Installation Procedures for ABS, PVC and CPVC Piping Systems

The following information contains installation and testing procedures. These instructions, however, do not encompass all of the requirements for the design or installation of a piping system.

- Systems should be installed in a good and workmanlike manner consistent with normal industry standards and in conformance with all applicable plumbing, fire and building code requirements.
- Pipe and fitting systems should be used for their intended purpose as defined by local plumbing and building codes and the applicable ASTM standard.
- Follow manufacturers' instructions for all products.

PVC, CPVC and ABS piping systems may be joined by solvent cementing, with threaded connections, flanges or roll grooving. Detail on each of these joining systems is provided within the following pages. When applicable, Charlotte Pipe recommends socket (solvent cement) joining for PVC, CPVC and ABS piping systems.

Cutting, Joint Preparation and Solvent Cement

The tools, cleaner, primer, solvent cement and techniques required to properly join plastic piping systems are dependant upon application, pipe diameter and weather conditions. Charlotte Pipe and Foundry recommends that installers be trained and pass the ASME B 31.3 Bonder Qualification Test.

Please see the Special Considerations section of this manual for additional information.

This installation manual provides direction for the installation of the following piping systems:

- ½" – 2" FlowGuard Gold® and ReUze® CTS CPVC pipe and fitting systems with one step solvent cement.
- ½" – 4" Iron Pipe Size ABS, PVC and CPVC pipe and fitting systems with two step solvent cement.
- 6" Iron Pipe Size and larger ABS, PVC and CPVC pipe and fitting systems with two step solvent cement.

⚠ WARNING

To reduce the risk of death or serious injury from an explosion, collapse or projectile hazard and to reduce the risk of property damage from a system failure:

- Always follow the warnings and procedures provided in this manual.
- Only use PVC/ABS/CPVC pipe and fitting for the conveyance of fluids as defined within the applicable ASTM standards.
- Never use PVC/ABS/CPVC pipe and fittings for the conveyance of gasses.
- Never use PVC/ABS/CPVC pipe or fittings in structural application or in any load-bearing applications.
- Never strike the pipe or fittings or drive them into the ground or into any other hard substance.

⚠ WARNING

Failure to follow **safety precautions** may result in misapplication or improper installation and testing which can cause severe personal injury and / or property damage.

⚠ WARNING

Do not use for SPUD GUNS, FLAMETHROWERS, or COMPRESSED AIR GUNS. May result in property damage, injury or death. Use only for fluid handling / plumbing applications.

NOTICE

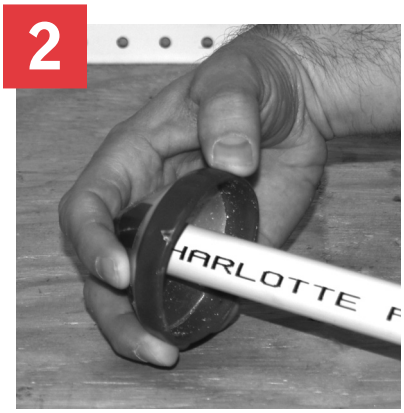
- Using an external heat source to bend PVC, CPVC, or ABS may result in structural damage to pipe and fittings.
- Always make changes in direction with fittings.

FlowGuard Gold® and ReUze® CTS Installation Procedures

1. Cut Pipe

- Cut pipe square with the axis. All joints are sealed at the base of the fitting hub. An angled cut may result in joint failure.
- Acceptable tools include ratchet type pipe cutter, miter saw or wheel type pipe cutter. Wheel type pipe cutters must employ a blade designed to cut plastic pipe. Ratchet cutters should be sharpened regularly.
- If any indication of damage or cracking is evident at the tube end, cut off at least 2" of pipe beyond any visible cracks.

2. Remove Burrs and Bevel



- Remove all pipe burrs from inside and outside diameter of pipe with a knife edge, file or de-burring tool.
- Chamfer (bevel) the end of the pipe 10° - 15°.

3. Clean and Dry Pipe and Fittings

- Remove surface dirt, grease or moisture with a clean dry cloth.

4. Dry Fit

- With light pressure, pipe should go one half to two thirds of the way into the fitting hub. Pipe and fittings that are too tight or too loose should not be used.

5. Applicator

- Use an applicator that is one half the size of the pipe's diameter.
- Too large an applicator will force excess primer or cement into the inside of the fitting. Too small an applicator will not apply sufficient cement.

6. Coat Surface with Cement

- Stir or shake the cement prior to use.
- Apply a full even layer of cement to the pipe surface to a point ½" beyond the hub depth. Aggressively work the cement into the surface.
- Without re-dipping the applicator in the cement, apply a thin layer of cement to the fitting socket aggressively working it into the surface.

- Do not allow cement to puddle or accumulate inside the system.
- Solvent cement should conform to ASTM F 493 as shown in the accompanying table. All purpose cement is not recommended.
- Primer is not required for FlowGuard Gold® one-step cement, but may be used. Check local code requirements.

7. Join Pipe and Fittings

- Assemble pipe and fittings quickly while cement is fluid. If cement has hardened, cut pipe, dispose of fitting and start over.
- Insert pipe into fitting hub giving a quarter turn ensuring an even distribution of cement within the joint.
- Once the pipe contacts the socket bottom hold pipe and fitting together until the pipe does not back out.
- Align all piping system components properly without strain. Do not bend or pull pipe into position after being solvent welded.
- See table for recommended set and cure times.
- Remove excess cement from the exterior. A properly made joint will show a continuous bead of cement around the perimeter. If voids appear sufficient cement may not have been applied and joint failure may result.

⚠ WARNING

Primers and cements are extremely flammable and may be explosive. Do not store or use near open flame or elevated temperatures, which may result in injury or death.

- Solvent fumes created during the joining process are heavier than air and may be trapped in newly installed piping systems.
- Ignition of the solvent vapors caused by spark or flame may result in injury or death from explosion or fire.
- Read and obey all manufacturers' warnings and any instructions pertaining to primers and cements.
- Provide adequate ventilation to reduce fire hazard and to minimize inhalation of solvent vapors when working with cements, primers and new piping systems.

ABS, PVC and CPVC Iron Pipe Size Installation Procedures

1/2" – 4" Iron Pipe Size ABS, PVC and CPVC Pipe and Fitting Systems

1. Cut Pipe

- Cut pipe square with the axis. All joints are sealed at the base of the fitting hub. An angled cut may result in joint failure.
- Acceptable tools include ratchet type pipe cutter, miter saw, reciprocating saw, mechanical cut off saw with carbide tipped blade or wheel type pipe cutter. Wheel type pipe cutters must employ a blade designed to cut plastic pipe. Ratchet cutters should be sharpened regularly.
- If any indication of damage or cracking is evident at the pipe end, cut off at least 2" of pipe beyond any visible cracks.

2. Remove Burrs and Bevel

- Remove all pipe burrs from inside and outside diameter of pipe with a knife edge, file or de-burring tool.
- Chamfer (bevel) the end of the pipe 10° - 15°.

3. Clean and Dry Pipe and Fittings

- Remove surface dirt, grease or moisture with a clean dry cloth.

4. Dry Fit

- With light pressure, pipe should go one half to two thirds of the way into the fitting hub. Pipe and fittings that are too tight or too loose should not be used.

5. Applicator

- Use an applicator that is one half the size of the pipe's diameter. Daubers, natural bristle brushes or swabs are recommended. Rollers are not recommended.
- Too large an applicator will force excess primer or cement into the inside of the fitting. Too small an applicator will not apply sufficient cement.

6. Coat Surface with Primer

- Apply primer to the fitting socket aggressively working it into the surface.

- Apply primer to the pipe surface to a point ½" beyond the hub depth. Aggressively work the primer into the surface.

- Apply a second coat of primer to the fitting socket aggressively working it into the surface.

- More applications of primer may be required on hard surfaces or cold weather conditions.
- Once the surface is primed remove all puddles of excess primer from the fitting socket.
- Primer should conform to ASTM F 656.
- The use of primer for ABS is not recommended. Check local code requirements.

7. Coat Surface with Cement

- Cement must be applied while primer is wet.
- Stir or shake the cement prior to use.
- Apply a full even layer of cement to the pipe surface to a point ½" beyond the hub depth. Aggressively work the cement into the surface.
- Without re-dipping the applicator in the cement, apply a medium layer of cement to the fitting socket aggressively working it into the surface. On bell end pipe do not coat beyond the socket depth.

- Apply a second full coat of cement to the pipe surface aggressively working it in.

- Do not allow cement to puddle or accumulate inside the system.
- Solvent cement should conform to the appropriate ASTM standard for the piping system as shown in the accompanying table. All purpose cement is not recommended

8. Join Pipe and Fittings

- Assemble pipe and fittings quickly while cement is fluid. If cement has hardened, cut pipe, dispose of fitting and start over.
- Insert pipe into the fitting hub giving a quarter turn as the pipe is being inserted, ensuring an even distribution of the cement within the joint. Do not quarter turn the pipe after contact with socket bottom.
- Once the pipe contacts the socket bottom hold pipe and fitting together until the pipe does not back out.
- See table for recommended set and cure times.

- Remove excess cement from the exterior. A properly made joint will show a continuous bead of cement around the perimeter. If voids appear sufficient cement may not have been applied and joint failure may result.

- Align all piping system components properly without strain. Do not bend or pull pipe into position after being solvent welded.

⚠ WARNING

Primers and cements are extremely flammable and may be explosive. Do not store or use near open flame or elevated temperatures, which may result in injury or death.

- Solvent fumes created during the joining process are heavier than air and may be trapped in newly installed piping systems.
- Ignition of the solvent vapors caused by spark or flame may result in injury or death from explosion or fire.
- Read and obey all manufacturers' warnings and any instructions pertaining to primers and cements.
- Provide adequate ventilation to reduce fire hazard and to minimize inhalation of solvent vapors when working with cements, primers and new piping systems.

ABS, PVC and CPVC Iron Pipe Size Installation Procedures

6″ and Larger Iron Pipe Size ABS, PVC and CPVC Pipe and Fitting Systems

Joining larger diameter piping systems, particularly for pressure applications, requires a higher degree of skill. Proper installation technique is critical. Close attention to the steps below will help professional mechanics to complete successful installations.

1. Cut Pipe

- Cut pipe square with the axis. All joints are sealed at the base of the fitting hub. An angled cut may result in joint failure.
- Acceptable tools include reciprocating saw, mechanical cut off saw with carbide tipped blade or other appropriate tool.
- If any indication of damage or cracking is evident at the (tube / pipe) end, cut off at least 2″ of pipe beyond any visible cracks.

2. Remove Burrs and Bevel

- Remove all pipe burrs from inside and outside diameter of pipe with a de-burring tool.
- Chamfer (bevel) the end of the pipe 10° - 15°. Powered and manual chamfering tools are available.

3. Clean and Dry Pipe and Fittings

- Remove surface dirt, grease or moisture with a clean dry cloth.

4. Mark Insertion Depth

- Measure the fitting hub depth. Using a pipe wrap as a straight edge mark the insertion depth plus 2″ in a heavy continuous line around the circumference of the pipe.

5. Dry Fit

- With light pressure, pipe should go one half to two thirds of the way into the fitting hub. Pipe and fittings that are too tight or too loose should not be used.

6. Applicator

- Use an applicator that is one half the size of the pipe's diameter. Use of an appropriately sized applicator will ensure that adequate cement is applied. Natural bristle brushes or swabs are recommended. Rollers are not recommended.
- Too small an applicator will not apply sufficient cement.

7. Crew Size

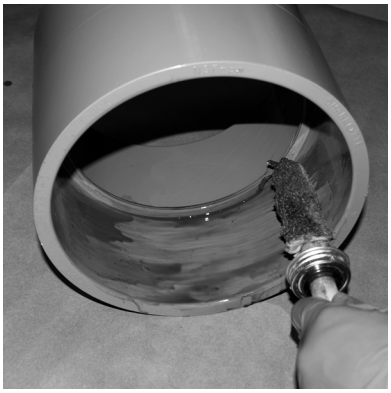
- Working rapidly, especially in adverse weather conditions, will improve installations. For 6" to 8" diameters a crew size of 2 to 3 mechanics is required. For 10" pipe diameters and larger a crew of 3 to 4 mechanics may be required.

8. Coat Surface with Primer

- Apply primer to the fitting socket aggressively working it into the surface.

- Apply primer to the pipe surface to a point ½" beyond the hub depth. Aggressively work the primer into the surface.

- Apply a second coat of primer to the fitting socket aggressively working it into the surface.
- More applications of primer may be required on hard surfaces or cold weather conditions.



- **NOTICE:** Pipe diameters 6" and larger must be installed using IPS P-70 or Oatey Industrial Grade primers.

⚠ WARNING

Primers and cements are extremely flammable and may be explosive. Do not store or use near open flame or elevated temperatures, which may result in injury or death.

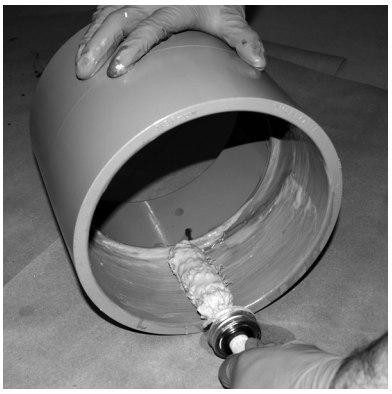
- Solvent fumes created during the joining process are heavier than air and may be trapped in newly installed piping systems.
- Ignition of the solvent vapors caused by spark or flame may result in injury or death from explosion or fire.
- Read and obey all manufacturers' warnings and any instructions pertaining to primers and cements.
- Provide adequate ventilation to reduce fire hazard and to minimize inhalation of solvent vapors when working with cements, primers and new piping systems.

- Once the surface is primed remove all puddles of excess primer from the fitting socket.
- The use of primer for ABS is not recommended. Check local code requirements.

9. Coat Surface with Cement

- Cement must be applied while primer is wet. It is ideal if one mechanic applies the primer while a second immediately applies the cement.
- Stir or shake the cement prior to use.
- Apply a full even layer of cement to the pipe surface to a point ½" beyond the hub depth. Aggressively work the cement into the surface.

- Apply a medium layer of cement to the fitting socket aggressively working it into the surface. On bell end pipe do not coat beyond the socket depth.



- Apply a second full coat of cement to the pipe surface aggressively working it in.

- Do not allow cement to puddle or accumulate inside the system.
- Solvent cement should conform to the appropriate ASTM standard for the piping system as shown in the accompanying table. Heavy bodied cement is recommended. All purpose cement is not recommended
- **NOTICE:** CPVC Schedule 80 systems must be installed using IPS 714 or Oatey CPVC Heavy Duty Orange solvent cements.

10. Join Pipe and Fittings

- Assemble pipe and fittings quickly while cement is fluid. If cement has hardened, cut pipe, dispose of fitting and start over.
- It is very important that the pipe is fully inserted to the fitting stop at the bottom of the fitting. Large diameter pipe is heavy and can develop significant resistance during insertion. The use of a pulling tool designed for plastic piping systems is recommended.

⚠ CAUTION

Failure to follow proper installation practices, procedures, or techniques may result in personal injury, system failure or property damage.

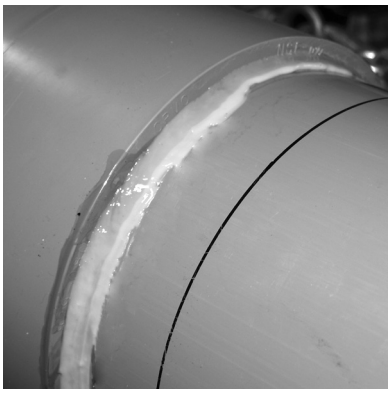
- Use a solvent cement / primer applicator that is 1/2 the size of the pipe's diameter. Too large an applicator will result in excess cement inside the fitting. Too small an applicator will not apply sufficient cement.
- Cut pipe square.
- Do not use dull or broken cutting tool blades when cutting pipe.
- Do not test until recommended cure times are met.
- Align all piping system components properly without strain. Do not bend or pull pipe into position after being solvent welded.

- Measure to verify that the pipe has been inserted to within 2" of the insertion line.

- To ensure joint integrity, once insertion is complete, the pulling tool can be used to hold the joint in place during set time and also to ensure that the pipe does not back out.

- See table for recommended set and cure times.

- Remove excess cement from the exterior. A properly made joint will show a continuous bead of cement around the perimeter. If voids appear sufficient, cement may not have been applied and joint failure may result.
- Align all piping system components properly without strain. Do not bend or pull pipe into position after being solvent welded.



⚠ WARNING

Primers and cements are extremely flammable and may be explosive. Do not store or use near open flame or elevated temperatures, which may result in injury or death.

- Solvent fumes created during the joining process are heavier than air and may be trapped in newly installed piping systems.
- Ignition of the solvent vapors caused by spark or flame may result in injury or death from explosion or fire.
- Read and obey all manufacturers' warnings and any instructions pertaining to primers and cements.
- Provide adequate ventilation to reduce fire hazard and to minimize inhalation of solvent vapors when working with cements, primers and new piping systems.

Solvent Cements

Pipe and Fitting System	Diameter (in.)	Solvent Cement Standard	Cement Color (common usage, check local code)	Description	Primer (common usage, check local code)
ABS DWV	1½ - 6	ASTM D 2235	Black	Regular or Medium-Bodied	Not Recommended
ABS Plus® Foam Core Pipe	1½ - 4	ASTM D 2235	Black	Regular or Medium-Bodied	Not Recommended
FlowGuard Gold® and ReUze® CTS CPVC	½ - 2	ASTM F 493	Yellow	Regular-Bodied	Optional
CPVC Sch. 80	½ - 2	ASTM F 493	IPS 714 or Oatey CPVC Heavy Duty Orange	Heavy-Bodied	IPS P-70 or Oatey Industrial Grade
CPVC Sch. 80	2½ - 8	ASTM F 493	IPS 714 or Oatey CPVC Heavy Duty Orange	Heavy-Bodied	IPS P-70 or Oatey Industrial Grade
CPVC Sch. 40 ChemDrain	1¼ - 8	ASTM F 493	ChemDrain Mustard Yellow (Required)	Heavy-Bodied	6" and larger: IPS P-70 or Oatey Industrial Grade required
PVC DWV or Sch. 40 Pressure	½ - 4	ASTM D 2564	Clear	Regular or Medium-Bodied	Required ASTM F 656
PVC DWV or Sch. 40 Pressure	6 - 16	ASTM D 2564	Clear or Grey	Medium or Heavy-Bodied	Required ASTM F 656
PVC Sch. 80	¼ - 2	ASTM D 2564	Grey	Medium or Heavy-Bodied	Required ASTM F 656
PVC Sch. 80	2½ - 16	ASTM D 2564	Grey	Heavy-Bodied	IPS P-70 or Oatey Industrial Grade

NOTICE: Aerosol or spray-on type primers/solvent cements are not recommended. The practice of aggressively scouring the pipe and fittings with both primer and solvent cement is an integral part of the joining process. Not working the primer or solvent cement into the pipe or fitting could cause potential system failure or property damage.

⚠ WARNING

Primers and cements are extremely flammable and may be explosive. Do not store or use near open flame or elevated temperatures, which may result in injury or death.

- Solvent fumes created during the joining process are heavier than air and may be trapped in newly installed piping systems.
- Ignition of the solvent vapors caused by spark or flame may result in injury or death from explosion or fire.
- Read and obey all manufacturers' warnings and any instructions pertaining to primers and cements.
- Provide adequate ventilation to reduce fire hazard and to minimize inhalation of solvent vapors when working with cements, primers and new piping systems.

Applicator Types

Nominal Pipe Size (in.)	Applicator Type		
	Dauber	Brush Width (in.)	Swab Length (in.)
¼	A	½	NR
⅜	A	½	NR
½	A	½	NR
¾	A	1	NR
1	A	1	NR
1¼	A	1	NR
1½	A	1 - 1½	NR
2	A	1 - 1½	NR
2½	NR	1½ - 2	NR
3	NR	1½ - 2½	NR
4	NR	2 - 3	3
6	NR	3 - 5	3
8	NR	4 - 6	7
10	NR	6 - 8	7
12	NR	6 - 8	7
14	NR	7 - 8	7
16	NR	8+	8

A = Acceptable NR = Not Recommended

NOTICE: Rollers are not recommended.

Joint Curing

The joint should not be disturbed until it has initially set. The chart below shows the recommended initial set and cure times for ABS, PVC and CPVC in iron pipe size diameters as well as for FlowGuard Gold® and ReUze® CTS CPVC.

Recommended Initial Set Times

Temperature Range	Diameter ½'' to 1¼''	Diameter 1½'' to 3''	Diameter 4'' to 8''	Diameter 10'' to 16''
60° - 100° F	15 min	30 min	1 hr	2 hr
40° - 60° F	1 hr	2 hr	4 hr	8 hr
0° - 40° F	3 hr	6 hr	12 hr	24 hr

NOTICE

A joint should not be pressure tested until it has cured. The exact curing time varies with temperature, humidity, and pipe size. The presence of hot water extends the cure time required for pressure testing. Pressurization prior to joint curing may result in system failure.

Recommended Curing Time Before Pressure Testing

RELATIVE HUMIDITY 60% or Less*	CURE TIME Diameter ½'' to 1¼''		CURE TIME Diameter 1½'' to 3''		CURE TIME Diameter 4'' to 8''		CURE TIME Diameter 10'' to 16''
Temperature Range During Assembly and Cure Periods	Up to 180 psi	Above 180 to 370 psi	Up to 180 psi	Above 180 to 315 psi	Up to 180 psi	Above 180 to 315 psi	Up to 100 psi
60° - 100° F	1 hr	6 hr	2 hr	12 hr	6 hr	24 hr	24 hr
40° - 60° F	2 hr	12 hr	4 hr	24 hr	12 hr	48 hr	48 hr
0° - 40° F	8 hr	48 hr	16 hr	96 hr	48 hr	8 days	8 days

*For relative humidity above 60%, allow 50% more cure time.
The above data are based on laboratory tests and are intended as guidelines.
For more specific information, contact should be made with the cement manufacturer.

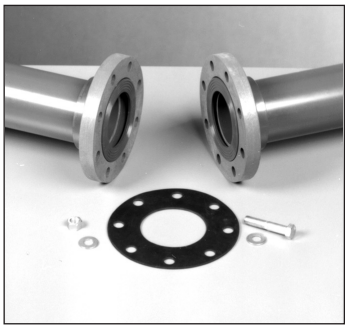
*Average number of joints per Quart for Cement and Primer (Source: IPS Weld-on)

Pipe Diameter	½''	¾''	1''	1½''	2''	3''	4''	6''	8''	10''	12''	15''	18''
Number of Joints	300	200	125	90	60	40	30	10	5	2 to 3	1 to 2	¾	½

For Primer: double the number of joints shown for cement.
* These figures are estimates based on IPS Weld-on laboratory tests.
Due to many variables in the field, these figures should be used as a general guide only.

Flanges

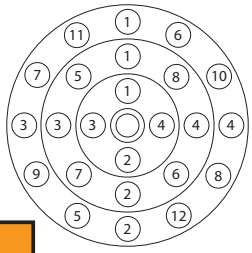
For systems where dismantling is required, flanging is a convenient joining method. It is also an easy way to join plastic and metallic systems.



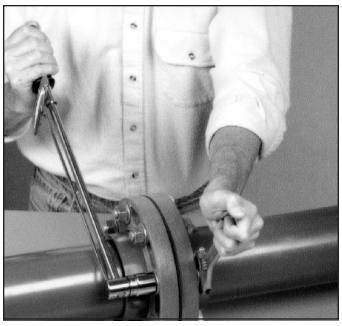
Installation

1. Join the flange to the pipe using the procedures shown in the solvent cementing or threading sections. Due to the tensile stresses placed on the solvent cement joint for flange connections, double the recommended curing time before joint assembly and pressure testing.
2. Use a full faced elastomeric gasket which is resistant to the chemicals being conveyed in the piping system. A gasket ⅛" thick with a Durometer, scale "A", hardness of 55 -80 is normally satisfactory.
3. Align the flanges and gasket by inserting all of the bolts through the mating flange bolt holes. Be sure to use properly sized flat washers under all bolt heads and nuts.
4. Sequentially tighten the bolts using a torque wrench, corresponding to the patterns shown below in increments of 10 ft-lbs at a time up to the recommended torque. New bolts and nuts should be used for proper torque.
5. Tighten flanges only to maximum recommended torque limits; do not tighten bolts in such a manner as to cause the flange ring to bend or be under stress. Connect to full face flanges or valves that conform to ANSI B16.5 150 pound dimensions and that provide full support under the entire flange face.

Flange Tightening Sequence



6. Use a torque wrench to tighten the bolts to the torque values shown below.
7. Use of thread lubricant will ensure proper torque. Confirm that the thread lubricant is chemically compatible with pipe and fittings.



8. When installing flanges in a buried application where settling could occur, the flange must be supported to maintain proper alignment in service.

Recommended Torque

Pipe Size In Inches	No. Bolt Holes	Bolt Diameter	Recommended Torque ft-lbs
½	4	½	10 - 15
¾	4	½	10 - 15
1	4	½	10 - 15
1¼	4	½	10 - 15
1½	4	½	10 - 15
2	4	⅝	20 - 30
2½	4	⅝	20 - 30
3	4	⅝	20 - 30
4	8	⅝	20 - 30
6	8	¾	33 - 50
8	8	¾	33 - 50
10	12	⅞	53 - 65
12	12	⅞	53 - 75

Note: Flanges meet the bolt-pattern requirements of ANSI / ASME B 16.5

⚠ WARNING

Testing with or use of compressed air or gas in PVC / ABS / CPVC pipe or fittings can result in explosive failures and cause severe injury or death.

- NEVER test with or transport/store compressed air or gas in PVC / ABS / CPVC pipe or fittings.
- NEVER test PVC / ABS / CPVC pipe or fittings with compressed air or gas, or air over water boosters.
- ONLY use PVC / ABS / CPVC pipe or fittings for water or approved chemicals.
- Refer to warnings on PPFA's website and ASTM D 1785.

NOTICE

- Exceeding recommended flange bolt torque may result in component damage, system failure and property damage.
- Use the proper bolt tightening sequence as marked on the flange.
- Make sure the system is in proper alignment.
- Flanges may not be used to draw piping assemblies together.
- Flat washers must be used under every nut and bolt head.
- Connect to full face flanges or valves that conform to ANSI B16.5 150 pound dimensions and that provide full support under the entire flange face.
- Exceeding recommended pressure rating and/or temperature ratings may result in component damage, system failure and property damage.
- Ensure that thread lubricant is chemically compatible with pipe and fittings.
- Piping systems differ in chemical resistance. Pipe or fittings may be damaged by contact with products containing incompatible chemicals resulting in system failure and/or property damage.
- Corrosion resistant bolts, nuts, and flat washers are recommended in chemical applications.

For information on the pressure ratings of PVC and CPVC flanges please refer to the pressure rating of fittings, flanges, and union sections in the design and engineering section of this manual.

Unions

A union fitting permits easy disconnection of a piping system for replacement or repair in the line. Union fittings consist of three separate parts that when installed properly join two sections of pipe together.

Installing the union threaded piece and union piece socket end should be done in accordance with the solvent cementing instructions provided in this manual. Care should be taken so that solvent cement does not come into contact with the union threads or the union face. **Note:** It is important to remember to place the union shoulder piece on the pipe prior to solvent cementing to the pipe. Thread or solvent cement the union threaded piece to the pipe. The joint should not be disturbed until it has initially set. Once the joints have properly cured, ensure that the two mating pieces are flush to one another prior to tightening the union ring. The ring should not draw piping systems together or correct improper alignment of the system. The ring should be hand tightened or tightened with a strap wrench only.

NOTICE

Do not exceed the maximum working pressure of any system components including pipe, fittings, valves, molded or cut threads, unions, mechanical coupling or flanges.

- The pressure rating of all components must be reduced at temperatures above 73 degrees F. Refer to de-rating table in this manual.
- Exceeding the maximum working temperature or pressure of the system may result in system failure and property damage.

NOTICE

Unions may be damaged by contact with products containing incompatible chemicals resulting in property damage or personal injury.

- Do not use lubricants or thread sealants on the union nuts.
- Never use common wrenches or tools designed for metallic pipe systems. Only use strap wrenches.
- Unions may not be used to draw piping assemblies together.
- Exceeding recommended pressure rating and/or temperature rating may result in component damage, system failure and property damage.

For information on the pressure ratings of PVC and CPVC schedule 80 unions please refer to the pressure rating of fittings, flanges, and union sections in the design and engineering section of this manual.

Procedure for Cutting Threads in Schedule 80 Pipe

1. Cutting

The pipe must be cut square using a power saw, a miter box, or a plastic pipe cutter. Burrs should be removed using a knife or deburring tool.

2. Threading

Threads can be cut using either hand held or power threading equipment. The cutting dies should be clean, sharp, and in good condition. Special dies for cutting plastic pipe are available and are recommended.

When using a hand threader, the dies should have a 5° to 10° negative front rake. When using a power threader, the dies should have a 5° negative front rake and the die heads should be self-opening. A slight chamfer to lead the dies will speed production. However, the dies should not be driven at high speeds or with heavy pressure.

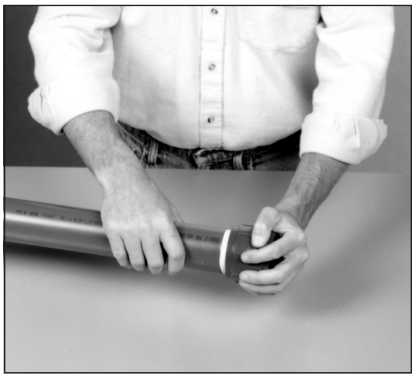
When using a hand held threader, the pipe should be held in a pipe vise. To prevent crushing or scoring of the pipe, a protective wrap such as emery paper, canvas, rubber, or a light metal sleeve should be used.

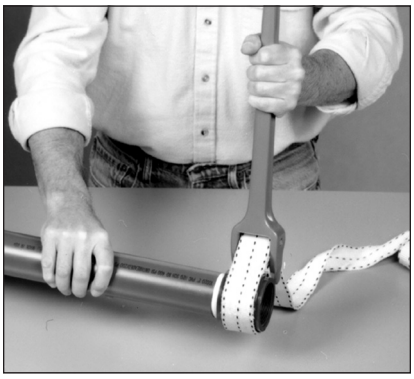
Insert a tapered plug into the end of the pipe to be threaded. This plug will provide additional support and prevent distortion of the pipe in the threading area.

It is recommended that a water soluble machine oil, chemically compatible with PVC and CPVC, be used during the threading operation. Also, clearing the cuttings from the die is highly recommended.

Do not over-thread the pipe. Consult the diagram and table showing ASTM F 1498 dimensions for American Standard Taper pipe threads. Periodically check the threads with a ring gauge to ensure that the threads are accurate. The tolerance is ±1½ turns.

*Trademark of the E.I. DuPont Company





Installation of ABS, PVC and CPVC Threaded Connections

Diameters 1 inch or Smaller

1. Make sure the threads are clean.
2. Charlotte Pipe recommends Teflon® tape thread sealant for threaded connections 1-inch or smaller. Use a good quality Teflon tape which has .4 minimum density, .003" thick, .50% elongation and chemically inert. Wrap the Teflon tape around the entire length of the threads; start with two wraps at the end and wrap all threads overlapping half the width of the tape. Wrap in the direction of the threads on each wind.
3. Maximum wrench-tightness is two turns past finger tight. Tighten with a strap wrench or similar tool. Do not use common wrenches or tools designed for metallic pipe systems.

NOTICE

All pipe thread sealants must conform to the requirements of IAPMO's PS 36 and with the thread sealant manufacturer to confirm that these sealants are chemically compatible with ABS, PVC, and CPVC. Incompatible pipe thread sealants may result in the degradation of plastic pipe or fittings resulting in product failure and property damage.

- Verify that paints, thread sealants, lubricants, plasticized PVC products, foam insulations, caulks, leak detectors, insecticides, termiticides, antifreeze solutions, pipe sleeve, firestop materials or other materials are chemically compatible with ABS, PVC or CPVC.
- Do not use edible oils such as Crisco® for lubricant.
- Read and follow chemical manufacturer's literature before using with piping materials.
- Confirm compatibility of pipe marking adhesive tape with the manufacturer of the tape to ensure chemical compatibility with CPVC pipe and fittings.

Diameters 1-1/4 inch or Larger

1. Make sure the threads are clean.
2. Charlotte Pipe recommends paste type non-hardening thread sealant for threaded connections 1-1/4 inch or larger. All thread sealants must conform to the requirements of IAPMO PS 36 and NSF Standard 61. Chemical compatibility of joint compounds and thread sealants with PVC, ABS and CPVC should be verified with the thread sealant manufacturer.
3. Maximum wrench-tightness is two turns past finger tight. Tighten with a strap wrench or similar tool. Do not use common wrenches or tools designed for metallic pipe systems.

NOTICE: All pipe thread sealants must conform to the requirements of IAPMO PS 36 and with the thread sealant manufacturer to confirm that these sealants are chemically compatible with ABS, PVC and CPVC. Incompatible pipe thread sealants may result in the degradation of plastic pipe or fittings resulting in product failure and property damage.

NOTICE

Exceeding recommended torque for threaded connections may result in component damage, system failure and property damage.

The following chart shows the correct amount of tape and torque required to make a properly functioning assembly.

Installation of Brass and CPVC Threaded Fittings			
	Torque Setting		
Pipe Size	Brass Threaded Fittings	CPVC Threaded Fittings	Teflon Tape
½″	14 ft.lbs.	3 to 5 ft.lbs.	½″ width
¾″	18 ft.lbs.	4 to 6 ft.lbs.	½″ width
1″	24 ft.lbs.	5 to 7 ft.lbs	½″ width
1¼″	30 to 60 ft.lbs.	5 to 7 ft.lbs	
1½″	23 to 34 ft.lbs.	6 to 8 ft.lbs	
2″	36 to 50 ft.lbs.	8 to 10 ft.lbs	

Note: 1 foot pound = 12 inch pounds

⚠ WARNING

Testing with or use of compressed air or gas in PVC / ABS / CPVC pipe or fittings can result in explosive failures and cause severe injury or death.

- NEVER test with or transport/store compressed air or gas in PVC / ABS / CPVC pipe or fittings.
- NEVER test PVC / ABS / CPVC pipe or fittings with compressed air or gas, or air over water boosters.
- ONLY use PVC / ABS / CPVC pipe or fittings for water or approved chemicals.
- Refer to warnings on PPFA's website and ASTM D 1785.

NOTICE

Use of FlowGuard Gold® CTS CPVC all-plastic threaded male adapters in hot water applications may result in system failure and property damage.

- Use plastic threaded CTS CPVC male adapters in cold water applications only.
- Use CTS CPVC x brass threaded transition fittings for hot water applications.
- Do not use compression fittings with brass ferrules to connect to CTS CPVC pipe or fittings where water temperatures will exceed 140 degrees F.
- CPVC pipe can be used with standard brass ferrules to make compression connections where the operating temperature will not exceed 140°F. Apply Teflon (PTFE) tape over the ferrule to allow for the dissimilar thermal expansion and contraction characteristics of the metal ferrule and the plastic pipe.

Important Information on Threaded Connections

Millions of PVC, ABS and CPVC threaded fittings have been produced over the years. When properly installed these fittings provide excellent service in both pressure and drainage applications. Some of the most common installation errors include over-tightening and the inappropriate use of female adapters.

Tapered Threads

American National Standard B2.1 is the dominant standard used for threaded fittings in piping applications. Adherence to this standard ensures that mating parts will thread properly and provide appropriate service. ANS B2.1 requires that fittings be made with tapered threads. Fittings with tapered threads work like a wedge; the wedge forming the water seal like a cork in a bottle and the threads holding the two parts together. However, this wedge also exerts tremendous force which can crack female fittings just as a small wedge tapped into a hole can be used to split giant boulders in a quarry.

In piping applications the force generated when a tapered fitting (wedge) is tightened is referred to as strain. If a threaded fitting is over-tightened, the strength of the plastic material can be exceeded, causing the material to yield and the fitting to fail.

Strain increases as the pipe diameter decreases, making it easier to split smaller-diameter threaded fittings than larger fittings. At the same time, it is easier for an installer to over-tighten small diameter fittings because less effort is required to tighten them.

Threaded Fitting Applications

Threaded plastic pipe and fittings fall into two categories of application. The first is when they are used in all-plastic systems. The second is when they are used to transition from metal to plastic. There are three possible combinations: 1) plastic male to plastic female (recommended); 2) plastic male to metal female (recommended); 3) metal male to plastic female (not recommended). Threading metal male thread into a plastic female thread produces very high stress in the plastic fitting and is not recommended by Charlotte Pipe. For reasons cited above, the Uniform Plumbing Code expressly prohibits the use of CTS CPVC female adapters.

Why do metal male threads cause so much damage when threaded into plastic female threaded fittings? Why doesn't a plastic male thread cause as much of a problem? The answer is that when plastic-to-plastic threaded fittings are tightened, the female fitting expands and the male fitting compresses. The stress is shared equally between the two. However, when a metal male thread is tightened into a plastic female thread, stress is not shared equally. Since metal has a much greater strength compared to plastic, it does not compress when tightened. This places all the stress on the plastic female fitting.

Female Adapters

An excellent example of an application where female plastic threads can be a problem is the use of Schedule 40 PVC threaded caps to test a domestic water system. In this scenario a steel pipe nipple is connected to a newly constructed domestic water system and a PVC threaded cap is used to seal the nipple as shown in the photograph.

There are several problems with this application. First, the International and Uniform Plumbing Codes do not permit the use of PVC 40 pipe and fittings to be used in domestic water

NOTICE

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- Verify that paints, thread sealants, lubricants, plasticized PVC products, foam insulations, caulks, leak detectors, insecticides, termiticides, antifreeze solutions, pipe sleeves, firestop materials or other materials are chemically compatible with ABS, PVC, or CPVC.
- Do not use edible oils such as Crisco® for lubricant.
- Confirm compatibility of pipe marking adhesive tape with the manufacturer of the tape to ensure chemical compatibility with CPVC pipe and fittings.

Exceeding recommended torque for threaded connections may result in component damage, system failure, and property damage.

Never use thread sealant when installing a P-Trap or a Trap adapter with a plastic or metallic nut. Use of thread sealants could cause seal separation or cause damage to the fitting through over-tightening.

Maximum wrench-tightness is two turns past finger tight. Plastic or metal nuts should be tightened with a strap wrench only. Never use common wrenches or tools designed for metallic pipe systems.

systems within the walls of a building, so this application is not code compliant and therefore excluded under the Charlotte Pipe and Foundry limited warranty. Second, these parts are produced to conform to ASTM D 2466 for pressure piping applications, and are not designed to be part of a test apparatus for repeated and temporary installation and testing of domestic water systems. If not installed correctly and properly tightened, system or property damage could result. For this application galvanized malleable iron threaded caps would be recommended.

Do's and Don'ts For Threaded Connections

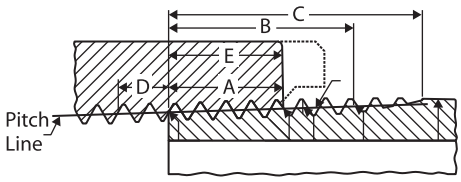
Do's

- Avoid female plastic pipe threads whenever possible.
- CPVC plastic threaded male adapters are recommended for cold water applications only.
- CPVC brass threaded transition fittings are recommended for hot and cold water applications. Brass threaded transition fittings are manufactured from low lead brass and are available in male, female and drop ear ell configurations.
- Only join to threaded components conforming to ANSI/ASME B 1.20.1 or ASTM F 1498.
- De-rate plastic threaded fittings an additional 50% beyond the pressure rating for pipe and fittings.
- Use Teflon tape for thread sealant on 1" and smaller only.
- Tighten threaded connections using a strap wrench only.
- Tighten threaded connections a maximum of two turns past finger tight.
- Make threaded plastic fitting connections in conformance to ASTM F 1498

Don'ts

- Use pneumatic tools for tightening.
- Never clamp female brass threaded transition fittings in a vise.
- Never apply more than light pressure on male brass or CPVC threaded fittings when clamping in a vise.
- Never tighten threaded fittings using common wrenches or tools designed for metallic piping systems.
- Never tighten threaded connections more than two turns past finger tight.
- Never use ABS, PVC or CPVC threaded caps as part of an assembly to test a domestic water system.

Taper Thread Dimensions



*Per ANSI/ASME B1.20.1 and ASTM F 1498

PIPE		* EXTERNAL THREAD				* INTERNAL THREAD	
Nominal Size In Inches	Outside Diameter In Inches	Number of Threads Per Inch	Normal Engagement By Hand In Inches (A)	Length of Effective Thread In Inches (B)	Total Length: End of Pipe to Vanish Point In Inches (C)	Overall Thread Internal Length In Inches (D)	Number of Threads per Inch Internally (E)
¼	.540	18	.228	.4018	.5946	.500	9.00
⅜	.675	18	.240	.4078	.6006	.500	9.00
½	.840	14	.320	.5337	.7815	.640	8.96
¾	1.050	14	.339	.5457	.7935	.650	9.10
1	1.315	11½	.400	.6828	.9845	.810	9.32
1¼	1.660	11½	.420	.7068	1.0085	.850	9.78
1½	1.900	11½	.420	.7235	1.0252	.850	9.78
2	2.375	11½	.436	.7565	1.0582	.900	10.35
2½	2.875	8	.682	1.1375	1.5712	1.210	9.68
3	3.500	8	.766	1.2000	1.6337	1.300	10.40
4	4.500	8	.844	1.3000	1.7337	1.380	11.04
6	6.625	8	.958	1.5125	1.9462	1.600	12.80
8	8.625	8	1.063	1.7125	2.1462	1.780	14.24

NOTICE

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Maximum wrench-tightness is two turns past finger tight. Plastic or metal nuts should be tightened with a strap wrench only. Never use common wrenches or tools designed for metallic pipe systems.

WARNING! To reduce the risk of death or serious injury, read and follow important safety, installation and application information at www.charlottepipe.com

For additional safety, installation and application information please call 800-438-6091. You may also get information 24 hours a day by calling our fax-on-demand number at 800-745-9382 or by visiting our website at www.charlottepipe.com.

Failure to follow safety and installation instructions may result in death, serious injury or property damage.

Joining Roll-Grooved Pipe

Roll-grooved PVC pipe is designed for use with conventional gasketed mechanical couplings. It offers a method of joining which is quick and convenient, and it can be used in applications where frequent assembly and disassembly are desirable.

Installation

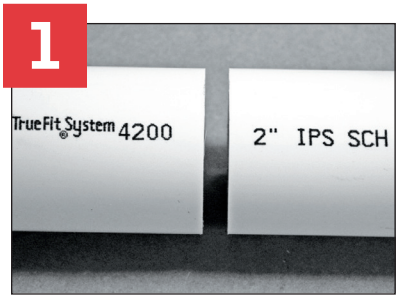
1. Consult with the manufacturer of the couplings for recommendations on the coupling style(s) designed for use with PVC pipe and the gasket material which is suitable for the intended service.

2. Check the pipe ends for any damage, roll marks, projections, or indentations on the outside surface between the groove and the end of the pipe. This is the sealing area, and it must be free of any defects.
3. Disassemble the coupling and remove the gasket. Inspect for any damage and make sure the gasket material is suitable for the intended service. Apply a thin coat of silicone lubricant to the gasket tips and the outside of the gasket.
4. Slide the gasket onto the end of one length of pipe so that it is flush with the end. Align and bring the end of another length of pipe together while sliding the gasket back over this junction. The gasket should be centered between the grooves and should not extend into the groove on either length of pipe.
5. Place the coupling housings over the gasket. The housing keys should engage into the grooves. Insert the bolts and apply the nuts. Tighten to "finger tight."
6. Using a wrench, alternately tighten the nuts to the coupling manufacturer's specifications. Over tightening is not necessary, and uneven tightening may cause gasket pinching.

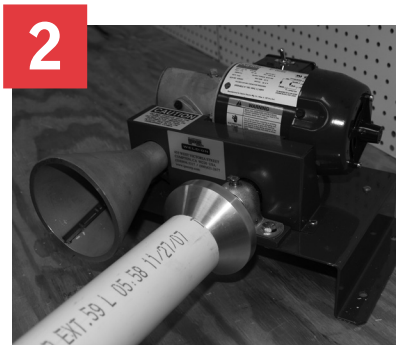
Repair Coupling Installation

Not for Pressure Applications

1. Cut out the segment of pipe to be replaced.

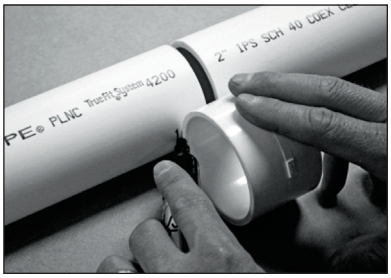


2. Remove all pipe burrs from inside and outside diameter of pipe with a knife edge, file or de-burring tool.

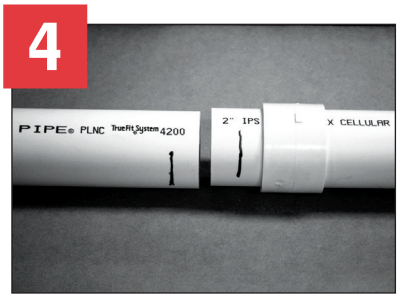


Chamfer (bevel) the end of the pipe 10° - 15°.

3. Position the repair coupling so that half of its length is equally divided between the two pipe ends. Mark each pipe end using the repair as a length guide.



4. Place the repair coupling on the pipe with the larger pipe ID (inside diameter) end facing the gap between the pipe ends. (The larger pipe ID of the coupling has raised quarter mark lines on the outside diameter of the coupling.)



5. Apply primer between the mark and pipe end on both pipe ends.
Note: The use of primer for ABS is not recommended. Check local code requirements.

6. Apply heavy body cement (if using PVC) and apply medium body cement (if using ABS) between the mark and pipe end on both pipe ends.

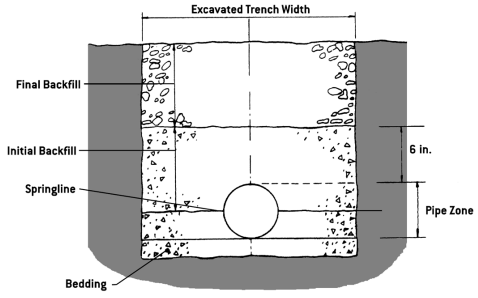
7. Push the repair coupling toward the gap until you reach the mark on the other pipe end. A bead of cement will be present around the entire diameter of the pipe and coupling.

Underground Installation of Plastic Pipe

Plastic pipe should always be buried in strict accordance with the ASTM standard relevant to the type of plastic piping system being installed. Those standards are:

ASTM D2321	Standard practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications
ASTM D2774	Standard Practice for Underground Installation of Thermoplastic Pressure Piping
ASTM F1668	Standard Guide for Construction Procedures for Buried Plastic Pipe

Note: In addition to these standards, pipe should always be installed in accordance with all local code requirements.



Recommendations for underground installation of plastic drainage pipe:

1. The minimum width of the trench should be the pipe OD (outside diameter) plus 16 inches, or the pipe outside diameter times 1.25 plus 12 inches. This will allow adequate room for joining the pipe, snaking the pipe in the trench to allow for expansion and contraction where appropriate, and space for backfilling and compaction of backfill. The space between the pipe and trench wall must be wider than the compaction equipment used to compact the backfill.

2. Provide a minimum of 4 inches of firm, stable and uniform bedding material in the trench bottom. If rock or unyielding material is encountered, a minimum of 6 inches of bedding shall be used. Blocking should not be used to change pipe grade or to intermittently support pipe over low sections in the trench.

3. The pipe should be surrounded with an aggregate material which can be easily worked around the sides of the pipe. Backfilling should be performed in layers of 6 inches with each layer being sufficiently compacted to 85% to 95% compaction.

4. A mechanical tamper is recommended for compacting sand and gravel. These materials contain fine-grains such as silt and clay. If a tamper is not available, compacting should be done by hand.

5. The trench should be completely filled. The backfill should be placed and spread in uniform layers to prevent any unfilled spaces or voids. Large rocks, stones, frozen clods, or other large debris should be removed. Stone backfill shall pass through an 1-1/2" sieve. Heavy tampers or rolling equipment should only be used to consolidate the final backfill.

6. To prevent damage to the pipe and disturbance to pipe embedment, a minimum depth of backfill above the pipe should be maintained. Pipe should always be installed below the frost level. Typically, it is not advisable to allow vehicular traffic or heavy construction equipment to traverse the pipe trench.

Note: This section is a general reference guide and should not be considered a complete engineering resource addressing all aspects of design and installation of pipe in buried applications. Charlotte Pipe recommends that a design professional use this manual along with other industry references, taking into account sub-surface conditions unique to each project, and that all installations be made in accordance with the requirements found in ASTM D 2321 and in compliance with applicable code requirements.

Gasketed Pipe Assembly*

Bar and block is the recommended method of assembly. Small-diameter pipes can be assembled by one worker, while larger diameters may require two people working together.

Besides quicker installation of a pipe line, the major advantage of barring pipe (see Bar & Block illustration below) is that the worker has a feel for the process. This assures proper alignment and assembly.

NOTE: Assembly with power equipment is not recommended.

Standard good mechanical assembly practice take alignment into consideration and produces reliable, leak-free pipe lines.

Straight alignment assembly will not dislodge gaskets. Forced, improper alignment insertion produces an insertion curve characterized by the tremendous force necessary to dislodge the gasket from the race, trap it between the bell and spigot surfaces, and stretch it backwards. The insertion force necessary to assemble a joint with dislodged gaskets is so extreme, it can only be accomplished using mechanical equipment without the operator's knowledge of the dislocation.

Joint Insertion Instructions

1. Clean the gasket area. Remove sand, dirt, grease, and debris. Do not remove gaskets from bells.

2. Check the gasket. Make sure it is seated uniformly in the groove by running your finger around the inner edge of the gasket. If the gasket has a plastic retainer ring, make sure it it's properly seated into the rubber portion of the gasket.

3. Clean the spigot. Use a rag to wipe the spigot clean.

4. Lower the pipe into the trench carefully to avoid getting dirt onto the bell or spigot.

5. Lubricate. Apply approved pipe lubricant to the bevel of the spigot end and approximately mid-way back to the reference line. A thin layer of lubricant may be applied to the face of the gasket, but be careful not to get lubricant behind or under the gasket.

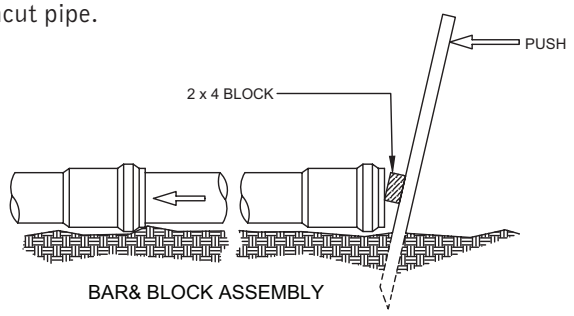
6. Keep lubricated areas clean. If dirt or sand adheres to lubricated areas, clean and re-lubricate.

7. Assemble pipe. Insert the spigot end into the pipe until it contacts the gasket uniformly or is a short distance from the gasket. Straight alignment is essential. Apply steady pressure by hand or by mechanical means (bar and block, come-along, hydraulic jack) until the spigot slips through the gasket. Insert pipe until the assembly stop line is flush with the bell end.

8. If undue resistance to pipe insertion is encountered or if the pipe cannot be inserted to the reference mark, disassemble the joint and check the position of the gasket. If the gasket is still properly positioned, verify proper positioning of the reference mark. Relocate the mark if it is not correctly positioned. In general, fittings allow less insertion than do pipe bells.

9. If the pipe must be field-cut, mark the entire circumference to ensure a square cut. Bevel the field cut the same as a factory bevel. If being installed into fittings, follow manufacturer's recommendations. Round off any sharp edges on the leading edge of the bevel with a pocket knife

or a file. Mark cut end with an insertion line similar to uncut pipe.



*Data and language courtesy of Hultec

Unstable Soil

Burial of pipe under slab in soils that are unstable is often accomplished by suspending the piping systems from structural slabs. The use of plastic pipe in such installations must be in accordance with ASTM F 2536. Cellular core pipe is specifically not permitted for these applications.

CTS CPVC Under-Slab Installations

FlowGuard Gold® and ReUze® CPVC is suitable for under-slab installations when approved by prevailing plumbing and building codes.

When performing under-slab installations, it is important that the pipe be evenly supported. Charlotte Pipe recommends pressure testing with water prior to backfilling and pouring the slab. Backfill should be clean earth, sand, gravel or other approved material, which must not contain stones, boulders or other materials that may damage or break the piping. The pipe should be protected from damage by tools and equipment used to finish the concrete. Because CPVC does not react to concrete or stucco and is inert to acidic soil conditions, it does not need to be sleeved. **NOTE:** Some code jurisdictions require sleeving at slab penetrations. Verify code requirements prior to installation.

Do not bend FlowGuard Gold® and ReUze® 1/2″ and 3/4″ pipe in a radius tighter than 18″; 1″ pipe should not be bent in a radius tighter than 24″.

Check applicable plumbing and building codes before making under-slab installations.

In-Slab Installations

CPVC is not suitable for in-slab radiant heating systems.

CPVC piping can be installed embedded in a concrete slab, because CPVC does not react to concrete or stucco and it is inert to acidic soil conditions.

ABS and PVC In-Slab Installations

ABS and PVC can be installed embedded in a concrete slab. PVC or ABS is unaffected by direct contact with concrete and thermal expansion is not an issue in standard DWV applications. Care must be taken to properly support any piping system when pouring concrete so that the weight of the concrete does not affect the pipe system and that any heat generated by curing concrete does not exceed the capability of the system.

Some codes require sleeving or protection of piping at slab penetrations. While not necessary due to any corrosion issues, always follow applicable code requirements on any installation.

Testing and Inspection

⚠ WARNING

In any test, proper safety procedures and equipment should be used, including personal protective equipment such as protective eyewear and clothing. Installers should always consider local conditions, codes and regulations, manufacturer's installation instructions, and architects'/engineers' specifications in any installation.

Once the roughing-in is completed on a plastic piping system, it is important to test and inspect all piping for leaks. Concealed work should remain uncovered until the required test is made and approved. When testing, the system should be properly restrained at all bends, changes of direction, and the end of runs.

There are various types of procedures used for testing installed plastic systems. However, a water or hydrostatic test is a technically superior test method for inspecting a completed plastic piping system installation and is the testing procedure recommended by Charlotte Pipe. It is also the most recommended test in most plumbing code standards. The purpose of the test is to locate any leaks at the joints and correct them prior to putting the system into operation. Since it is important to be able to visually inspect the joints, a water test should be conducted prior to closing in the piping or backfilling of underground piping.

Testing DWV System

Water Test

The system should be properly restrained at all bends, changes of direction, and the end of runs. To isolate each floor or section being tested, test plugs are inserted through test tees in the stack. All other openings should be plugged

or capped with test plugs or test caps.

When testing Foam Core pipe, always use external caps to eliminate the possibility of leakage through the foam core layer of the pipe.

Fill the system to be tested with water at the highest point. As water fills a vertical pipe it creates hydrostatic pressure. The pressure increases as the height of the water in the vertical pipe increases. Charlotte Pipe recommends testing at 10 feet of hydrostatic pressure (4.3 pounds per square inch.) Filling the system slowly should allow any air in the system to escape as the water rises in the vertical pipe. All entrapped air in the system should be expelled prior to the beginning of the test. Failure to remove entrapped air may give faulty test results.

Once the stack is filled to "ten feet of head," a visual inspection of the section being tested should be made to check for leaks. If a leak is found, the joint must be cut out and a new section installed. Once the system has been successfully tested, it should be drained and the next section prepared for testing.

⚠ WARNING

Testing with or use of compressed air or gas in PVC / ABS / CPVC pipe or fittings can result in explosive failures and cause severe injury or death.

- NEVER test with or transport/store compressed air or gas in PVC / ABS / CPVC pipe or fittings.
- NEVER test PVC / ABS / CPVC pipe or fittings with compressed air or gas, or air over water boosters.
- ONLY use PVC / ABS / CPVC pipe or fittings for water or approved chemicals.
- Refer to warnings on PPFA's website and ASTM D 1785.

Alternate Test Methods

Vacuum Test

Charlotte Pipe and Foundry recognizes vacuum testing of ABS and PVC DWV piping system to 8.75 inches of mercury is a safe practice and does not object to conducting this type of test. However, vacuum testing is complex and requires dedicated equipment. Identifying leak sites can be difficult. The plumbing industry has not developed an efficient methodology for vacuum testing piping systems in the field.

The Smoke Test

⚠ WARNING

To reduce the risk of fire, smoke inhalation, chemical inhalation or burns, never use chemical mixtures for producing smoke. These mixtures may be dangerous and can cause serious personal injury.

Should a smoke test be specified by an engineer, architect, or plumbing code, proceed as follows:

1. Permanently connect all fixtures and fill all traps with water.
2. Be prepared to test all parts of the plumbing drainage and ventilation system.
3. Close all windows in the building until the test has been completed.
4. Fill the system with a thick, penetrating smoke that has been generated by one or more smoke-producing machines.
5. When smoke begins to appear at the stack opening on the roof, close off that opening.
6. Continue filling the system with smoke until a pressure equal to one inch of water is built up.
7. Maintain this pressure for fifteen minutes or longer, as required to test the entire system.
8. Check all components of the system to help ensure that smoke is not escaping. Smoke should not be visible at any point, connection, or fixture.

The Peppermint Test

This test is most often used in older installations to detect faulty plumbing. **NOTE:** Peppermint oils are not chemically compatible with ABS and therefore should not be used to test ABS DWV systems. The peppermint test should only be used to test PVC DWV systems.

1. Permanently connect all fixtures and fill all traps with water.
2. Be prepared to test all parts of the plumbing drainage and ventilation system.
3. Close all windows in the building until the test has been completed.
4. Mix two ounces of peppermint oil with one gallon of hot water.
5. Pour the mixture into the system's roof opening.
6. Tightly close the roof opening.

7. Have a person other than the one that poured the mixture into the system inspect the system for any odor of peppermint.
8. Inspect all system points, connections, and fixtures. There should be no odor of peppermint within the building.

Testing Pressure System

1. Prior to testing, safety precautions should be instituted to protect personnel and property in case of test failure.
2. Conduct pressure testing with water.
3. The piping system should be adequately anchored to limit movement. Water under pressure exerts thrust forces in piping systems. Thrust blocking should be provided at changes of direction, change in size and at dead ends.
4. The piping system should be slowly filled with water, taking care to prevent surge and air entrapment. The flow velocity should not exceed 5-feet per second for PVC and 8-feet per second for CPVC CTS (see Friction Loss and Flow Velocity charts in this manual).

⚠ WARNING

Testing with or use of compressed air or gas in PVC / ABS / CPVC pipe or fittings can result in explosive failures and cause severe injury or death.

- NEVER test with or transport/store compressed air or gas in PVC / ABS / CPVC pipe or fittings.
- NEVER test PVC / ABS / CPVC pipe or fittings with compressed air or gas, or air over water boosters.
- ONLY use PVC / ABS / CPVC pipe or fittings for water or approved chemicals.
- Refer to warnings on PPFA's website and ASTM D 1785.

5. All trapped air must be slowly released. All valves and air relief mechanisms should be opened so that the air can be vented while the system is being filled.
6. Once an installation is completed and cured the system should be filled with water and pressure tested in accordance with local code requirements.
7. Any leaking joints or pipe must be cut out and replaced and the line recharged and retested using the same procedure.

NOTICE

Do not exceed the maximum working pressure of any system components including pipe, fittings, valves, molded or cut threads, unions, mechanical coupling or flanges.

- The pressure rating of all components must be reduced at temperatures above 73 degrees F. Refer to de-rating table in this manual.
- Exceeding the maximum working temperature or pressure of the system may result in system failure and property damage.

⚠ WARNING

Entrapped Air

- **Pressure surges associated with entrapped air may result in serious personal injury, system failure, and property damage.**
- Install air relief valves at the high points in a system to vent air that accumulates during service.
- Failure to bleed trapped air may give faulty test results and may result in an explosion.

The installation tips, warnings and technical information in this Additional Considerations section are intended to help improve material selection and installation techniques. The information found in this section enhances but does not replace the information found in other sections of this Technical Manual.

Additional Considerations

- Antifreeze Solutions for Pressure PVC and CPVC Systems
- Antifreeze Solutions for ABS DWV Systems
- FlowGuard Gold® Domestic Water Systems
- Disinfection
- The Advantages of a FlowGuard Gold® CPVC System
- Chemical Compatibility with CPVC Products
- Low Temperature and Cold Weather Conditions

Antifreeze Solutions for Pressure PVC and CPVC Systems

Glycerin antifreeze solutions are recommended for use with FlowGuard Gold® and Corzan® water distribution systems and for PVC pressure and DWV applications.

Glycerin antifreeze should be diluted to the appropriate concentration that provides adequate protection for the intended application. Maximum freeze protection for glycerin-water solutions is -51.7°F (-46.5°C) and occurs when the weight percent of glycerin is 66.7%. The effectiveness of a glycerin/water antifreeze solution diminishes above this concentration. Freeze points of glycerin-water solutions follow:

Freezing Points of Glycerin-Water Solutions (weight %)

Glycerin by weight (%)	Freeze Point °F (°C)
0	32.0 (0.0)
10	29.1 (-1.6)
20	23.4 (-4.8)
30	14.9 (-9.5)
40	4.3 (-15.4)
50	-9.4 (-23.0)
60	-30.5 (-34.7)
66.7	-51.7 (-46.5)
Greater than 66.7	Not Recommended

Propylene glycol or ethylene glycol antifreeze solutions are suitable for use in pressure testing PVC and CPVC pressure and DWV piping systems as follows:

⚠ CAUTION

- Solutions greater than 50% propylene glycol are incompatible with PVC and may cause damage to PVC piping systems.
- Solutions greater than 25% propylene or 50% ethylene are incompatible with CPVC and may cause damage to CPVC piping systems.
- Ethylene glycol is compatible with PVC piping systems up to 100% concentrations.
- 25% Propylene glycol solutions are approved for use with potable water systems and provide freeze protection to about 15°F (-10°C), 50% solutions provide freeze protection to -30°F (-34°C).
- Please see the Chemical Resistance chart contained in this manual for complete chemical resistance data.
- Ethylene glycol solutions are toxic and must therefore be avoided in potable water and food processing systems. 25% ethylene glycol solutions provide freeze protection to about 8°F (-13°C) and 50% solutions provide freeze protection to about -33°F (-36°C).

Antifreeze Solutions for ABS DWV Systems

Only the following antifreeze may be used with or in conjunction with ABS and ABS Plus® DWV foam core systems:

- 60% glycerol, by weight, in water. Use undiluted.
- 22% magnesium chloride, by weight, in water. Use undiluted.
- "Plastic Pipe Antifreeze" (especially made for plastic pipe).

Do not use any other type antifreeze except those recommended above.

FlowGuard Gold® Domestic Water Systems

FlowGuard Gold pipe and fittings are made from a specialty plastic known as chlorinated polyvinyl chloride (CPVC). FlowGuard Gold CPVC is the result of new technology that ensures product toughness year round. FlowGuard Gold water distribution systems are assembled with readily available tools. Solvent cement joints – proven with nearly 50 years of successful service history – help assure the reliability of a FlowGuard plumbing system.

FlowGuard Gold CPVC pipe and fittings are designed, manufactured and listed for domestic water applications. Piping systems using CPVC should be installed by licensed plumbing contractors in accordance with normal industry standards, good plumbing practices and in compliance with applicable plumbing codes, building codes and other regulations.

NOTICE: CPVC Schedule 80 domestic water systems must be installed using IPS P-70 or Oatey Industrial Grade primers and IPS 714 or Oatey CPVC Heavy Duty Orange solvent cements. FlowGuard Gold, the industry-leading hot and cold water system, is typically installed in ½ -2 inch applications.

Disinfection

FlowGuard Gold and ReUze® CPVC have been tested and found to be unaffected by chlorine in concentrations up to 3,000 parts per million in water. Normal system disinfection at 50 parts per million chlorine will not harm CPVC.

The Advantages of a FlowGuard Gold® CPVC System

A FlowGuard Gold water distribution system outperforms a metal plumbing system in several important ways:

- It's more energy efficient – with better heat retention and lower hot water heating costs.
- Condensation is reduced – significantly reducing the risk of drip damage.
- It operates quietly – with silent water flow and no banging from water hammer.
- CPVC is resistant to corrosion, pitting and scaling – this means no loss of water pressure and reduced maintenance.

NOTICE

All pipe thread sealants must conform to the requirements of IAPMO's PS 36 and with the thread sealant manufacturer to confirm that these sealants are chemically compatible with ABS, PVC, and CPVC. Incompatible pipe thread sealants may result in the degradation of plastic pipe or fittings resulting in product failure and property damage.

- Verify that paints, thread sealants, lubricants, plasticized PVC products, foam insulations, caulks, leak detectors, insecticides, termiticides, antifreeze solutions, pipe sleeve, firestop materials or other materials are chemically compatible with ABS, PVC or CPVC.
- Do not use edible oils such as Crisco® for lubricant.
- Read and follow chemical manufacturer's literature before using with piping materials.
- Confirm compatibility of pipe marking adhesive tape with the manufacturer of the tape to ensure chemical compatibility with CPVC pipe and fittings.

Chemical Compatibility With CPVC Products

CPVC domestic water systems have been used successfully for 50 years in new construction, repipe and repair. CPVC products are ideally suited for domestic water applications due to their corrosion resistance. Occasionally, however, CPVC can be damaged by contact with chemicals found in some construction products including thread sealant, fire stopping compounds, pipe sleeves or insulation. Reasonable care needs to be taken to ensure that products coming into contact with CPVC systems are chemically compatible. Charlotte Pipe recommends that CPVC chemical compatibility be confirmed with the manufacturer of any product coming into contact with CPVC piping systems. If chemical compatibility with CPVC is in question, Charlotte Pipe recommends isolating the suspect product from contact with CPVC pipe or fittings. Please call Charlotte Pipe at 800/438-6091 or visit our web site www.CharlottePipe.com for the latest CPVC Chemical Compatibility sheet.

Care should be taken to isolate CPVC piping systems from direct contact with heavy concentrations of termiticides. Vinyl piping materials such as CPVC may be damaged by termiticides where they are injected into the annular space between the pipe wall and sleeving material trapping the termiticides against the pipe wall. Common-sense precautions will prevent installation problems.

NOTICE: In understanding spray polyurethane foams, there are two general areas of concern for CPVC pipe and fittings; (1) chemical compatibility and (2) potential damage to pipe and fittings due to high temperatures generated as a result of the exothermic chemical reaction during the installation and curing process. It is possible to apply polyurethane foam insulation properly without damage to CPVC pipe and fittings. However, the use of polyurethane foam insulation in conjunction with CPVC has resulted in the failure of CPVC pipe and fittings and property damage. Therefore, Charlotte Pipe and Foundry does not recommend the use of polyurethane spray on foam insulation in conjunction with its CPVC pipe and fittings.

NOTICE

Use of FlowGuard Gold® CTS CPVC all-plastic threaded male adapters in hot water applications may result in system failure and property damage.

- Use plastic threaded CTS CPVC male adapters in cold water applications only.
- Use CTS CPVC x brass threaded transition fittings for hot water applications.
- Do not use compression fittings with brass ferrules to connect to CTS CPVC pipe or fittings where water temperatures will exceed 140 degrees F.
- CPVC pipe can be used with standard brass ferrules to make compression connections where the operating temperature will not exceed 140°F. Apply Teflon (PTFE) tape over the ferrule to allow for the dissimilar thermal expansion and contraction characteristics of the metal ferrule and the plastic pipe.

Low Temperature and Cold Weather Conditions

Low Temperature Recommendation

Like most materials, PVC and CPVC become more brittle at low temperatures, particularly at temperatures below freezing (32°F). Charlotte Pipe and Foundry recommends taking proper precautions when installing systems at low temperatures including providing proper insulation. If a system is designed to operate at temperatures below freezing (32°F), Charlotte Pipe recommends the following:

1. Reduce water hammer pressure surges to a minimum by:
   a. Using only slow-acting solenoid valves, if any.
   b. Reducing pump start-up pressure surges with slow start-up motors and rubber expansion devices.
   c. Not exceeding maximum fluid velocity of 5-feet per second for PVC and 8-feet per second for CPVC CTS.
2. Provide more than minimum Charlotte Pipe recommended support spacing.
3. Thrust blocking at branches, changes in direction and end of runs.
4. Use expansion/contraction devices when temperature changes occur in runs.
5. Strictly follow chemical-resistance recommendations.
6. Protect piping from UV, if applicable.

Cold Weather Considerations for CPVC

The following precautions are recommended in cold-weather situations.

1. Freeze Issues

   CPVC is a ductile material, which expands and contracts more than metallic plumbing pipe. However, CPVC, like all other piping materials, needs to be protected from freezing. All model plumbing codes require that piping exposed to freezing temperatures be properly insulated.

2. Frozen CPVC Water Lines

   Drain the system if overnight temperatures are likely to drop below 32°F. CPVC may split like other materials when water freezes in it.

   Immediately take action to eliminate the source of cold air causing the freezing condition, then thaw the water line if possible. If the frozen section of pipe is accessible, heated air can be blown directly onto the frozen area by using a low wattage heater/blower. Also, electrical heat tapes can be applied to the frozen area. **NOTICE:** To avoid damaging the pipe when thawing a frozen CPVC water line, the heat source should not exceed 180°F.

3. Handling

   Refrain from unnecessary abuse. Do not drop pipe from trucks, drag pipe on the ground, step on pipe or drop pipe on the ends.

   Inspect pipe ends for hairline cracks before making a joint. If any indication of damage or cracking is evident at the tube end, cut off at least 2 inches beyond any visible crack. Do not use dull or broken cutting tools. A wheel-type pipe cutter is recommended.

   Store pipe in a heated area whenever possible.

NOTICE

In understanding spray polyurethane foams, there are two general areas of concern for CPVC pipe and fittings; (1) chemical compatibility and (2) potential damage to pipe and fittings due to high temperatures generated as a result of the exothermic chemical reaction during the installation and curing process. It is possible to apply polyurethane foam insulation properly without damage to CPVC pipe and fittings. However, the use of polyurethane foam insulation in conjunction with CPVC has resulted in the failure of CPVC pipe and fittings and property damage. Therefore, Charlotte Pipe and Foundry does not recommend the use of polyurethane spray on foam insulation in conjunction with its CPVC pipe and fittings.

Closed-Loop Systems

A closed-loop plumbing system is one in which water from the premises side of the water meter is unable to backflow into the main. This circumstance is becoming more and more prevalent as the result of the growing use of devices such as backflow preventers and pressure-reducing valves.

Allowance must be made for "thermal expansion of the water." Backflow-prevention devices with built-in bypass capabilities, auxiliary pressure-relief valves or bladder-type expansion tanks are several options available to help resolve the problem and to insure long-term system performance.

Do not rely on an expansion tank to handle thermal expansion of the piping system. Expansion tanks accommodate expansion of the fluid, not longitudinal expansion of the pipe. The piping system must be designed to allow for thermal expansion.

NOTICE

All pipe thread sealants must conform to the requirements of IAPMO's PS 36 and with the thread sealant manufacturer to confirm that these sealants are chemically compatible with ABS, PVC, and CPVC. Incompatible pipe thread sealants may result in the degradation of plastic pipe or fittings resulting in product failure and property damage.

- Verify that paints, thread sealants, lubricants, plasticized PVC products, foam insulations, caulks, leak detectors, insecticides, termiticides, antifreeze solutions, pipe sleeve, firestop materials or other materials are chemically compatible with ABS, PVC or CPVC.
- Do not use edible oils such as Crisco® for lubricant.
- Read and follow chemical manufacturer's literature before using with piping materials.
- Confirm compatibility of pipe marking adhesive tape with the manufacturer of the tape to ensure chemical compatibility with CPVC pipe and fittings.

Connecting CTS CPVC to Fixtures or Other Materials

Stub-outs for Plumbing Fixtures

CTS CPVC pipe can be used for stub-outs for lavatories, closets and sinks.

Brass Compression Ferrules

CTS CPVC pipe can be used with standard brass ferrules to make compression connections where the operating temperature will not exceed 140°F. The O.D. of copper tube size (CTS) CPVC pipe is identical to that of copper. We recommend that Teflon (PTFE) tape be applied over the ferrule to allow for the dissimilar thermal expansion and contraction characteristics of the metal ferrule and the plastic pipe that could possibly result in a drip leak over a period of time. **NOTICE:** Do not over-torque the compression connection as over-torquing may result in a cracked pipe. Non-metallic or nylon ferrules are not recommended.

FlowGuard Gold® and Corzan® Domestic Water Systems Do's and Don'ts

While not a complete list, the following is intended to highlight many of the Do's and Don'ts when installing a FlowGuard Gold and Corzan domestic water system.

Do's

- Do install CPVC Schedule 80 domestic water systems using IPS P-70 or Oatey Industrial Grade primers.
- Do install CPVC Schedule 80 domestic water systems using IPS 714 or Oatey CPVC Heavy Duty Orange solvent cements.
- Installation should be in accordance with normal industry standards, good plumbing practices, applicable plumbing codes, building codes and other regulations.
- Follow recommended safe work practices.
- Follow proper material handling procedures.
- Keep pipe and fittings in original packaging until needed.
- Cover pipe and fittings with opaque tarp when stored outdoors.
- Make certain that thread sealants, gasket lubricants and firestop materials are compatible with CPVC pipe and fittings.
- Use only latex paint if painting is desired.
- Use tools designed for plastic pipe and fittings.
- Cut pipe square.
- Deburr and bevel pipe before solvent cementing.
- Apply primer and cement with an applicator that is one half the size of the pipe's diameter.
- Rotate pipe ¼ to ½ turn as the pipe is being inserted into the fitting socket.
- Avoid puddling of solvent cement in fitting or pipe.
- Follow recommended cure time for the required pipe diameter and temperature.
- Align all piping system components properly without strain. Do not bend or pull pipe into position after being solvent welded.
- Fill lines slowly and bleed all trapped air from the system prior to conducting a hydrostatic test.
- Visually inspect all joints for proper cementing.

- Allow for movement due to thermal expansion and contraction.
- Use pipe straps that fully encircle the tube.
- Drill holes ¼ inch larger than the outside diameter of the pipe or tube when penetrating wood studs.
- Use protective pipe isolators that allow movement when penetrating steel studs.
- Use metallic or tear drop hangers when suspending tube from all thread rod.
- Confirm compatibility of pipe marking adhesive tape with the manufacturer of the tape to ensure chemical compatibility with CPVC pipe and fittings.
- If pipe sleeve is used, verify that it is chemically compatible with CPVC.
- If pipe sleeve is used, extend it 12 inches above and below the slab.
- Backfill and cover underground piping prior to spraying termiticides in preparation for concrete pour.
- Design the system not to exceed the maximum working pressure of all system components including pipe, fittings, valves, unions and flanges. De-rate the pressure rating of all components if the working temperature will exceed 73 degrees Fahrenheit.

NOTICE

In understanding spray polyurethane foams, there are two general areas of concern for CPVC pipe and fittings; (1) chemical compatibility and (2) potential damage to pipe and fittings due to high temperatures generated as a result of the exothermic chemical reaction during the installation and curing process. It is possible to apply polyurethane foam insulation properly without damage to CPVC pipe and fittings. However, the use of polyurethane foam insulation in conjunction with CPVC has resulted in the failure of CPVC pipe and fittings and property damage. Therefore, Charlotte Pipe and Foundry does not recommend the use of polyurethane spray on foam insulation in conjunction with its CPVC pipe and fittings.

Don'ts

- Do not test with air or any compressed gas. Compressed air or gas testing may result in injury or death.
- Do not use to convey compressed air or any compressed gas. Conveying compressed air or gas may result in injury or death.
- Do not use solvent cement that exceeds its shelf life or has become discolored or gelled.
- Do not use solvent cement near sources of heat, open flame, or when smoking.
- Do not hydrostatically test until recommended cure times are met.
- Do not use dull or broken cutting tool blades when cutting pipe. At low temperatures a wheel type pipe cutter designed for plastic pipe is recommended.
- Do not use petroleum or solvent based paints, sealants, lubricants, or firestop materials.
- Do not use edible oils such as Crisco for lubricant.
- Do not restrict expansion or contraction.
- Do not install in cold weather without allowing for thermal expansion.
- Do not use tube straps that tend to over tighten or restrain the system.
- Do not use wood or plastic wedges that restrain the system.
- Do not bend CPVC tube transmitting mechanical stress to a fitting. Do not install fittings under stress.
- Do not terminate a pipe run against an immovable object (e.g. wall or floor joist).
- Do not allow heavy concentrations of termiticides to come into direct and sustained contact with CPVC pipe.
- Do not inject termiticides into the annular space between pipe wall and sleeving material.
- Do not spray termiticides, when preparing the slab, without first backfilling over underground piping.
- Do not exceed a maximum fluid flow velocity of 8-feet per second for CPVC CTS and 5-feet per second for CPVC Schedule 80.
- Do not exceed the maximum pressure rating of pipe, fittings, valves or flanges.
- Do not use an external heat source to bend CPVC.
- Do not exceed the max operating temperature or pressure of any system components.
- Do not connect CTS CPVC or Schedule 80 CPVC directly to a boiler.

NOTICE

Use of FlowGuard Gold® CTS CPVC all-plastic threaded male adapters in hot water applications may result in system failure and property damage.

- Use plastic threaded CTS CPVC male adapters in cold water applications only.
- Use CTS CPVC x brass threaded transition fittings for hot water applications.
- Do not use compression fittings with brass ferrules to connect to CTS CPVC pipe or fittings where water temperatures will exceed 140 degrees F.
- CPVC pipe can be used with standard brass ferrules to make compression connections where the operating temperature will not exceed 140°F. Apply Teflon (PTFE) tape over the ferrule to allow for the dissimilar thermal expansion and contraction characteristics of the metal ferrule and the plastic pipe.

Tub Fillers, Showerheads and Outside Sillcocks

CTS CPVC should be connected to tub fillers, showerheads and outside sillcocks with a CPVC to brass threaded transition fitting or a metal nipple. Direct connection to CPVC or CPVC threaded fittings is not recommended.

Water Heaters / Boilers

Instructions from the manufacturer of the water heater and applicable local plumbing and building codes should be followed.

Do not use FlowGuard Gold CTS CPVC pipe or fittings on systems capable of achieving temperatures greater than 180°F.

When FlowGuard Gold CTS CPVC pipe is used with an electric water heater, a CPVC-to-brass transition fitting should be used. CPVC threaded male adapters should not be used to connect to water heaters or connect to metallic nipples in close proximity to water heater.

When connecting to a gas water heater, at least 6 inches of metal nipple or appliance connector should be used so that the CPVC tubing cannot be damaged by the build-up of excessive radiant heat from the draft diverter. Some high-efficiency direct-vent gas water heaters eliminate the radiant heat from the flue and can be piped directly to the water heater. A brass threaded CPVC transition fitting must be used for connection to the water heater.

NOTICE: Do not connect CTS CPVC or Schedule 80 CPVC directly to a boiler due to excessive heat generated. The maximum recommended temperature and de-rating of working pressure applies to both heat generated from fluid being distributed through pipe system and heat generated from sources external to the pipe system.

CPVC can be connected to tankless gas water heaters using a CPVC-to-brass threaded transition fitting. Verify code requirements prior to installation.

T/P Relief Valve Drainage Pipe

(Elevated-Temperature Performance)

CTS CPVC pipe conforming to ASTM D 2846 is rated for continuous operation at 180°F/100 psi. The following addresses the expected capabilities of CPVC during short-term exposure to temperatures and/or pressures above 180°F/100 psi that may occur from time to time. However, CTS CPVC pipe is not recommended for pressure applications where temperatures will consistently exceed 180°F.

1. Use of CTS CPVC for T/P relief valve drainage lines

   CPVC is a suitable material for T/P discharge piping. A CPVC-to-brass transition fitting should be used connecting to T/P relief valve.

   FlowGuard Gold pipe and fittings meet the Uniform Plumbing Code short term working pressure requirement of 48 hours at 210°F/150 psi. Furthermore, CPVC pipe is approved for T/P discharge piping under the following model codes:

SBCCI	Standard Plumbing Code - Section 1210.1.
BOCA	BOCA National Plumbing Code - Section P 1506.4.2 (1991)
UPC	Uniform Plumbing Code - Installation Std. IS-20 - Sec. 1007.1.
ICC	International Code Council Section 504.6.2/605.5

2. Short-term elevated pressure performance

   CPVC meets the quality control provisions of the ASTM D 2846 Standard (Table 5) which requires that CPVC-CTS systems (pipe, fittings, and cemented joints) have the capability of withstanding short-term pressure tests at 180°F of at least 521 psi for 6 minutes and 364 psi for 4 hours.

HVAC Condensate Drain Lines

NOTICE

Prior to installing PVC or CPVC piping in hydronic applications, it is important to flush the interior of the heat exchangers and the exterior of the evaporator coils thoroughly with a mild ionic detergent solution to remove incompatible oils. Failing to do so could result in system failure and property damage.

Verify that all boiler cleaning and sealing chemicals used in hydronic radiant heating systems are compatible with PVC or CPVC. Failure to do so could result in system failure and property damage.

Equipment leaks in refrigeration or HVAC systems may release POE oils or other contaminants into the piping system. These oils and contaminants are incompatible with PVC or CPVC and such exposure may result in pipe or fitting failure regardless of flushing.

Exercise caution when using FlowGuard Gold® CPVC pipe or fittings for HVAC- or refrigerant-condensate lines. Some refrigerant systems contain oils that may damage CPVC products. In HVAC applications, some heat exchangers or condenser coils may contain residual oils from the manufacturing process which can cause cracking of CPVC. Caution should be exercised when installing CPVC in combination hot/air handling units or as condensate-drain lines from air conditioning systems. Confirm the compatibility of CPVC with residual oils prior to installation. The interior of heat exchangers or the exterior of condenser coils may be thoroughly cleaned with a detergent solution to remove incompatible oils prior to piping installation. A rinse with clean water to completely clean the system is advisable as a final flushing. Charlotte Pipe and Foundry will not accept responsibility for failure resulting from exposure to compressor oils in HVAC- or refrigerant-condensate lines.

Thermal Expansion

Expansion Tanks do not compensate for linear expansion and contraction of the pipe and fittings. Expansion tanks are designed to compensate for the expansion of the liquids within the system.

For information on thermal expansion please see Expansion and Contraction in the Design and Engineering Data section of this manual.

R-Values and Thermal Conductivity

Thermal Conductivity

R-Value is a measure of the thermal resistance of a material. Thermal resistance is an index of a material's resistance to the flow of heat. K-Value is a measure of a material's thermal conductivity measured in BTU's and is the reciprocal of the R-Value. The thermal resistances for PVC and CPVC remain constant as C-Values. They are as follows:

PVC Thermal Conductivity C = 1.2 BTU in/Hr Sq Ft °F
CPVC Thermal Conductivity C = .96 BTU in/Hr Sq Ft °F
R-Value can be viewed as an equation when calculating for various thickness of pipe.

R = Pipe Wall Thickness divided by C

The table below represents the R-Values for PVC Schedule 40 & 80 and CPVC CTS FlowGuard Gold.

Note: Always follow local code requirements for insulation installation. Some code jurisdictions require insulation to be installed in accordance with the International Energy Conservation Code.

Condensation and Sweating

Due to its low coefficient of thermal conductivity, it is often not necessary to insulate FlowGuard Gold CPVC against condensation within conditioned buildings. Two conditions that control sweating of a pipe are (1) the pipe surface temperature, which depends on the temperature of the water inside the pipe and (2) the relative humidity of the air around the pipe. Because each of the factors can vary greatly, it is possible that conditions exist that can cause CPVC pipe to sweat. Under most conditions that cause copper pipe to sweat and drip, FlowGuard Gold pipe will remain free of condensation.

Nominal Pipe Size	Schedule 40 Wall Thickness	PVC Schedule 40 R-Value	Schedule 80 Wall Thickness	PVC Schedule 80 R-Value	SDR 11 CTS Wall Thickness	CPVC SDR 11 R-Value
¼″			0.119	0.099		
⅜″			0.126	0.105		
½″	0.109	0.091	0.147	0.123	0.068	0.071
¾″	0.113	0.094	0.154	0.128	0.080	0.083
1″	0.133	0.111	0.179	0.149	0.102	0.106
1¼″	0.140	0.117	0.191	0.159	0.125	0.130
1½″	0.145	0.121	0.200	0.167	0.148	0.154
2″	0.154	0.128	0.218	0.182	0.193	0.201
2½″	0.203	0.169	0.276	0.230		
3″	0.216	0.180	0.300	0.250		
4″	0.237	0.198	0.337	0.281		
5″	0.258	0.215	0.375	0.313		
6″	0.280	0.233	0.432	0.360		
8″	0.322	0.268	0.500	0.417		
10″	0.365	0.304	0.593	0.494		
12″	0.406	0.338	0.687	0.573		
14″	0.437	0.364	0.750	0.625		
16″	0.500	0.417	0.843	0.703		

Water Hammer Arrestors

Quick closing valves, actuated valves, starting or stopping pumps or rapid increases or decreases in system flow rate can result in pressure surge or "water hammer" capable of damaging PVC or CPVC piping systems. Systems should be designed by the engineer of record and in conformance to local code requirements to manage the effects of pressure surge. In applications where severe or repeated water hammer is encountered, especially at elevated temperatures or in a commercial laundry or commercial kitchen, the use of a water hammer arrestor is advisable.

Hydronic Heating, Chilled Water or Geothermal Applications

NOTICE

Prior to installing PVC or CPVC piping in hydronic applications, it is important to flush the interior of the heat exchangers and the exterior of the evaporator coils thoroughly with a mild ionic detergent solution to remove incompatible oils. Failing to do so could result in system failure and property damage.

Verify that all boiler cleaning and sealing chemicals used in hydronic radiant heating systems are compatible with PVC or CPVC. Failure to do so could result in system failure and property damage.

Equipment leaks in refrigeration or HVAC systems may release POE oils or other contaminants into the piping system. These oils and contaminants are incompatible with PVC or CPVC and such exposure may result in pipe or fitting failure regardless of flushing.

When plastic piping is used for recirculating systems such as hydronic, chilled water or geothermal heat pump systems, careful consideration of piping material characteristics and system requirements must be made. This includes taking into account pressure, temperature, flow velocity, design stresses, environmental factors and the chemical resistance of the piping materials to the fluids (heat-transfer fluids, anti-freeze solutions and other chemicals) in the system. Ultimately the engineer, designer or owner must evaluate these characteristics and system requirements in order to select the correct piping product for the particular application. The table below highlights some of the key points to consider when designing or installing these types of systems.

This manual is not a complete engineering reference addressing all aspects of design and installation of these systems. Many excellent references are available on this topic. The International Ground Source Heat Pump Association: www.igshpa.okstate.edu or The GEO Exchange at www.geoexchange.org.

CPVC CTS FlowGuard Gold does not typically require an oxygen barrier. In accordance with ASTM D 2846, CPVC CTS is manufactured as a solid-wall piping system and is not manufactured in a cross-linked or co-extruded process like other materials that are prone to oxygen permeation. Unlike CPVC, some cross-linked systems used in applications such as hydronic heating require a layer of aluminum to be present to stop oxygen diffusion through the polymer matrix.

With regard to oxygen permeability of a CPVC system, the following data should be considered:

1) The oxygen transmission rate in CPVC at 73°F (23°C) is approximately 7.2 cc/(m^2/day).

2) The oxygen permeation coefficient in CPVC at 73°F (23°C) is approximately 180 cc/mil/(m^2/day/atm).

3) The oxygen diffusion coefficient in CPVC is approximately 6.25e/9 cm^2/sec.

"DOs" for all hydronic applications

- Do install CPVC Schedule 80 domestic water systems using IPS P-70 or Oatey Industrial Grade primers.
- Do install CPVC Schedule 80 domestic water systems using IPS 714 or Oatey CPVC Heavy Duty Orange solvent cements.
- Install in accordance with both Charlotte Pipe and Foundry's and solvent cement manufacturer's recommendations and installation instructions.
- Follow recommended safe work practices.
- Verify that the maximum outlet temperature and pressure of the boiler is less than the temperature and pressure rating of the pipe (see charts below).
- Always use the proper derating factors with FlowGuard Gold and Corzan CPVC pipe to find the pressure rating at the applicable operating temperature.
- Always follow applicable codes and approvals when installing plumbing and heating equipment.
- Ensure that the system design allows for thermal expansion and contraction as recommended in the Charlotte Pipe and Foundry Plastics Technical Manual.
- Use only CPVC x brass threaded transition fittings when installing FlowGuard Gold systems.
- Use proper solvent cementing practices, including beveling and proper dauber sizing.
- Align all piping system components properly without strain. Do not bend or pull pipe into position after being solvent welded.
- Provide additional support to the brass side of a CPVC x

brass transition or other metallic components to support the weight of the metal system.

- Use check valves, heat traps or back flow preventers to prevent cross-connections between hot and cold water lines.
- Flush the interior of heat exchangers or the exterior of condenser coils thoroughly with mild ionic detergent solution to remove incompatible oils prior to piping installation.
- Rinse with clean water to purge the system as a final flushing.
- Verify that all boiler cleaning and sealing chemicals used in the hydronic radiant heating system are compatible with CPVC.

"DON'Ts" for all hydronic applications

- Do not exceed the operating temperature or operating pressure of the piping system.
- Do not use CPVC male or female adapters with plastic molded threads for FlowGuard Gold systems.
- Do not use the CPVC piping system to support any metallic components.
- Do not use compression fittings for hydronic radiant heating applications.
- Do not use solvent cement that exceeds its shelf life, has become discolored or has gelled.
- Do not use CPVC tees or other CPVC components as hot and cold mixing devices.
- Do not apply excessive solvent-cement to the joints. Puddling of solvent cement must be avoided.
- Do not rely on an expansion tank to handle thermal expansion of the piping system. Expansion tanks accommodate expansion of the fluid, not longitudinal expansion of the pipe. The piping system must be designed to allow for thermal expansion.

NOTICE

Failure to compensate for expansion and contraction caused by temperature change may result in system failure and property damage.

- Do not restrict expansion or contraction. Restraining movement in piping systems is not recommended and may result in joint or fitting failure.
- Use straps or clamps that allow for piping system movement.
- Align all piping system components properly without strain. Do not bend or pull pipe into position after being solvent welded.
- Do not terminate a pipe run against a stationary object (example: wall or floor joist).
- Do not install fittings under stress.

FlowGuard Gold® Pressure Rating Chart (psi)

Pipe Size	73°F	80°F	120°F	140°F	180°F
ALL (SDR-11)	400	328	260	200	100

Corzan® Schedule 80 Pressure Rating Chart (psi)

Pipe Size	73°F	80°F	120°F	140°F	180°F
2″	400	328	260	200	100
3″	370	303	241	185	93
4″	320	262	208	160	80
6″	280	230	182	140	70
8″	250	205	163	125	63

NOTICE

Do not exceed the maximum working pressure of any system components including pipe, fittings, valves, molded or cut threads, unions, mechanical coupling or flanges.

- The pressure rating of all components must be reduced at temperatures above 73 degrees F. Refer to de-rating table in this manual.
- Exceeding the maximum working temperature or pressure of the system may result in system failure and property damage.

NOTICE

Prior to installing PVC or CPVC piping in hydronic applications, it is important to flush the interior of the heat exchangers and the exterior of the evaporator coils thoroughly with a mild ionic detergent solution to remove incompatible oils. Failing to do so could result in system failure and property damage.

Verify that all boiler cleaning and sealing chemicals used in hydronic radiant heating systems are compatible with PVC or CPVC. Failure to do so could result in system failure and property damage.

Equipment leaks in refrigeration or HVAC systems may release POE oils or other contaminants into the piping system. These oils and contaminants are incompatible with PVC or CPVC and such exposure may result in pipe or fitting failure regardless of flushing.

NOTICE

Use of FlowGuard Gold® CTS CPVC all-plastic threaded male adapters in hot water applications may result in system failure and property damage.

- Use plastic threaded CTS CPVC male adapters in cold water applications only.
- Use CTS CPVC x brass threaded transition fittings for hot water applications.
- Do not use compression fittings with brass ferrules to connect to CTS CPVC pipe or fittings where water temperatures will exceed 140 degrees F.
- CPVC pipe can be used with standard brass ferrules to make compression connections where the operating temperature will not exceed 140°F. Apply Teflon (PTFE) tape over the ferrule to allow for the dissimilar thermal expansion and contraction characteristics of the metal ferrule and the plastic pipe.

Using Plastics in Multi-Story Construction

Incorporating plastic piping systems into multi-story construction raises special design considerations. Charlotte Pipe plastic pipe and fittings are warranted to conform to ASTM or other applicable product-based standard, not for any particular system design.

Products and materials selected for use in multi-story construction (four floors and up) must conform to all applicable building, plumbing and fire codes. Product selection and/or specification should be made by an architect, engineer, contractor, or other licensed professional. This must include specification of a code-compliant, chemically compatible firestop system with an appropriate service life, which must be properly installed and inspected for conformance to building, plumbing and fire codes by the responsible governmental authority.

In selecting products and material for multi-story construction, consideration should be given to Charlotte Pipe's cast iron soil pipe products, which are an excellent choice for many multi-story applications. Charlotte Pipe recommends noncombustible cast iron DWV piping systems in multi-story construction.

Using Plastics for Combustion Gas Venting

Charlotte Pipe recommends that inquiries about the suitability of plastic piping systems for venting combustion gases should be directed to the manufacturer of the water or space heating equipment being installed. As stated in the International Code Council's International Fuel Gas Code 503.4.1.1:

> *Plastic Pipe and fittings used to vent appliances shall be installed in accordance with the appliance manufacturer's installation instructions.*

The residential water heater certification and safety standard, ANSI Z21.10 1-2014/CSA 4.1-2014, has been modified as it relates to the use of certain plastic venting materials and now prohibits the use of cellular core pipe. Charlotte Pipe prohibits the use of its PVC and ABS cellular core pipe for all combustion gas venting applications.

Furthermore, several of the ASTM standards applicable to plastic pipe and fittings that Charlotte Pipe manufactures include the following note: **This standard specification does not include requirements for pipe and fittings intended to be used to vent combustion gases.**

⚠ WARNING

Combustion Gas Venting

Failure to properly vent combustion gas may result in serious injury or death from carbon monoxide.

- Always install / use pipe or fittings as specified by the appliance manufacturer's installation instructions to vent appliances.
- Never use PVC cellular core, ABS cellular core pipe or ConnecTite® fittings for combustion gas venting.

Repairs or Modifications to Existing ABS, PVC or CPVC Systems

It is important to note that the chemical properties of all thermoplastic materials change over time. Visually, this often means that the pipe may experience color variations. In CTS CPVC applications the temperature of the water running through the pipe often determines the degree of variation, with hot water causing a more noticeable change. Exposure to ultraviolet (UV) light may also cause the exposed surface of PVC or CPVC to brown. Purple PVC, purple CPVC or ABS pipe tend to fade with UV exposure (please see **Weathering / UV Exposure** for additional information). Color variations do not indicate that the pressure carrying capabilities of the pipe have been compromised. In fact, the pressure carrying capability of thermoplastic pipe increases as the pipe ages.

What also changes over time is the impact resistance of ABS, PVC and CPVC piping systems, which has little effect upon installed systems. It does mean, however, that if a cut-in is necessary, additional care should be taken to prevent damaging the existing system. This is typically a greater issue with thin-wall, smaller-diameter piping systems such as CTS CPVC, PVC PR 200, PVC PR 160 or Schedule 40 PVC. Ratchet cutters may compress the pipe and cause end cracks on aged pipe. Even if the cracks are not visible, they can eventually propagate through the fitting and cause a leak.

Charlotte Pipe recommends using a fine-tooth saw when performing cut-in operations. Once the pipe is cut, continue with standard installation procedures. Keep in mind that if the area is wet, additional cure time is required and may be three times as long. The inside and outside diameter of pipe and fittings should be kept as dry as possible.

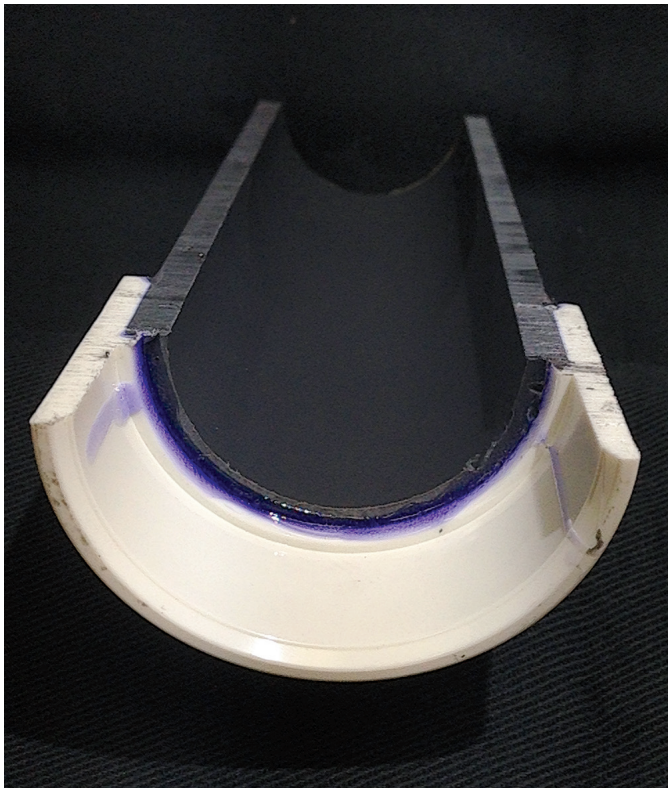
PVC Schedule 80 Pipe for DWV Applications

Occasionally a designer will specify Schedule 80 PVC pressure pipe meeting ASTM D 1785 for a DWV application in combination with Schedule 40 PVC DWV (Drainage) fittings meeting ASTM D 2665. Typically the application is underground and the designer is interested in specifying a pipe that is more robust than standard Schedule 40 PVC.

Charlotte Pipe does not recommend using Schedule 80 pipe in combination with Schedule 40 DWV fittings due to the dimensional mismatch between these products. Schedule 80 pipe has a significantly smaller inside diameter (ID) than Schedule 40 pipe. When Schedule 80 pipe is installed in a DWV fitting hub, the reduced ID of Schedule 80 pipe forms a restriction or ledge at every fitting hub that will impede flow, possibly leading to buildup and clogs. Additionally, Schedule 80 PVC pipe is not marked or listed in the model plumbing codes for DWV applications. ASTM D 1785 is exclusively a standard for pressure-rated pipe. Additionally, pressure-pattern fittings do not have a sanitary turn which is necessary to allow waste to travel through the fitting unobstructed; therefore, Schedule 80 pressure-pattern fittings would not be an appropriate product for the application. There is no ASTM standard for Schedule 80 DWV fittings and except for some large-diameter fabricated fittings, no Schedule 80 DWV fittings are offered by any U. S. manufacturer.

If Schedule 80 pipe is being specified for a DWV application, it is often motivated by a desire for a more robust product with greater earth / live load carrying capability in underground applications. In these instances Charlotte Pipe recommends Cast Iron Soil Pipe for the application as it is a robust product with the ability to resist tremendous earth and live loads. In contrast, PVC pipe is a flexible conduit which is dependent upon the support provided by the surrounding soil for its ability to withstand external loads.

If the designer determines that PVC is the best material for a commercial DWV application, Charlotte Pipe recommends Schedule 40 DWV pipe and fittings that conform to ASTM D 2665; this will ensure a Schedule 40 solid-wall PVC pipe product that is more robust than cellular or foam-core pipe. Cellular or foam-core Schedule 40 pipe conforms to ASTM F 891, is lighter, has reduced pipe stiffness, reduced resistance to mechanical damage, and most specifiers believe it is less appropriate for commercial applications. PVC pipe should always be installed underground per ASTM D 2321. For pipe being installed in unstable or unusual soil conditions, additional installation procedures may be required. Consult a soil expert and/or structural engineer for guidance. Plastic pipe suspended from an on-grade slab must be installed in accordance with ASTM F 2536.



Material Selection, Special System Design and Engineering Considerations

Selection of Materials For Sanitary and Storm Drainage

Engineers and designers today have a number of materials from which to choose as they design sanitary and storm drainage systems for residential and commercial projects. Due to its exceptional strength and combination of being non-combustible and extremely quiet, cast iron soil pipe is a very popular choice for commercial construction. Upscale homes often feature cast iron stacks combined with plastic used for lavs, showers and tubs for a system Charlotte Pipe calls a "Quiet House®" design. PVC and ABS DWV systems are allowed under all of the major national plumbing codes unless restricted by local or state amendment and are very popular as well.

Charlotte Pipe manufactures ABS cellular (foam) core pipe conforming to ASTM F 628 and ASTM F 1488 as well as PVC pipe in both solid wall and cellular core types. PVC solid wall meets the requirements of ASTM D 1785 and D 2665, and PVC cellular core pipe conforms to ASTM F 891. All of these plastic pipe systems are allowed for sanitary and storm drainage both above and below grade in the Uniform Plumbing Code (UPC), the International Plumbing Code (IPC), the National Standard Plumbing Code (NSPC) and most local or state variations thereof. None of these national model codes differentiate between residential or commercial uses of these plastic systems or otherwise restrict the use of any of these systems to any specific class of construction. All of the systems can be installed below grade, under slab and above grade in most areas except those classified as "return air plenums."

Solid wall pipe is just as the name implies: solid PVC material throughout the entire pipe wall. Cellular core pipe is manufactured using a unique co-extrusion process that produces pipe with a thin solid inner layer and outer layer with a foam core between these walls. Foam core pipe has the exact same dimensions as solid wall, yet is lighter and less expensive. Noise transmission is a function of density so while cast iron is by far the quietest material, PVC solid wall would be somewhat less noisy than either PVC or ABS cellular core pipe. While both are suitable for burial at most depths and common soil types, solid wall pipe is somewhat more "robust" and has a higher pipe stiffness, particularly in sizes 6" and smaller. Both ASTM F 628 and F 891 have the following limitation; Appendix X3, Installation, paragraph X3.1: maximum aggregate size shall be limited to 1/2 in. (13 mm) for angular and 3/4 in. (19 mm) for rounded particles. This statement is significant as ASTM D 2321 allows aggregate and stone that pass through 1½" sieve. PVC is classified as a flexible piping system, and as such it is dependant upon proper bedding and backfill for its ability to withstand Earth and live loads. Therefore, all plastic pipe must be installed below grade in accordance with ASTM D 2321. Cellular core pipe of any type is designed for drainage only, carries no pressure rating and Charlotte Pipe marks each piece with the print line "Not for Pressure." PVC solid wall pipe is "dual marked" and meets the ASTM standards for both pressure and drainage pipe.

Many designers allow the use of cellular core pipe on residential or light commercial projects and require the use of solid wall PVC or cast iron on commercial projects such as institutions, schools, restaurants, hospitals etc. Charlotte Pipe recommends that cellular core PVC pipe be installed in commercial applications with caution. Underground installations should be in strict conformance to ASTM D 2321. Ultimately the engineer, designer, developer or owner must evaluate the requirements of each project and specify the products they feel best suit their design criteria.

Engineered Applications

Over the past few years many new innovations have been introduced to the industry including siphonic roof drainage, sovent, air admittance devices and other products. Some of these products do not conform to existing standards or to the requirements of the model plumbing codes in some instances, reducing the pipe inside diameter and reducing flow. Rather, they are designed into the system by engineers and approved as an alternate material within the code.

Charlotte Pipe and Foundry manufactures pipe and fitting systems that conform to published ASTM and Cast Iron Soil Pipe Institute standards. Products are warranted to conform to the requirements of applicable standards when used for the applications defined within these standards. Charlotte Pipe and Foundry will not accept liability for applications that do not conform to the standards to which we manufacture.

⚠ WARNING

To reduce the risk of death or serious injury from an explosion, collapse or projectile hazard and to reduce the risk of property damage from a system failure:

- Always follow the warnings and procedures provided in this manual.
- Only use PVC/ABS/CPVC pipe and fitting for the conveyance of fluids as defined within the applicable ASTM standards.
- Never use PVC/ABS/CPVC pipe and fittings for the conveyance of gasses.
- Never use PVC/ABS/CPVC pipe or fittings in structural application or in any load-bearing applications.
- Never strike the pipe or fittings or drive them into the ground or into any other hard substance.

Quiet House is a registered trademark of Charlotte Pipe and Foundry Company.