst pressure.

F-441: "Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80"

This specification covers chlorinated poly(vinyl chloride) (CPVC) pipe made in Schedule 40 and 80 sizes and pressure-rated for water. Included are criteria for classifying CPVC plastic pipe materials and CPVC plastic pipe, a system of nomenclature for CPVC materials, workmanship, dimensions, sustained pressure, burst pressure, flattening and extrusion quality. Methods of marking are also given.

ASME/ANSI (American Society of Mechanical Engineers / American National Standards Institute)

These standards were developed for metal pipe systems and some or all of the components have been adopted by the plastic piping industry. It its extremely important for the engineer or specifying influence to understand the scope of these standards and the extent to which plastic piping will conform.

B16.5: Flanges and Flanged Piping

In plastic piping systems, this standard is used to establish the flange O.D., bolt hole pattern and bolt hole size.

B1.20.1: National Pipe Thread Taper - Pipe Thread Dimensions

This is a dimensional specification covering standard tapered pipe threads, identified by GF Piping Systems as FPT (Female Pipe Thread) and MPT (Male Pipe Thread).

NSF/ANSI (National Sanitation Foundation / American National Standards Institute)

This company acts as the third-party certification agency for the plastics industry, as well as providing a certification regarding the acceptability of product for certain applications, such as potable water or chemical waste.

Standard 14: Plastic Piping Systems Components and Related Materials

This standard applies to inspection for compliance with all relevant industry standards. This primarily relates to ASTM but NSF will certify compliance with any standards the company publicly claims to meet.

Standard 61: Drinking Water Systems Components – Health Effects

This standard relates to the suitability of product in potable water systems.

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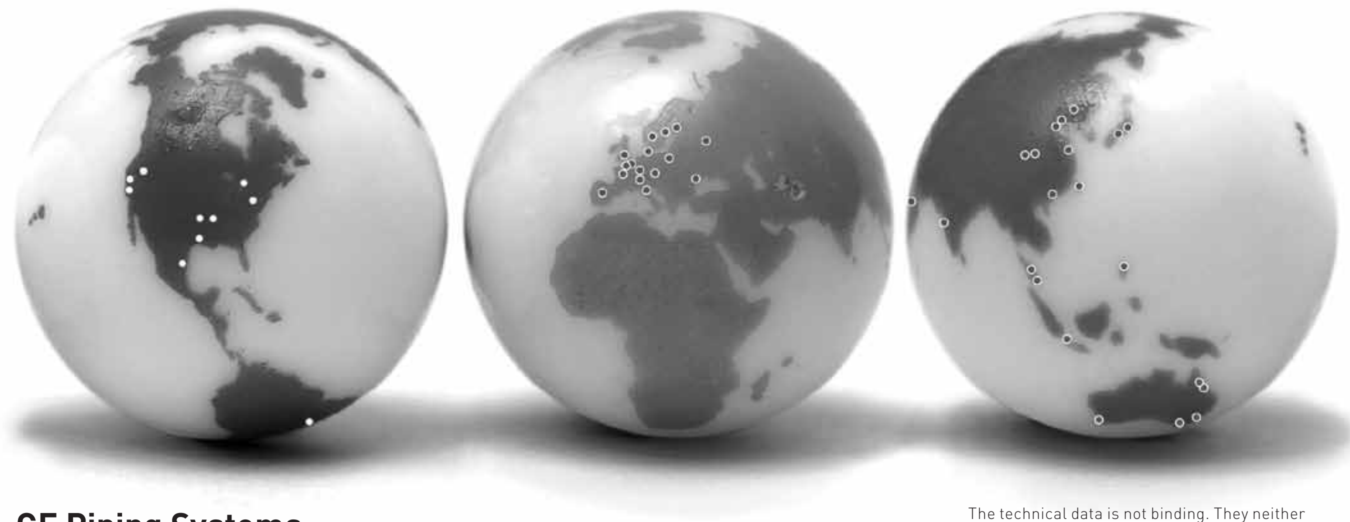

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