SPEARS®

EverTUFF®

CPVC CTS Plumbing System

CPVC CTS Products Design and Installation Manual

⚠ WARNING

Failure to follow instructions and warnings can result in serious personal injury, property damage, and/or product failure.

- Read and understand all instructions before attempting to install any Spears® CPVC Products.
- Wear safety glasses, hardhat, and foot protection.

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PURPOSE OF THIS MANUAL

This manual is intended for use by specifiers, installers, and users in the selection, design, installation, and inspection of CPVC systems installed using Spears® CPVC products. All information contained within this manual is considered vital to obtain proper system performance and must be read and fully understood before attempting to install these products. If you have any questions about the safe and proper installation of these products, contact Spears® Manufacturing Company 15853 Olden Street, Sylmar CA 91342 USA, Telephone (818) 364-1611 • (800) 862-1499.

HAZARD IDENTIFICATION

Definitions for identifying the various hazard levels are provided below.

This safety alert symbol indicates important safety messages. When you see this symbol, be alert to the possibility of personal injury. Carefully read and fully understand the message that follows.

⚠ DANGER

The use of the word "DANGER" identifies an immediate hazard with a likelihood of severe personal injury or death if instructions, including recommended precautions, are not followed.

⚠ WARNING

The use of the word "WARNING" identifies the presence of hazards or unsafe practices that could result in severe personal injury if instructions, including recommended precautions, are not followed.

⚠ CAUTION

The use of the word "CAUTION" identifies possible hazards or unsafe practices that could result in personal injury, product damage, and/or property damage if instructions, including recommended precautions, are not followed.

NOTICE

The use of the word "NOTICE" identifies special instructions that are important but not related to hazards.

INSTALLER SAFETY INSTRUCTIONS

Read and understand this manual before proceeding with the installation and testing of the Spears® CPVC system. Education and a complete understanding of the instructions provided are requirements for the installer of the Spears® CPVC system. These instructions contain important information. If you need additional copies of this manual, or if you have any questions about the safe installation and use of this system, contact Spears® Manufacturing Company 15853 Olden Street, Sylmar CA 91342 USA, Telephone (818) 364-1611 • (800) 862-1499.

1. Inspect the product. Make sure all parts are included with the shipment and that all necessary tools are available for proper installation.
2. Wear safety glasses, hardhat, and foot protection.
3. Avoid dangerous environments. If using electrically powered tools for installation, make sure the area is free from moisture or wetness that could create unsafe working conditions. Keep work areas well lit. Allow sufficient space for measuring and dry-fitting the system.
4. Prevent back injury. Always practice safe lifting and installation techniques.
5. Use only tools specifically designed for plastic tube and fittings.
6. Work in a well-ventilated area. Ensure that there is proper ventilation when applying primers and cements and/or soldering materials
7. Wear protective gloves. PVA-coated protective gloves are recommended when applying solvent cement. If hands contact solvent cement, use a waterless, abrasive soap to remove all residue..
8. When solvent cementing, avoid sources of heat or open flame. DO NOT smoke while handling solvent cement.
9. Keep work areas clean. Cluttered areas and slippery floors can create hazardous working conditions.
10. Wear hearing protection. Protect your hearing if you are exposed to long periods of very noisy job-site operations.
11. Keep visitors away. All visitors should be kept a safe distance away from the work area.
12. Follow all manufacturers' recommended precautions when cutting or sawing tubes, or when using any heat, flame, or power tools.

MODEL CODES

Spears® CPVC products meet ASTM D 2846 requirements, as referenced in the current version of the following model codes.

Code	Organization
BOCA National Plumbing Code	Building Officials and Code Administrators International, Inc.
CABO 1- and 2-Family Dwelling Code	Council of American Building Officials
Canadian Plumbing Code	National Research Council, Canada
International Plumbing Code	BOCA, ICBO, SBCCI
National Standard Plumbing Code	National Association of Plumbing-Heating-Cooling Contractors
Standard Plumbing Code	Southern Building Code Congress International Inc.
Uniform Plumbing Code	International Association of Plumbing and Mechanical Officials

LISTING AGENCIES

Standard	Organization
Standards 14 and 61	NSF International (ANSI/NSF)

HELPFUL INFORMATION - ENGLISH AND METRIC CONVERSION CHART

The following table can be used as a guide for converting measurements listed throughout this manual.

Convert U.S. to Metric →				← Convert Metric to U.S.		
25.4	X	Inches (in.)	=	millimeters (mm)	X	0.03937
0.3048	X	feet (ft.)	=	meters (m)	X	3.281
0,4536	X	pounds (lbs.)	=	kilograms (kg)	X	2.205
28,35	X	ounces (oz.)	=	grams (g)	X	0.03527
6.894	X	pressure (psi)	=	kilopascals (kPa)	X	0.145
.069	X	pressure	=	Bar	X	14.5
4.45	X	end load (lbs.)	=	Newtons (N)	X	0.2248
1.358	X	torque (ft-lbs)	=	Newton meters (N•m)	X	0.738
F – 32 ÷ 1.8		temp. (° F)	=	Celsius (° C)		C X 1.8 + 32
745.7	X	horsepower (hp)	=	watts (W)	X	1.341 X 10^{-3}
3.785	X	gal. per min. (GPM)	=	liters per min. (L/M)	X	0.2642
3.7865	X	10^{-3} gal. per min. (GPM)	=	cubic meters per min. (m^3/m)	X	264.2

HANDLING AND STORAGE

Spears® CPVC products resist attack from a large group of chemicals that are corrosive to metallic piping. However, care must be taken to avoid contact with chemicals that are harmful to CPVC. Specific chemicals, or chemical vapors, that contact CPVC can weaken or damage the system. Consult with Spears® before using these CPVC products with any questionable materials.

⚠ WARNING

- **DO NOT expose Spears® CPVC products to edible oils, esters, ketones, or petroleum-based products, such as: cutting oils; packing oils; traditional pipe thread paste or dopes; and certain lubricants. Consult with Spears® before using certain chemicals with these CPVC products.**

Failure to follow this instruction could cause product/system damage, resulting in serious personal injury and/or property damage.

Spears® recommends that CPVC products be stored indoors. If storing outdoors, these products must be covered with a non-transparent material to prevent extended sunlight exposure. Brief exposure to direct sunlight on the job site may result in color fade, but it will not affect the material's physical properties. Spears® CPVC fittings should be stored in their original containers to keep them free from dirt and to help reduce the possibility of damage.

⚠ WARNING

- **Spears® CPVC products must not be subjected to prolonged sunlight exposure.**
- **For outdoor storage, products must be stored in their original shipping containers, or they must be covered with a non-transparent material.**

Failure to follow this instruction could cause product/system damage, resulting in serious personal injury and/or property damage.

Reasonable care must be exercised in handling Spears® CPVC products. Do not drop these products or allow anything to drop on them. If improper handling results in scratches, splits, or gouges, the damaged fitting or section of tubing must be discarded.

SYSTEM LISTINGS, USAGE, AND STANDARDS

Penetrating Fire-Rated Walls and Partitions

Spears® CPVC products can be used within fire-rated buildings, provided all penetrations of fire barriers are constructed so that the fire rating of the barrier is not compromised. Most codes accept penetration sealing systems or devices that are UL Listed or have passed the appropriate ASTM E 119 or E 814 tests. The PPFA manual, "Plastic Pipe in Fire Restrictive Construction" (NER370), provides more information and lists the applicable test reports. In addition, reference can be made to the current issue of the "Underwriters Laboratories Inc. Directories of Fire Resistance – Vol. II" or the "WHI Certification Listings." Before starting an installation, always consult the building codes and local authority having jurisdiction.

⚠ WARNING

- **Some fire-stopping systems contain chemicals that can damage CPVC products. Always consult with Spears® and the fire-stop manufacturer concerning compatibility with CPVC products.**

Failure to follow this instruction could cause product/system damage, resulting in serious personal injury and/or property damage.

Underslab Installations

Spears® CPVC products are approved for underslab installations (with joints) in all model-plumbing codes. When performing underslab installations, it is important to support the tube evenly on a smooth surface. The bedding and backfill should be sand or clean soil that is free from sharp rocks and other debris that could damage the tube.

Underslab installations that contain joints must be pressure tested before pouring the slab. NOTE: IAPMO IS 2098, "Installation Standard for CPVC Solvent Cemented Hot and Cold Water Distribution Systems," requires a test at 150 psi for 2 hours. The tube should be sleeved where it penetrates the slab, along with construction joints within the slab.

Spears® CPVC products can be used with tube manufactured in accordance with ASTM D 2846, which is available in coils for underslab installations. When turning coiled tubing up through a slab, into walls, etc., make sure the tubing does not kink. Sections of tube that contain kinks must be cut out and replaced.

Freeze Protection/Sunlight Exposure

CPVC piping must be protected from freezing in all installation locations. Attention shall be paid to local insulating techniques and codes that require a particular method. Use only methods and materials suitable for use with CPVC piping. Where freezing is not an issue, CPVC shall not be installed so as to be subject to direct sunlight after installation and not installed on the surface of a building, unless protected by a covering or a chemically compatible paint, such as water based Latex.

Hose Bibb Installation

Hose bibbs are to be connected only to metal system components which are adequately anchored to the building structure. CPVC plastic systems must terminate in the wall.

Water Heater Connections

Before attempting to use Spears® CPVC products in water heater connections, determine if local plumbing codes contain detailed requirements for connections to gas or electric storage-type heaters. DO NOT use Spears® CPVC products with commercial-type, non-storage water heaters.

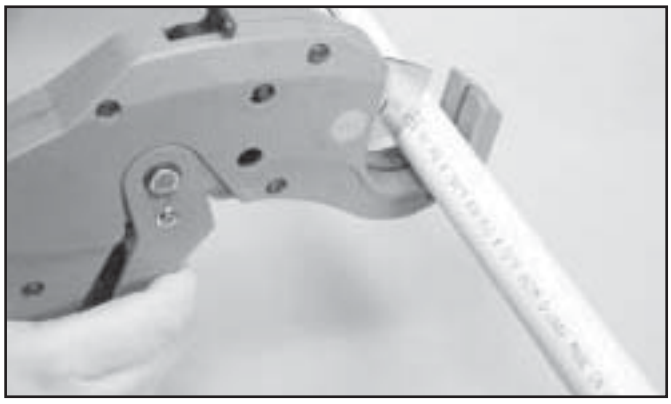
For areas where local plumbing codes do not have requirements, the following information can be used as a guide for water heater connections:

- On electric water heaters, CPVC can be joined directly to the heater, using metal-to-CPVC transition fittings.
- On high-efficiency gas water heaters that use plastic vent piping, CPVC can be joined directly to the heater in the same way as an electric water-heater connection.
- On all other gas water heaters, there should be at least 6" of clearance between the exhaust flue and any CPVC tubing. A minimum of 6" metallic pipe should connect directly to the heater so that the CPVC tubing cannot be damaged by the buildup of excessive, radiant heat from the flue.
- A temperature/pressure relief valve should be installed so that the sensing element contacts the water at the top of the heater.
- Spears® CPVC products are approved by all model codes for use as relief-valve drain lines. A metal-to-CPVC transition fitting should be used to connect the tubing to the relief valve. Then, the tubing should be continued to the outlet. Both horizontal and vertical pressure relief drain should be supported every 3 feet.
- For horizontal runs, slope the tubing toward the outlet. Support the tubing at 3-foot centers or closer. The tubing must discharge to the atmosphere at an approved location.
- Instantaneous water heaters (i.e., under sink units) require at least 6" of metallic pipe connected to heater inlet and no CVPC installed down stream.

BASIC JOINT ASSEMBLY

Cutting the Tube

CPVC tubing can be cut easily with a ratchet cutter, wheel-type plastic tubing cutter, a power saw, or any other fine-tooth saw.

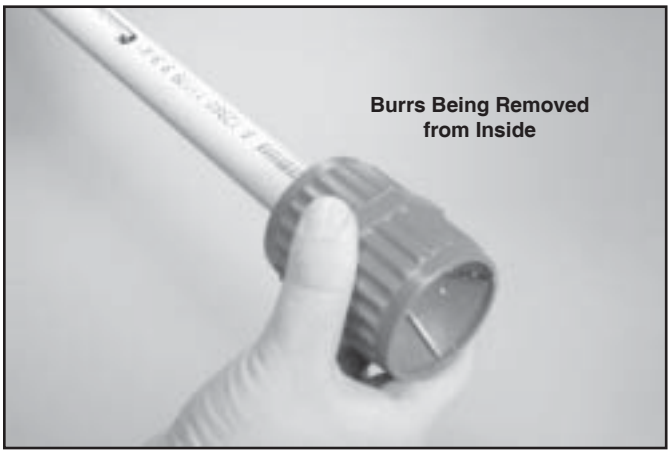


Be careful not to split the tube if using a ratchet-type cutter, especially in temperatures below 50° F. If any damage or cracking is evident, cut off at least 2" of the tube beyond any visible crack.

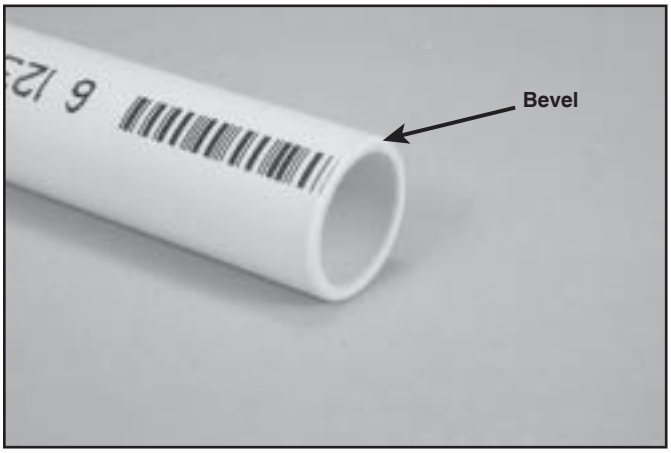
It is important that the cutting tools being used are designed for plastic tubing. To ensure that the tube is cut square, use a miter box when cutting the tube with a saw. Cutting the tube as square as possible provides the maximum bonding surface area.

Deburring

Burrs and filings can prevent contact between the tube and the fitting during assembly and must be removed from the outside and the inside of the tube. A chamfering tool or file is suitable for this purpose (refer to photos below).



A slight bevel must be placed at the end of the tube, as shown below. A slight bevel will ease the entry of the tube into the socket and minimize the chance of cement being wiped off the fitting.



Fitting Preparation

Using a clean, dry rag, wipe any loose dirt and moisture from the fitting's socket and tube end. Moisture can slow the cure time, and at this stage of assembly, excessive moisture can reduce joint strength.

⚠ WARNING

- **Before assembling any Spears® CPVC products, inspect all components for cuts, scratches, gouges, split ends, or any other irregularities that have occurred during shipping and handling.**

Failure to follow this instruction could cause joint/system failure, resulting in serious personal injury and/or property damage.

Check all mating components to ensure that tolerances and engagements are compatible. DO NOT use any components that appear irregular or do not fit properly. Contact Spears® regarding any questions about usability.

Check the dry fit of the tube and fitting. The tube should enter the fitting's socket easily 1/4 - 3/4 of the way.

⚠ WARNING

- **Always apply a second coat of cement to the tube for joints that are 1-1/4 inch and larger.**

Failure to follow these instruction could cause joint/system failure, resulting in serious personal injury and/or property damage.

SOLVENT CEMENTING PROCEDURES

Verify the expiration date located on the solvent cement container. The cement can be used for a period of 2 years from the date stamped on the container. When cementing tube and fittings in extremely cold temperatures, make sure the cement has not "JELLED." Jelled or expired cement must be discarded in an environmentally friendly fashion, in accordance with local regulations. To prolong the life of solvent cement, keep the containers tightly closed when not in use, and cover the container as much as possible during use. If an unopened solvent cement container is subjected to freezing temperatures, the cement may become extremely thick. Place the closed container in a room temperature area where, after a short time period, the cement will return to a usable condition. DO NOT attempt to heat solvent cement.

⚠ WARNING

- **Before assembling any Spears® CPVC products, verify that the solvent cement is within 2 years of the date stamped on the can and that it does not have a "JELLED" appearance. Jelled or expired solvent cement will not provide the strength needed to make a proper joint.**

Failure to follow these instruction could cause joint/system failure, resulting in serious personal injury and/or property damage.

The cement must be applied when the tubes and fittings are clean and free from any moisture and debris.

USING AN APPLICATOR OR NATURAL BRISTLE BRUSH THAT IS AT LEAST 1/2 THE SIZE OF THE TUBE DIAMETER, WORK THE CEMENT INTO THE JOINING SURFACES USING A CONTINUOUS, CIRCULAR MOTION.

Apply the cement in the following sequence, as pictured below:

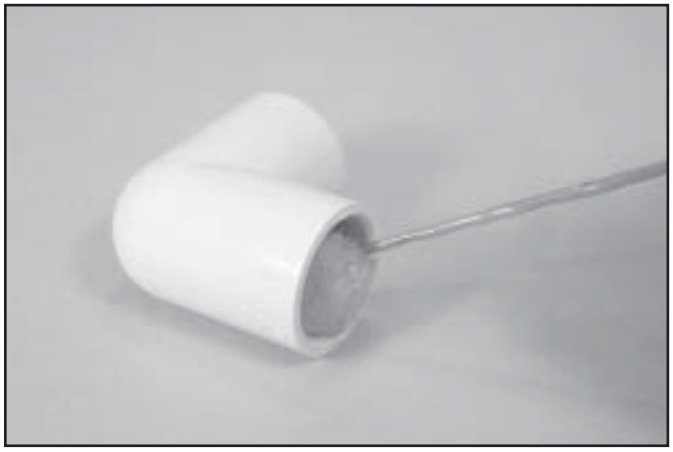
1. Apply a coat to the tube

2. Apply a coat to the fitting

3. Apply a second coat to the tube, if required

Avoid puddling the cement on or within the fitting and tube. Puddled cement causes excess softening and damage to the CPVC material.

Apply a heavy, even coat of cement to the outside of the tube end. Work the cement into the joining surfaces using a continuous, circular motion.



Apply a medium coat to the fitting socket. Avoid getting cement in other sockets or threaded connections.

A second application of cement must be applied to the tube end if a 1¼-inch and larger joint is being prepared.

⚠ WARNING

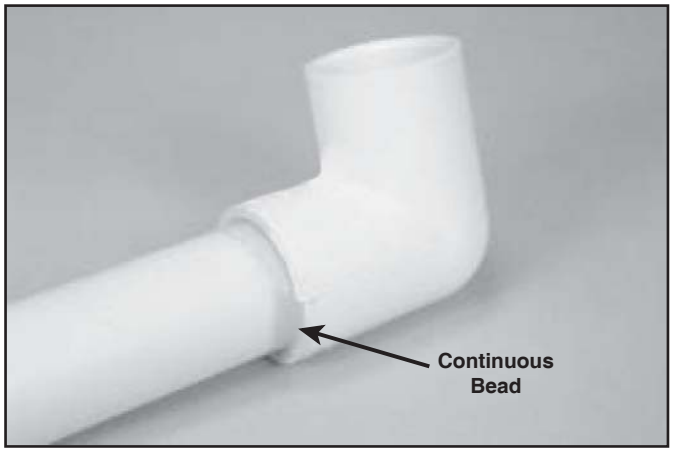
- **Always apply a second coat of cement to the tube for joints that are 1-1/4 inch and larger.**
- **Avoid puddling the cement on the tube or within the fitting.**
- **Avoid getting cement into other sockets or threaded connections.**

Failure to follow these instructions could cause joint/system failure, resulting in serious personal injury and/or property damage.

Joint Assembly

Immediately insert the tube into the fitting's socket while rotating the tube 1/4 turn. Align the fitting in the proper orientation at this time. Make sure the tube bottoms out at the fitting's stop.

Hold the assembly for 10 to 15 seconds to ensure initial bonding occurs. A bead of cement must be present around the tube and fitting juncture. If this bead is not continuous around the socket's shoulder, insufficient cement was applied.



If insufficient cement was applied, the joint must be cut out and discarded, and a new joint must be assembled.

Any cement, in excess of the bead, can be wiped off with a dry, clean rag.

Set and Cure Times

- The set and cure times for CPVC solvent cement depend on tube size, temperature, relative humidity, and tightness of fit. Drying time is faster for drier environments, smaller tube sizes, high temperatures, and tighter fits.
- Special care must be taken when assembling Spears® CPVC products in low temperatures (below 40° F) or high temperatures (above 80° F).
- Extra set and handling times must be allowed in colder temperatures. When cementing tube and fittings in cold temperatures, make sure the cement has not "JELLED." Jelled cement must be discarded.
- In higher temperatures, make sure both surfaces to be joined are still wet with cement during assembly.
- The assembly must be allowed to set, without any stress on the joint, for 5 minutes.

- Following the initial set period, the assembly can be handled carefully by avoiding stress on the joint.

Refer to the following table for minimum cure times before pressure testing.

MINIMUM CURE TIMES FOR SOLVENT CEMENT BEFORE PRESSURE TESTING

150-psi Maximum Test Pressure

Tubing Size	Ambient Temperature During Cure (Relative Humidity 60% or Less)		
Nominal Diameter inches	60° F to 100° F	40° F to 60° F	0° F to 40° F
1/2	15 minutes	20 minutes	30 minutes
3/4	15 minutes	20 minutes	30 minutes
1	15 minutes	20 minutes	30 minutes
1-1/4	15 minutes	20 minutes	30 minutes
1-1/4	30 minutes	45 minutes	1 hour
2	30 minutes	45 minutes	1 hour

⚠ WARNING

- **Make sure the cement is allowed to cure, according to the times listed in the chart, for the tube size and ambient temperature.**

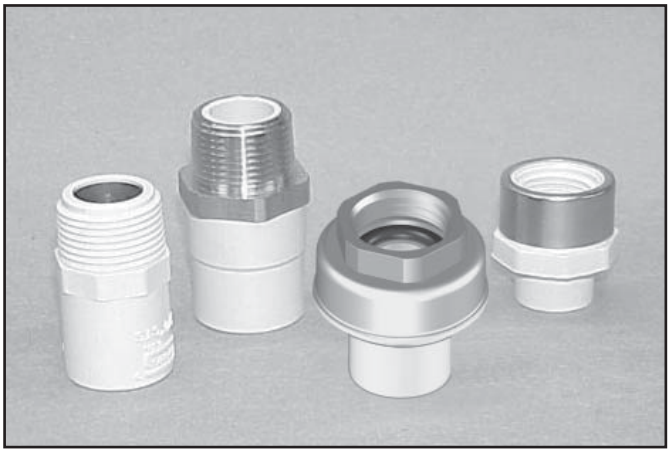
Failure to follow this instruction could cause joint/system failure, resulting in serious personal injury and/or property damage.

TRANSITION JOINTS AND FITTINGS

CPVC pipe can be connected to copper, brass, valves, and other materials using a variety of transition fittings including unions, compression fittings, specially reinforced male and female adapters, flanged joints, grooved joints and other readily available transition fittings.

Do not thread CPVC pipe and do not use regular CPVC female threaded fittings. Regular CPVC male threaded fittings shall only be used on cold water applications. Special reinforced male adapters, female adapters and other fittings with brass threads are recommended for hot water applications and threaded transitions to metal pipe. All approved threaded CPVC joints must be accessible. (See also Water Heater Connections section for additional installation details).

Standard compression fittings with brass ferrules can be used; however, Teflon® (TFE) tape must be applied over the brass ferrule to compensate for the dissimilar thermal expansion rates between the brass and CPVC. Caution must be exercised to prevent over tightening of compression fittings. Use extreme care when soldering any metal system to prevent flame contact with or heat distortion in CPVC pipe and fittings.



Assembling Threaded Connections

Threaded connections require the application of a thread sealant that is compatible with CPVC material. Spears® recommends the use of Spears® Blue 75 Thread Sealant.

⚠ WARNING

- **Use only thread sealants recommended by Spears®. Other joint compounds or pastes may contain substances that could cause stress cracks in CPVC or brass materials.**

Failure to follow these instructions could cause joint/system failure, resulting in serious personal injury and/or property damage.

Apply sealant to the male threads only. Make sure all threads are covered. DO NOT clog the waterway with excess sealant.

If Teflon tape is used, Spears® recommends a thickness of at least .0025" that meets or exceeds military specification, MIL-T-27730A. DO NOT use a combination of tape and thread sealant on the same joint.

Apply Teflon tape in the direction of the threads by starting with the first full thread and continuing over the entire thread length. Make sure all threads are covered. Generally, 2 – 3 wraps are sufficient to produce a watertight connection

⚠ WARNING

- **DO NOT use more than five wraps of Teflon tape. Excessive tape can cause bunching, resulting in fractures of the plastic fitting or the brass insert due to excessive hoop stress.**

Failure to follow these instructions could cause joint/system failure, resulting in serious personal injury and/or property damage.

*Teflon is a registered trademark of I.E. Dupont de Nemours.

DO NOT over-torque any threaded connections. Generally, one to two turns beyond finger-tight are required for a threaded connection. Factory testing has indicated that 10 – 25 ft-lbs of torque is adequate to obtain a leak-free seal. Spears® recommends the use of a smooth-jawed wrench or strap wrench when installing threaded connections.

⚠ WARNING

- **Tools with teeth MUST NEVER be applied to any part of a CPVC fitting. The teeth can damage and weaken CPVC material.**

Failure to follow these instructions could cause joint/system failure, resulting in serious personal injury and/or property damage.

ENGINEERING DATA SECTION

Tube and Fitting Specifications

CPVC tube is produced in SDR 11 dimensions using copper tube size (CTS) outside diameters, as specified in ASTM D 2846. Spears® fittings are produced in SDR 11 dimensions, in accordance with ASTM D 2846. The combined tube and fitting system is NSF listed for potable water. In addition, the system meets test requirements of the Uniform Building Code.

CPVC Tubing Dimensions

SDR 11 (Ref. ASTM D-2846)			
Size Nominal inches	**Average OD inches**	**Average ID inches**	**Weight lbs/ft**
1/2	0.625	0.485	0.085
3/4	0.875	0.713	0.140
1	1.125	0.921	0.218
1-1/4	1.375	1.125	0.330
1-1/4	1.625	1.329	0.460
2	2.125	1.739	0.790

Pressure Ratings

The Spears® CPVC system, including the joint, has a continuous rated working pressure of 100 psi at 180° F or 400 psi at 73° F. CPVC systems have the capability to withstand short-term temperature/pressure increases above 100 psi at 180° F, as evidenced by their ability to consistently surpass the 48-hour, 150-psi Uniform Building Code test at 210° F. CPVC pipe should not be used where temperatures will consistently exceed 180° F.

Pressure-Temperature De-Rating Factors
For CTSCPVC 4120 SDR 11 Piping Systems

° F	Factor	Rating, PSI
73	1.00	400
80	1.00	400
90	0.91	360
100	0.82	325
120	0.65	260
140	0.50	200
160	0.40	160
180	0.25	100

The pressure de-rating factor is the same for all pipe sizes.

Example: Determine the maximum allowable operating pressure for a CTS CPVC piping system with an operating temperature of 140° F. Using de-rating factor of 0.50 for 140° from the above chart, the maximum allowable operating pressure = 400 x 0.50 = 200 psi.

Hydraulic Design

Friction Loss – Friction loss through CPVC pipe is most commonly obtained by the use of the Hazen-Williams equations as expressed below for water:

$$f = .2083 \times \left(\frac{100}{C}\right)^{1.852} \times \frac{G^{1.852}}{di^{4.8655}}$$

where:

f = friction head of feet of water per 100' for the specific pipe size and I.D.

C = a constant for internal pipe roughness. 150 is the commonly accepted value for CPVC pipe.

G = flow rate of gallons per minute (U.S. gallons).

di = inside diameter of pipe in inches.

Compared to other materials on construction for pipe, thermoplastic pipe smoothness remains relatively constant throughout its service life.

Flow Velocities – Velocities for water in feet per second at different GPM's and pipe inside diameters can be calculated as follows:

$$V = .3208\frac{G}{A}$$

where:

V = velocity in feet per second
G = gallons per minute
A = inside cross sectional area in square inches

While these systems can operate with flow velocities in excess of 10 feet per second, a maximum of 8 feet per second velocity is recommended to extend system life.

The following table lists Friction Loss and Flow Velocities for SDR 11 CTS CPVC Pipe at different flow rates.

FRICTION LOSS AND FLOW VELOCITY FOR SDR 11 CTS CPVC PIPE

Friction head and friction loss are per 100 feet of pipe.

	1/2 in.			3/4 in.			1 in.			1-1/4 in.			1-1/4 in.			2 in.		
Gallons Per Minute	Velocity Feet Per Second	Head Loss Feet of Water Per 100 Ft.	Pressure Loss PSI Per 100 Ft.	Velocity Feet Per Second	Head Loss Feet of Water Per 100 Ft.	Pressure Loss PSI Per 100 Ft.	Velocity Feet Per Second	Head Loss Feet of Water Per 100 Ft.	Pressure Loss PSI Per 100 Ft.	Velocity Feet Per Second	Head Loss Feet of Water Per 100 Ft.	Pressure Loss PSI Per 100 Ft.	Velocity Feet Per Second	Head Loss Feet of Water Per 100 Ft.	Pressure Loss PSI Per 100 Ft.	Velocity Feet Per Second	Head Loss Feet of Water Per 100 Ft.	Pressure Loss PSI Per 100 Ft.
1	1.71	3.19	1.38	0.80	0.50	0.22	0.48	0.15	0.06									
2	3.42	11.43	5.00	1.60	1.82	0.79	0.96	0.53	0.23									
3	5.13	24.43	10.59	2.40	3.85	1.67	1.44	1.12	0.49									
4	6.83	41.62	18.04	3.20	6.55	2.84	1.93	1.91	0.83									
5	8.54	62.91	27.27	4.00	9.91	4.29	2.41	2.89	1.25	1.61	1.09	0.47	1.16	0.49	0.21	0.68	0.13	0.06
6	10.25	88.12	38.23	4.79	13.89	6.02	2.89	4.05	1.76									
7	11.96	117.32	50.86	5.59	18.47	8.01	3.37	5.39	2.34									
8	13.67	150.23	65.13	6.39	23.66	10.26	3.85	6.90	2.99									
9	15.38	186.85	81.00	7.19	29.42	12.76	4.33	8.58	3.72									
10	17.08	227.11	98.45	7.99	35.76	15.50	4.82	10.43	4.52	3.23	3.94	1.71	2.31	1.75	0.76	1.35	0.49	0.21
15				11.99	75.78	32.85	7.22	22.11	9.58	4.84	8.35	3.62	3.47	3.71	1.61	2.03	1.03	0.45
20				15.98	129.11	55.97	9.63	37.67	16.33	6.46	14.23	6.17	4.63	6.33	2.74	2.70	1.76	0.76
25							12.04	56.94	24.69	8.07	21.51	9.33	5.78	9.56	4.15	3.38	2.66	1.15
30							14.45	79.82	34.60	9.68	30.15	13.07	6.94	13.40	5.81	4.05	3.73	1.62
35							16.86	106.19	46.03	11.30	40.11	17.39	8.09	17.83	7.73	4.73	4.96	2.15
40										12.91	51.37	22.27	9.25	22.83	9.90	5.40	6.35	2.75
45										14.51	63.89	27.70	10.41	28.40	12.31	6.08	7.89	3.42
50										16.14	77.66	33.66	11.56	34.52	14.96	6.75	9.60	4.16
55										17.75	92.65	40.16	12.72	41.18	17.85	7.43	11.45	4.96
60													13.88	48.38	20.97	8.10	13.45	5.83
70													16.19	64.37	27.90	9.46	17.89	7.76
80																10.61	22.91	9.93
90																12.16	28.50	12.35
100																13.51	34.64	15.02
125																16.89	52.37	22.70

Hanger/Support Spacing

Since CPVC tube is rigid, it requires fewer supports than flexible, plastic systems.

Vertical runs should be supported at each level so that the weight of the run is not placed on a fitting or a joint.

Horizontal runs require support every 3 feet for 1/2" - 1" diameter pipe and every 4 feet for 1-1/4" and larger diameters. Support spacing should be in accordance with applicable local codes.

Horizontal runs must be braced so that the stress loads (caused by bending or snaking) will not be placed on a fitting or a joint. Hanger support spacing information is shown in Table A.

Spears® recommends that hangers, designed for supporting CPVC, be used to support CPVC tubing. However, some hangers, designed for steel pipe, may be used if their suitability is clearly established. These hangers must be selected to accommodate the specific tube size. In addition, they cannot contain rough or sharp edges that contact the tube, and they must not bind the tube from axial movement that is caused by expansion and contraction.

Table A - Hangers and Supports
Reference CPVC ASTM D-2846 Systems

Tube Size (CTS) Nominal inches	Maximum Support Spacing Feet	Water-filled Weight lbs/ft
1/2	3	0.153
3/4	3	0.294
1	3	0.486
1-1/4	4	0.726
1-1/4	4	1.014
2	4	1.733

⚠ WARNING

Horizontal runs and vertical risers of CPVC piping require additional support and provision for expansion and contraction, compared to metal piping systems. Systems must be designed and installed by qualified personnel, in accordance with the properties and capabilities of the material.

Failure to follow these instructions could causes joint or system failure, resulting in serious personal injury and/or property damage.

Material Properties

Table I
Modulus of Elasticity and Stress vs. Temperature

Property	Temperature ° F							
	73	80	90	100	110	120	140	150
Modulus of Elasticity "E" × 10^5 psi	3.900	3.840	3.780	3.700	3.460	3.210	3.050	2.840
Working Stress "S" psi	1900	1785	1630	1485	1345	1270	950	875

Table II
Physical and Thermal Properties

Property		CPVC	ASTM
Specific Gravity	"Sp. Gr."	1.51	D 792
IZOD Impact Strength (ft-lbs/inch of notch)		5.0	D 256A
Modulus of Elasticity, psi	"E"	3.9 × 10^{-5}	D 638
Ultimate Tensile Strength, psi		8,000	D 638
Compressive Strength, psi	"σ"	9,000	D 695
Poisson's Ration	"υ"	.35 - .38	–
Working Stress @ 73° F, psi	"S"	1,900	D 1598
Hazen-Williams "C" Factor	"C"	150	–
Coefficient of Linear Expansion in/(in ° F)	"e"	3.2 × 10	D 696
Thermal Conductivity BTU/(hr ° F tt/in^2)	"k"	0.95	C 177
Upper Temperature Limit	"° F"	205	
Flammability		Flame Retardant	
Electrical Conductivity		Non-Conductor	

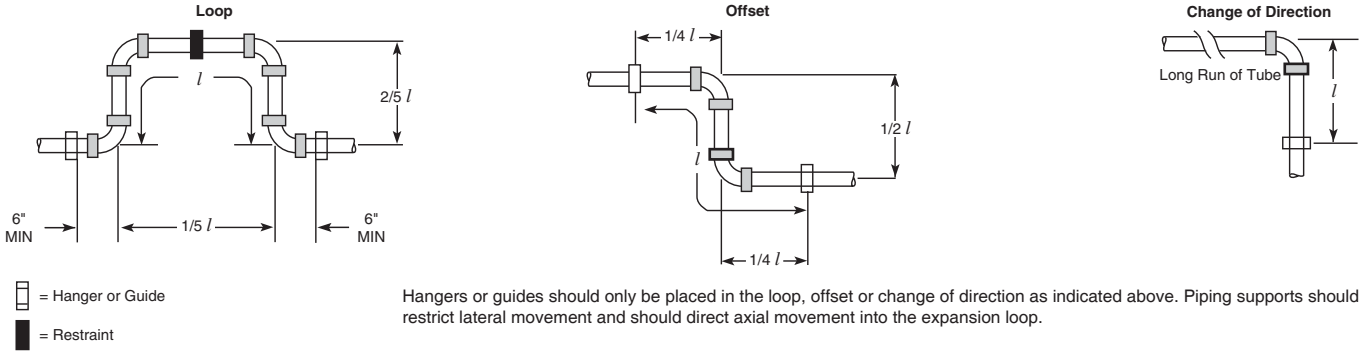
Expansion and Contraction

⚠ WARNING

Horizontal runs and vertical risers of CPVC piping require additional support and provision for expansion and contraction, compared to metal piping systems. Systems must be designed and installed by qualified personnel, in accordance with the properties and capabilities of the material.

Failure to follow these instructions could causes joint or system failure, resulting in serious personal injury and/or property damage.

Expansion Loop Offset Configurations



= Hanger or Guide

= Restraint

Hangers or guides should only be placed in the loop, offset or change of direction as indicated above. Piping supports should restrict lateral movement and should direct axial movement into the expansion loop.

CPVC, like all piping materials, expands and contracts with changes in temperature. The coefficient of linear expansion for CPVC is 3.2 X 10^{-5} inch/inch-° F. A 25° F change in temperature will cause an expansion of 1" for a 100-ft straight length. For most installation and operating conditions, expansion and contraction can be accommodated at changes of direction. Based on the following chart, an offset or loop is required on a long, straight run.

Table III: Thermal Expansion in inches

Temp Change ΔT ° F	Length of Run in feet													
	5	10	15	20	25	30	25	40	45	50	70	90	120	160
	Thermal Expansion ΔL (inches)													
20	0.04	0.08	0.12	0.15	0.19	0.23	0..27	0.31	0.35	0.38	0.54	0.69	0.92	1.23
30	0.06	0.12	0.17	0.23	0.29	0.35	0.40	0.48	0.52	0.58	0.81	1.04	1.38	1.84
40	0.08	0.15	0..23	0.31	0.38	0.46	0.54	0.61	0.69	0.77	1.09	1.38	1.84	2.46
50	0.10	0.19	0..29	0.38	0.48	0.58	0.67	0.77	0.86	0.98	1.34	1.73	2.90	3.07
60	0.12	0.23	0..35	0.46	0.58	0.69	0.91	0.92	1.04	1.15	1.61	2.07	2.78	3.69
70	0.19	0.27	0.40	0.54	0.67	0.81	0.94	1.09	1.21	1.34	1.88	2.42	3.23	4.30
80	0.15	0.31	0.48	0.61	0.77	0.92	1.08	1.23	1.38	1.54	2.15	2.78	3.69	4.92
90	0.17	0.35	0.52	0.68	0.86	1.04	1.21	1.38	1.56	1.73	2.42	3.11	4.15	5.53
100	0.19	0.38	0.58	0.77	0.96	1.15	1.34	1.54	1.73	1.92	2.69	3.46	4.61	6.14

ΔL = 12 el (ΔT)
e = 3.2 X 10^{-5} in./in. ° F (Coefficient of Linear Expansion – Table II)
L = Length of Run in feet
ΔT = Temperature Change in ° F

Example: How much will a 40-ft run of 2" CPVC tube expand if the expected ambient temperature will range from 45 ° F to 85 ° F?
ΔL = 12 el (ΔT)
ΔL = 12 (.000032) x 40 x 40
ΔL = .61"

Table IV: Expansion Loop Length in inches

Nominal Tube Size	Avg. O.D.	Length of Run in feet													
		5	10	15	20	25	30	35	40	45	50	70	90	120	160
		Length of Loop (inches) Temperature Change (ΔT) = 100° F - 30° F = 70° F													
1/2	0.625	6	8	10	11	13	14	15	16	17	18	21	24	27	32
3/4	0.875	7	9	11	13	15	16	18	19	20	21	25	28	32	38
1	1.125	8	11	13	15	17	18	20	21	23	24	28	32	37	43
1-1/4	1.375	8	12	14	17	19	20	22	24	25	26	31	35	41	47
1-1/2	1.625	9	13	16	18	20	22	24	26	27	29	34	39	44	51
2	2.125	10	15	18	21	23	25	27	29	31	33	39	44	51	58

Note: Table IV is based on 70° F temperature change. Values rounded.

$$l = \sqrt{\frac{3ED(\Delta L)}{2S}}$$

l = Length of Expansion Loop in inches
E = Modulus of Elasticity at 100° F (Table I)
D = Average OD of Tube
ΔL = Change in Length of Tube Due to Change in Tempeature (Table III)
S = Working Stress at 100° F (Table I)

Example: How much expansion can be expected in a 200-ft run of 2" CPVC tube? How long shou.d the expansion loop be to compensate for the expansion (the expected temperature range will be from 40° F to 110° F)?

First Find:

ΔT = (Change in Temperature)
$\Delta T = T2 - T1$
$\Delta T = 110° F - 40° F$
$\Delta T = 70° F$

To Find

ΔL = (Amount of Expansion in inches from Table III)
$\Delta L = \Delta L$ of 160 ft with a ΔT of 70° F + ΔL of 40 ft. with a ΔT of 70° F
$\Delta L = 4.30" + 1.08"$
$\Delta L = 5.38"$

— OR —

$\Delta L = 12 eL (\Delta T)$
$e = 3.2 \times 10^{-5}$ from Table II)
L = Length of Run in Feet
ΔT = Change in Temperature in ° F
$\Delta L = 12 \times 000032 \times 200 \times 70$
$\Delta L = 5.38"$

$$l = \sqrt{\frac{3ED(\Delta L)}{2S}}$$

l = Length of Expansion Loop in inches
E = Modulus of Elasticity at 110° F (Refer to Table I)
D = Average OD of Tube
ΔL = Change in Length of Tube Due to Change in Temperature
S = Working Stress at 110° F (Refer to Table I)

To find the length of the expansion loop or offset in inches

$$l = \sqrt{\frac{3ED(\Delta L)}{2S}}$$

l = Length of Expansion Loop in inches
E = Modulus of Elasticity at Maximum Temperature from Table I
D = Average Outside Diameter of the Tube from Table IV
S = Working Stress at Maximum Temperature from Table I)
ΔL = Change in Length of Tube Due to Change in Temperature from Table III

$$l = \sqrt{\frac{3 \quad 346{,}000 \quad 2.125 \times 5.38}{2 \times 1345}}$$

$$l = \sqrt{4412}$$

$l = 66.4$

Notes

Notes

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CPVC CTS PRODUCT LIMITED LIFETIME WARRANTY

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