ADDENDUM NO. 1

DATE: **January 18, 2016**
FROM: **City of Grand Junction Purchasing Division**
TO: **All Offerors**
RE: **2016 Waterline Replacement Project IFB-4158-16-NJ**

Offerors responding to the above referenced solicitation are hereby instructed that the requirements have been clarified, modified, superseded and supplemented as to this date as hereinafter described.

Please make note of the following clarifications:

1. **Updated Appendix B – Fusible PVC C-905 Information:** The corrected version of Appendix B is attached to this Addendum 1. The attached version shall supersede the previously published version.

The original solicitation for the project noted above is amended as noted.

All other conditions of subject remain the same.

Respectfully,

Nicholas C Jones, Buyer
City of Grand Junction, Colorado

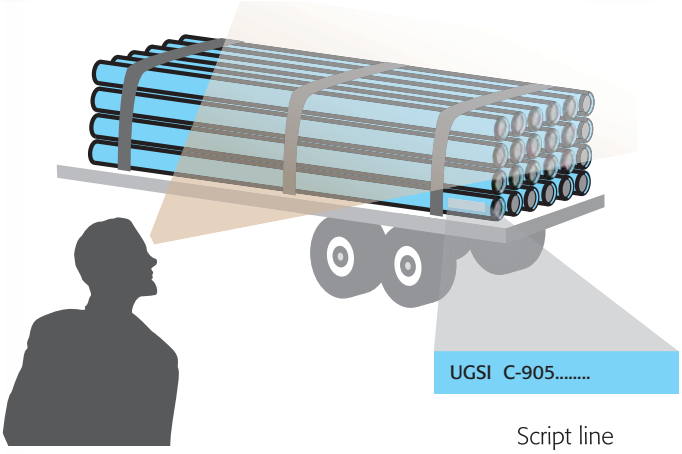
APPENDIX B

Fusible PVC C-905 Information

Pipe Handling

underground SOLUTIONS™

1) Inspect Shipment



Script line

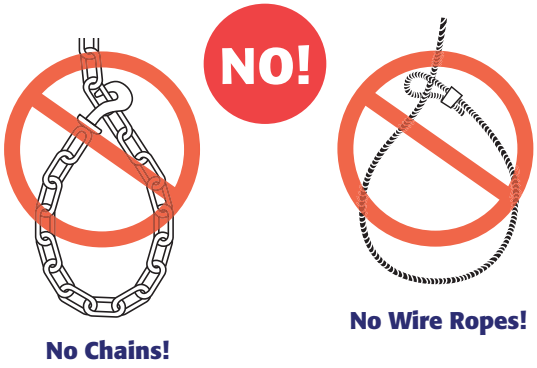
Inspect the pipe shipment prior to unloading for proper pipe size, type and color. Check for pipe damage or any other inconsistencies with the pipe load. Contact UGSI immediately if discrepancies are found.

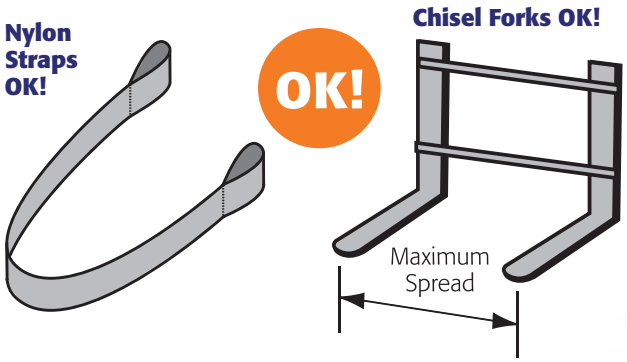
Be sure to check:

- Size (diameter)
- Thickness (DR Rating)
- Color
- Lengths
- Quantity

Problems? Call UGSI at (858) 679-9551

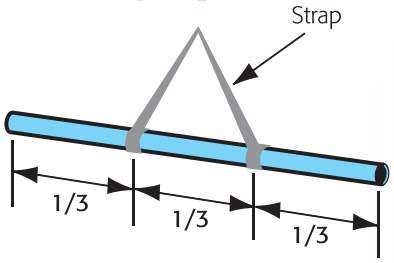
2) Lifting Mechanisms

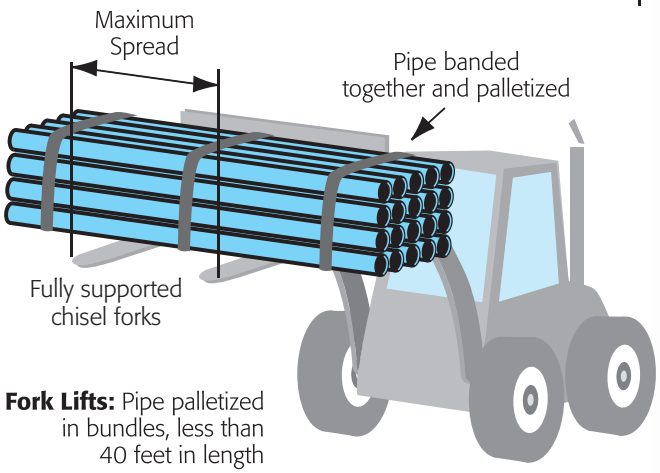




3) Moving and Unloading Pipe

Straps: For pipe lengths greater than 40 feet, as well as individual pipe lengths





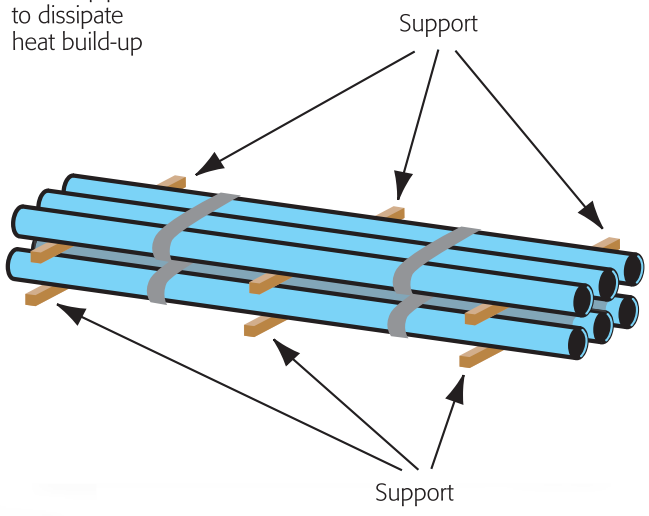
Fork Lifts: Pipe palletized in bundles, less than 40 feet in length

Machine rated for weight

4) Storage

If pipe is to be stored +1 year in direct sunlight, use opaque cover and allow air-circulation around pipe to dissipate heat build-up

Storage	
Pipe Diameter (inches)	Maximum Number of Rows Stacked
8 or less	5
12 to 21	4
24 to 30	3
33 to 48	2

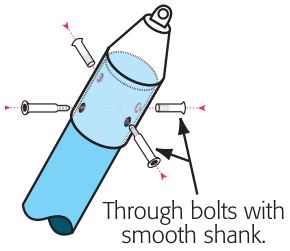


For detailed handling instructions: Please contact your local UGSI representative, or the Poway CA office at **(858) 679-9551**

Installation Procedures

1) Pulling Head Installation and Pipe End Sealing

Pull Head

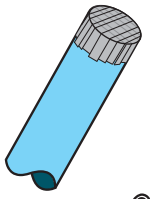


- Use UGSI recommended pulling head to achieve maximum allowable pull force recommendation for the pipe.
- Do not exceed maximum recommended allowable pull force for the given pipe selection.
- Do not exceed the maximum allowable bend radius for the given pipe selection.

Sealing Pipe End

Listed in the order of preference:

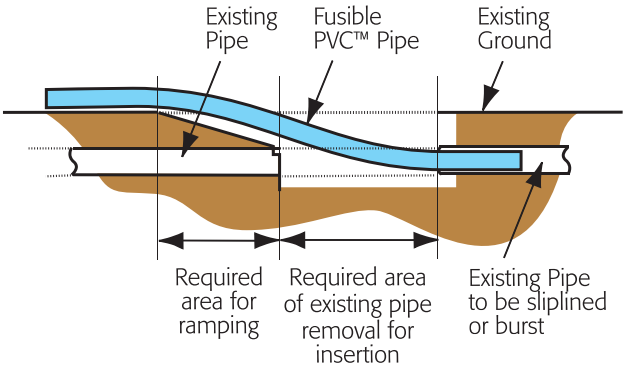
1) **Install Sewer plug.**



2) **Use Plastic and tape.**

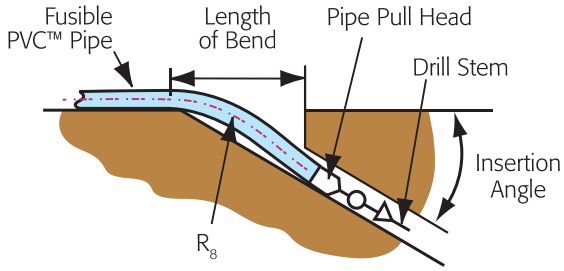
3) **Seal Pull Head.** Seal all holes with washers and/or silicon caulking.

2) 'S' Curve - Slip Line or Pipe Burst Insertion



- Determine 'S' curve length from depth of host pipe and size of Fusible PVC™ pipe, by contacting your UGSI representative.
- Determine required length of pipe removal, pit, and tail ditch from 'S' curve dimension, by contacting your UGSI representative.
- **For detailed installation procedures:** Please contact your local UGSI representative, or the Poway CA office at (858) 679-9551.

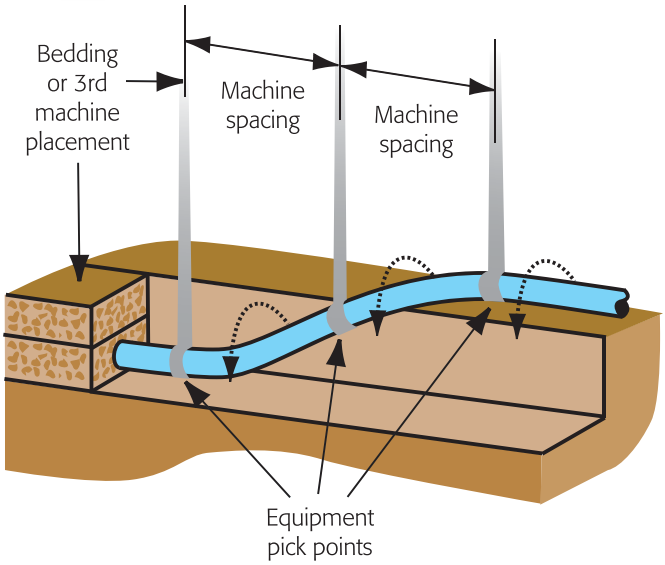
3) Horizontal Directional Drilling (HDD) Insertion



1) Determine entry point angle.
2) Determine factor from table based of angle of bore insertion.
3) Multiply the factor times the allow able bend radius of the Fusible PVC™ pipe being installed to determine the required length of bend prior to entry.
4) Consult UGSI website or local representative for the allowable bend radius for the product pipe, and detailed installation procedures.
www.undergroundsolutions.com

Curve Length Factor for Insertion Angle	
Degree of Insertion	Factor
6	.1
8	.14
10	.17
12	.21
14	.24
15	.26

4) Direct Bury Installation



1) Determine 'S' curve length from required offset and size of Fusible PVC™ pipe, by contacting your UGSI representative.
2) Use machines at beginning, middle and end of 'S' curve to lift and place pipe.
3) Or install by pulling pipe (See #2 illustration above).

For detailed installation procedures: Please contact your local UGSI representative, or the Poway CA office at **(858) 679-9551**

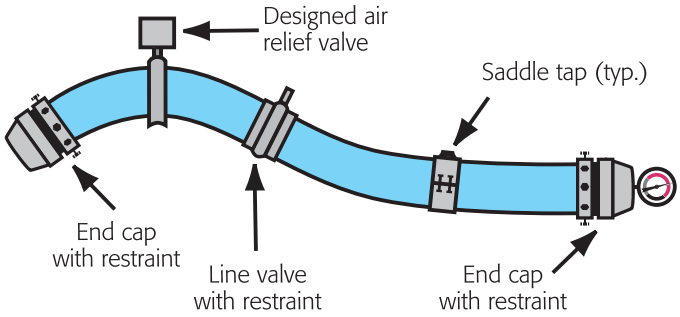
Hydrostatic Pressure Testing

underground SOLUTIONS™

1) Basics for Test

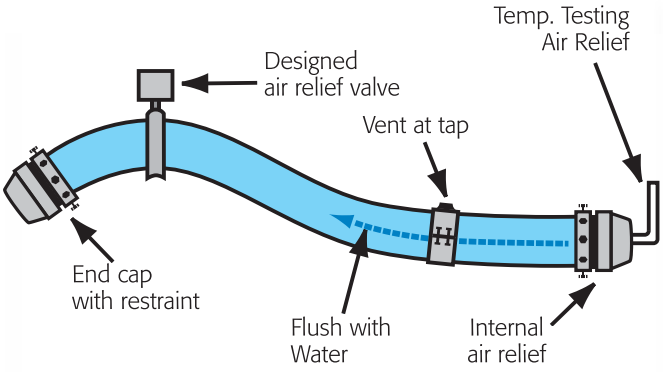
- Determine test pressure and duration from the standards having precedent over the installation.
- General Industry practice for testing is a 1 hour test at 150% of the long term working pressure for the pipeline.
- Perform all testing under supervision and adhering to all applicable safety standards.
- **WARNING** - Pressurized pipelines and attached appurtenances represent a possible safety hazard due to mis-installation, mis-handling, or mis-testing of the pipeline.
- It is recommended that all pipelines be tested AFTER installation and burial, if applicable.
- Testing is to be completed hydrostatically. Removal of air is mandatory.
- General guidelines for hydrostatic pressure testing of PVC water piping systems can be found under AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fitting for Water.

2) Check Appurtenances



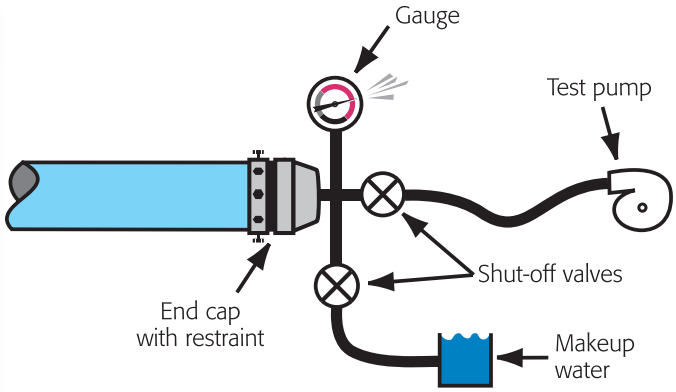
- All restraint devices are installed per manufactures's recommendations and appropriate torque.
- All devices are rated for test pressure.
- Set up test at lowest elevation.
- Remove air at the highest elevation(s).

3) Purge Air



- Use designed air relief valves, air flushing with water, temporary testing air relief at end caps, or taps in line.
- Assure all air is removed prior to test.
- Let air settle out of test water before final venting.

4) Perform Test



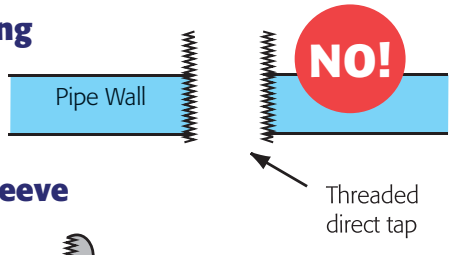
- Pressurize line.
- Hold for test period.
- Fix leaks, if any found.
- Retest if necessary.

For detailed testing procedures: Please contact your local UGSI representative, or the Poway CA office at **(858) 679-9551**

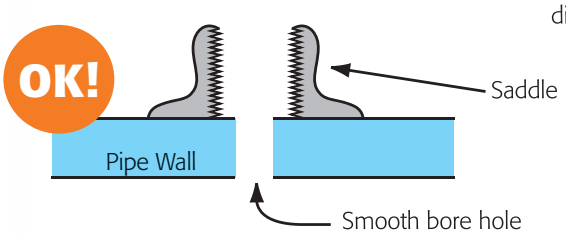
Tapping

1) Tapping Types for Pressure Application

Direct Tapping

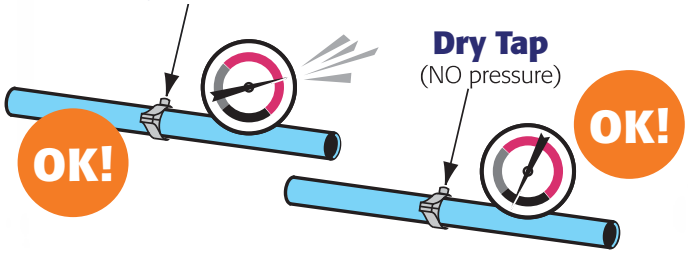


Saddle or Sleeve

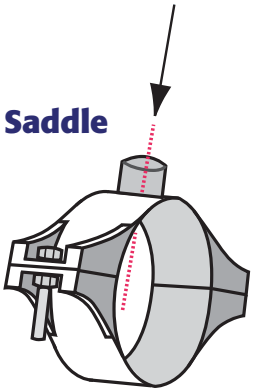


Wet Tap (under pressure)

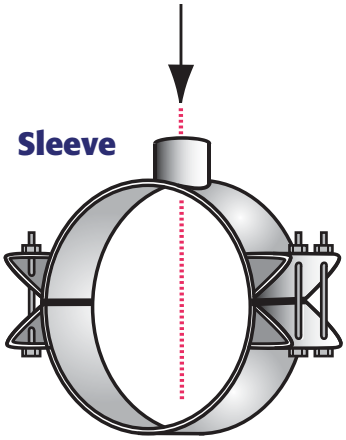
Dry Tap (NO pressure)



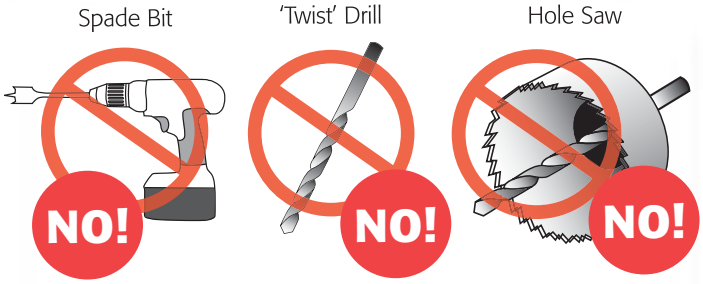
2) Saddles and Sleeves



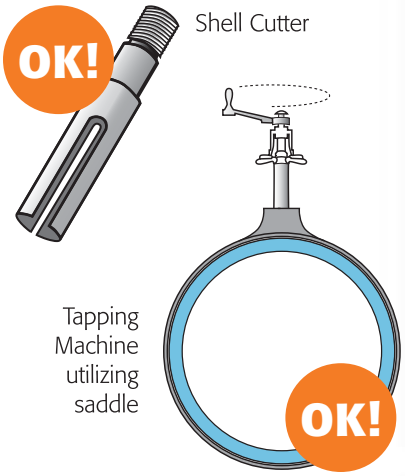
- Must be specifically designed for PVC.
- Install per manufacturer's instructions.
- UGSI recommends that all taps are performed with an appropriate saddle or sleeve.



3) Equipment



- Use appropriate Reed, Mueller, or approved equal tapping machine.
- Use appropriate PVC shell cutter, made for use with manufacturer specific tapping machine
- Use tapping machine per manufacturer's recommendations and instructions



4) Sizes Allowed

- If a greater size tap is required than is shown below, contact your UGSI representative, or the Poway, CA office, at (858) 679-9551.

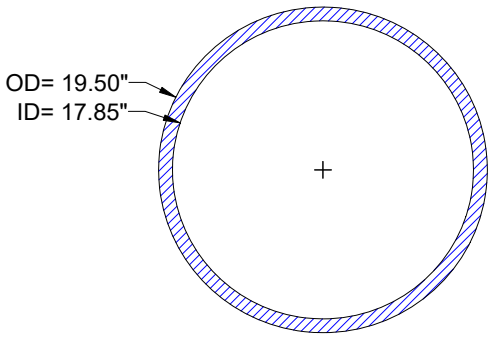
Pipe Size	Recommended Tap Sizes					
	3/4"	1"	1-1/2"	2"	4"	6"
6"	X	X				
8"	X	X				
10"	X	X				
12"	X	X				
14"	X	X				
16"	X	X	X	X		
18"	X	X	X	X		
20"	X	X	X	X	X	
24"	X	X	X	X	X	
30"	X	X	X	X	X	X

For detailed tapping instructions: Please contact your local UGSI representative, or the Poway CA office at **(858) 679-9551**

Fusible PVC®

Pipe Technical Data Sheet

	18" DR 25 Fusible C-905®
Pipe Material	Fusible C-905®
Total Pipe Length (LF)	3,650
Nominal Diameter (in)	18
Dimension Ratio	DR 25
Series	DIPS
Pressure Rating (PSIG)	165
Safety Factor	2.0
Outside Diameter (in)	19.50
Inside Diameter (in)	17.85
Cross Sectional Flow Area (in²)	250.1
Bend Radius (LF)	406
Tensile Strength (PSIG)	7,000
Safe Pulling Force (lbs)	128,400
Safe Pulling Stress (PSIG)	2,800
Relaxation Period (hrs)	0
Hydrostatic Design Basis (PSIG)	4,000
Critical Buckling Pressure (PSIG)	68
Connection to Host Pipe	Standard Mechanical Joint
Material Weight (lbs/ft)	29.8
Total Pipe Weight (lbs)	108,628
Water Disinfectant Induced Oxidation	High Resistance
Hydrocarbon Permeation	High Resistance

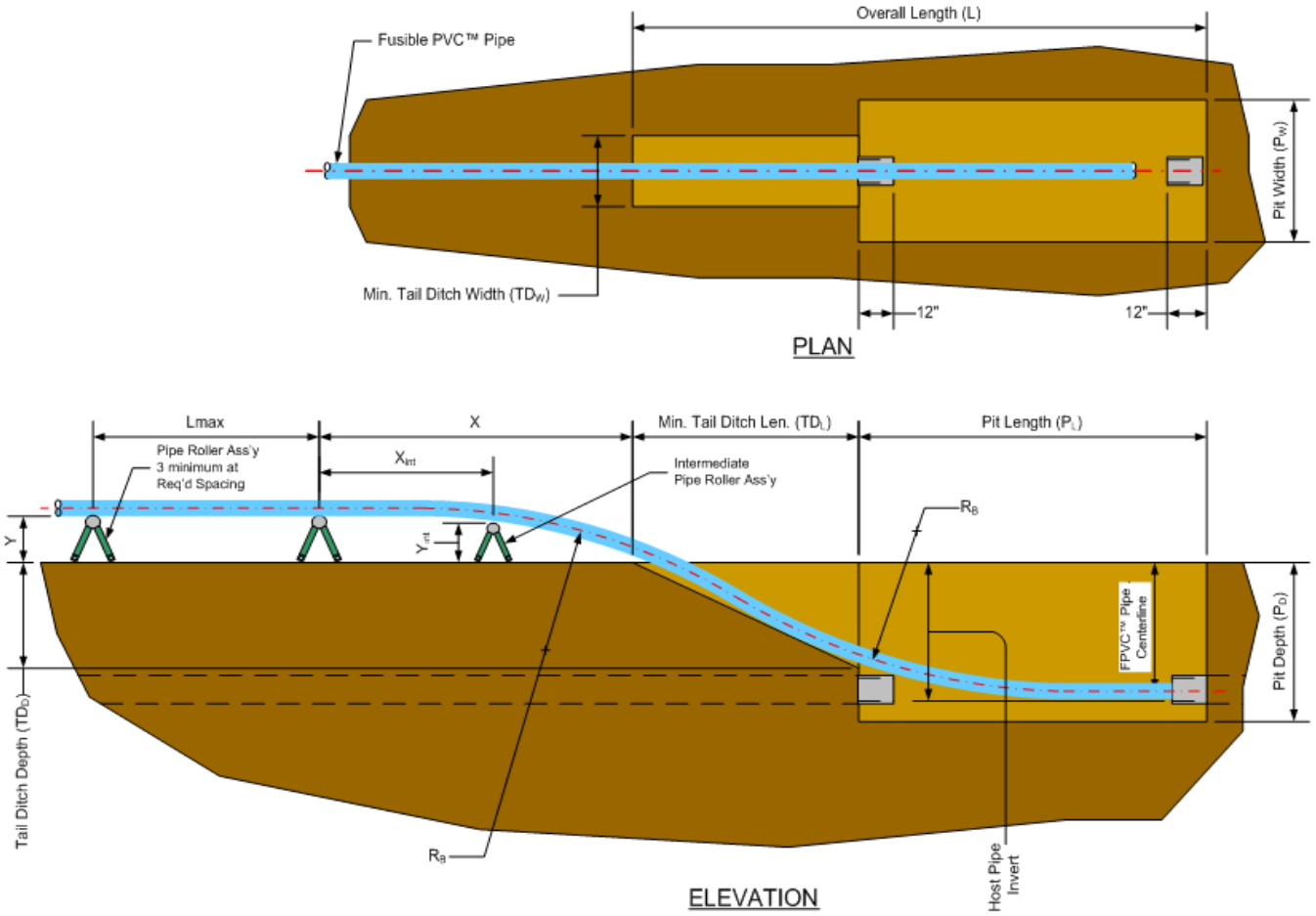


18" DR 25 Fusible C-905®

Fusible C-900® and Fusible C-905® pipe is now manufactured and marked to conform to the latest versions of the AWWA/ANSI C900 and C905 standards. The current version of AWWA/ANSI C900 increases the pressure classes for C900 PVC pipe to conform with pressure classes for C905 PVC pipe. During a transition period, UGSI may supply pipe manufactured and marked in accordance with either the 1997 or current versions of the appropriate standard, depending on pipe availability.

Supporting references for the above data can be found at:
http://www.undergroundsolutions.com/technical-data-references.php

Typical Slipline Pit Dimensions



18" DR 25 Fusible PVC® Pipe

Host Pipe Invert	Pit Length (P_L)	Min. Tail Ditch Length (TD_L)	Pit Depth (P_D)	Tail Ditch Depth (TD_D)	Pit Width (P_W)	Min. Tail Ditch Width (TD_W)	L_{max}	X	X_{int}	Y_{int}
3 ft	29 ft	8 ft	4 ft	0.83 ft	5.50 ft	2.50 ft	39 ft	40 ft	20 ft	18 ft
4 ft	29 ft	17 ft	5 ft	1.83 ft	5.50 ft	2.50 ft	39 ft	40 ft	20 ft	18 ft
5 ft	29 ft	25 ft	6 ft	2.83 ft	5.50 ft	2.50 ft	39 ft	40 ft	20 ft	18 ft

Notes:

1. All pit sizing calculations were made under the assumption that the host pipe ID is approximately 24 inches.
2. The calculations for the pit sizing showing are based on minimum requirements of the pipe product being used and do not take into consideration any soil bearing conditions, access requirements, required shoring, or project specific information, all of which should be considered and adjusted as necessary for each project.

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Recommended Cutting Procedure for Fusible PVC™ Pipe

Operational Bulletin

Recommended Cutting Procedure for Fusible PVC™ Pipe

Introduction

Fusible PVC™ pipe is made to water and wastewater industry PVC piping standards. Like regular PVC pipe, generally recommended practices for working with and handling PVC pipe apply to Fusible PVC™ pipe. However, lengths of Fusible PVC™ pipe, joined by butt-fusion, are subject to stresses not generally experienced by standard 20 foot lengths of bell and spigot PVC pipe. These stresses are related to the configuration of the pipe and/or the method of installation.

The purpose of this Operational Bulletin is to provide recommendations regarding the proper procedures and requirements for cutting Fusible PVC™ pipe.

Management of 'Bending' Stresses

Fusible PVC™ pipe is butt-fused together without mechanical joints or seals, therefore, Fusible PVC™ pipe assumes any changes in direction or grade by bending of the pipe barrel itself, rather than deflecting at joints or connections. Bending imparts longitudinal tensile and compressive stresses on the pipe. Considering that project sites tend to have some relief to them, and that most installations require some bending of the pipe either before, during, or after installation; these bending stresses need to be managed during the cutting of a Fusible PVC™ pipe string.

In an attempt to minimize the bending stresses, every effort should be made to create as straight of an alignment as possible on both sides of the pipe cut. If the adjacent pipe alignment cannot be fully straightened, resistive support on the outside of the curved section should be provided to offset the tensile stress on the outside of the curve, on both sides of the cut. The pipe should always be fully supported on both sides of the cut and, when possible, the pipe should be cut on level ground. When the pipe to be cut is cantilevered, such as the end of a pipe string that is supported from only one side; the unsupported side should be strapped to completely support the weight of the cantilevered end.

Management of 'Pulling' Stresses

The installation of the Fusible PVC™ pipe, particularly trenchless installations, will result in residual stresses in the pipe after the installation has been completed. Such residual stresses are the result of pulling the pipe into position, taking advantage of the tensile capacity of the pipe and joint.

In order to minimize or relieve the residual stresses from pulling, it is recommended that the lead end of the installed pipe length be pushed back gently in the reverse direction of the installation. This compressive force will act to relieve residual tension on the pipe after being pulled. Ideally, the back end of the installed pipe should move slightly, showing that the entire

pipe string has been compressively moved back through the final installation alignment. While this is ideal, it may not be possible in certain circumstances and installations, such as HDD installations.

Recommended Procedure for Cutting Fusible PVC™ Pipe

Regardless of the steps taken to relieve the 'bending' and/or 'pulling' stresses, it is possible that some residual stress might still remain in the Fusible PVC™ pipe string at the cut location. When the pipe is cut in the hoop direction, or perpendicular to the length of the pipeline, any unrelieved longitudinal stress will act to pull the pipe apart. This can result in separation of the pipe, prior to being cut the entire way through. The cutting creates an initiation point in the direction perpendicular to the orientation of the longitudinal stress, which can open the pipe in the hoop direction prior to the completion of the cut. While this phenomenon is sometimes advantageous in that it 'completes the cut' prior to having to actually cut the entire pipe wall section – the 'cut-ends' are not always clean and perpendicular – particularly in situations where the longitudinal stresses are uneven, such as with bent pipe.

To achieve as smooth of a cut face as possible, the following cutting procedure is recommended. This procedure will also help to confine the extent of the pipe separation to the intended cutting plane.

Referencing Figure 1, the following steps should be followed in order:

1. **ALWAYS DOUBLE-CHECK TO MAKE SURE THAT THE PIPE IS NOT INTERNALLY PRESSURIZED. ALL INTERNAL PRESSURE MUST BE RELIEVED.**
2. Considering the size of the cutting equipment that will be used to make the cut, position the pipe so that the bottom can be cut. Follow the management practices recommended above regarding the general position and nature of the pipe string and installation.
3. Using a tape, pipe cutting marker or other reference, mark on the pipe the intended cutting plane for the entire pipe circumference.
4. Score the pipe from the 9 o'clock to 6 o'clock positions to a depth of about ¼". Do not completely cut through the pipe.
5. Score the pipe from the 3 o'clock to 6 o'clock positions to a depth of about ¼". Do not completely cut through the pipe.
6. Score the pipe from the 12 o'clock to 3 o'clock positions to a depth of about ¼". Do not completely cut through the pipe.
7. Score the pipe from the 12 O'clock to 9 O'clock positions to a depth of about ¼". Do not completely cut through the pipe.
8. Cut the pipe completely from the 9 o'clock to 6 o'clock positions.
9. Cut the pipe completely from the 3 o'clock to 6 o'clock positions.
10. Cut the pipe completely from the 12 o'clock to 3 o'clock positions.
11. Cut the pipe completely from the 12 o'clock to 9 o'clock positions.

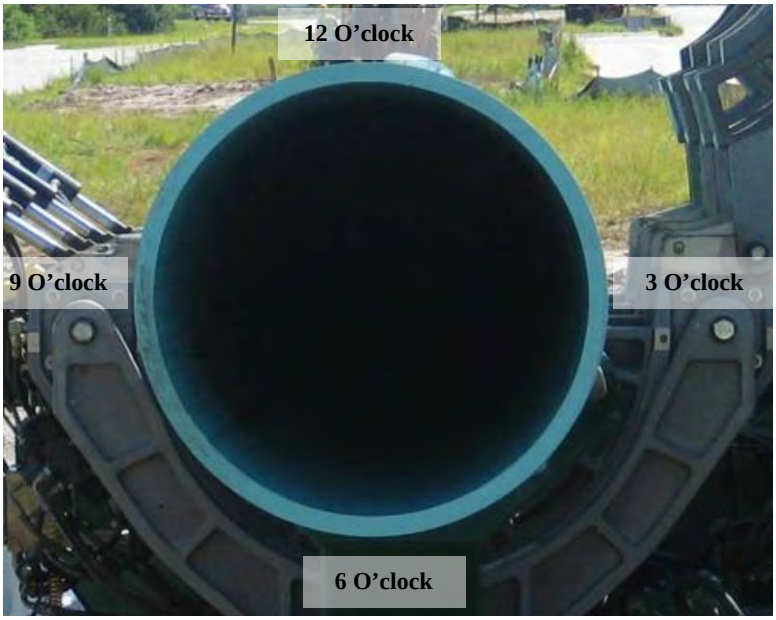

Figure 1

Figure 2, below, shows a 30" Fusible PVC™ pipe string that was cut using this method. Note the excavation under the pipe to allow the scoring and then ultimately the cutting of the full pipe section. Also note the full, level, soil support of the pipe on either side of the cut.

Figure 2

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Pull-Head Installation Operational Bulletin

Underground Solutions® Pull Head Installation and Use

Product Use Warnings:

- Connections to the pull-head clevis should be such that the pull head and the attached pipe are not allowed to rotate.
- The pull-head clevis should not be modified to fit a non-compatible pulling mechanism.
- Components of the pulling mechanism, such as sub-assemblies, swivels, clasps, and pins that will be located between the pull-head and the pulling mechanism must be rated at or above the allowable pulling force for the Fusible PVC™ pipe section being installed.
- Never exceed the maximum allowable pull force for the Fusible PVC™ pipe being installed.
- The end of the Fusible PVC™ pipe being installed should be sealed prior to installation of the pull-head to minimize the amount of foreign substances entering the interior of the pipe during pull-in (see "Installing the Pull-Head").

Parts List:

Before mounting the pull head on the end of the pipe, the parts and equipment listed in Table 1 will be required:

	Pull Head Size		
	10" and below	12" to 24"	30" to 36"
Smooth shank pull head nuts (supplied by UGSI)	Six (6)	Four (4)	Six (6)
All thread stock	Three (3) ¾" dia.	Two (2) 1-¾" dia.	Three (3) 1-¾" dia.
Hex wrenches	Two (2) ½"	Two (2) 1"	Two (2) 1"
Rolls of "Gorilla Tape" or 10.5 mil minimum Duct tape (not preferred)	One (1)	One (1)	One (1)
Rubber Washers (for bolt sealing)	Six (6) with ¾" hole	Four (4) with 1-¾" hole	Six (6) with 1-¾" hole
Inflatable Sewer Plug (optional)	One (1)	One (1)	One (1)
New/sharp hole saw or drill bit	One (1) ¾"	One (1) 1-¾"	One (1) 1-¾"
Small Tools	Small metal file, tape measure, marker, drill		

Table 1

Installing the Pull-Head:

Follow these steps when installing a UGSI designed pull-head:

1. ***CAUTION: THE PULL HEAD IS NOT DESIGNED TO STOP THE DRILLING MUD OR OTHER LIQUIDS FROM ENTERING THE PIPE.*** Seal the end of the pipe using one of the following methods in order of most preferable to least preferable:
   a. Insert a clean inflatable sewer plug into the end of the pipe ensuring that the plug has been inserted deeper that the deepest bolt holes. Inflate the plug until it seals with the inside of the pipe and tie off the plug to a cross bolt for easy retrieval. For extra sealing, follow step b or c below. Go to step 2.
   b. If a clean sewer plug is not available: use a piece of thick plastic (possibly a garbage bag) and "Gorilla Tape" to seal the end of the pipe. The plastic or bag should be slid onto the end of the pipe and taped to the outer diameter of the pipe. Taping should then be done as shown in Diagram 1 to seal the pipe-end as much as possible. Go to step 2.
   c. If "Gorilla Tape" is not available, a minimum of 10.5 mil duct tape can be used. Duct tape is not ideal for this application. Go to step 2.

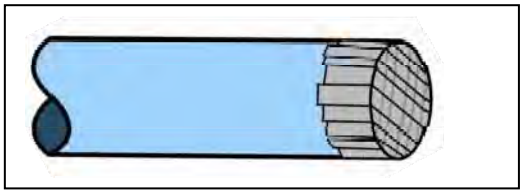

Diagram 1

2. Measure the outside of the pull head for the barrel length of the pull head to be used. Be sure not to measure past the barrel of the pull head into the cone portion. Measure the same distance from the end of the pipe on which the pull head will be installed and mark the position with a line using the marker.
3. Insert the pull head over the pipe until the pull head barrel reaches the general location of the line marked in step 2. The pull head is heavy and designed with a tight clearance so proper equipment should be used to mount the pull head. It might be necessary to push the pull head on with a piece of equipment.
4. Use a sharp (preferably new) hole saw or drill bit (see Table 1 for size) to drill holes in the pipe using the holes in the pull head as a template. When drilling, it is important to allow the teeth of the hole saw to do the cutting – putting additional pressure on the drill during this step could damage the pipe.
5. Cut the all thread stock to the proper size. ***CAUTION: When cutting all thread it is possible for the threads to bend and not allow the installation of the smooth shank pull head nuts. Use the file to clean the threads and ensure that the pull head nuts can be threaded onto the all thread. Cross-threading will not give the proper amount of strength to the assembly and must be avoided.*** Each size pipe is different so care should be taken to ensure that the all thread will reach across the pipe. NOTE: The all thread can always be trimmed but cannot be lengthened, so if there is any question as to length it is recommended that the all thread be cut longer than needed. If necessary, it can be cut again. Table 2 can be used as a reference for determining the proper all thread lengths.

Pipe Size	All Thread Length	Pipe Size	All Thread Length
4”	1.375”	16”	11.875”
6”	3.75”	18”	14.00”
8”	6.00”	20”	16.125”
10”	8.00”	24”	20.25”
12”	7.75”	30”	26.75”
14”	9.75”	36”	32.00”

Table 2

6. Install one of the smooth shank pull head nuts on to each piece of all thread. Tighten by hand until snug.
7. Insert the assembled hardware into one side of the available holes in the pull head. Rubber hose-washer style grommets may be used to prevent mud from entering the pull head assembly through the bolt holes. Slide each washer over the shank of the pull head nut and push to the flared head. Use another smooth shank pull head nut and insert it into the available hole exactly 180° from the inserted hardware and thread onto other side of the all thread until hand tight. Repeat until all holes in the pull head contain a pull head nut.
8. Tighten each of the pull-head nuts using the hex wrenches. Each smooth shank pull head nut should be completely flush with the pull head with no gaps.
9. After complete installation of all hardware, Gorilla Tape should be used to seal the pull head as much as possible. Gorilla Tape should be installed over the pull head nuts and wrapped entirely around the pull head. Duct tape may be used, but is not preferred and may not result in a complete seal.
10. Use Gorilla Tape to seal off the edge of the pull head to the pipe in order to prevent (as much as possible) drilling mud leaking up the pull head. ***NOTE: Silicone caulking can be used in concert with the Gorilla Tape to help seal the pull head. However, the caulking should only be used for sealing and cannot be used in lieu of the Gorilla Tape.*** Duct tape may be used, but is not preferred and may not result in a complete seal.

This process must be re repeated for each individual pull. The pull-head cannot be cut off and re-fused onto the end of the pipe as this could cause the pipe to fail at the pull head connection.
Please contact the UGSI Operations Department at (858) 679-9551 with any questions regarding pull-head installation or use.

Fusible PVC™ Pipe Products

Fusible C-900®/ Fusible C-905®/ FPVC®

Handling & Installation Guidelines

underground SOLUTIONS®

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Detailed Pipe Handling Procedures and Information for Fusible PVC™

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Detailed Pipe Handling Procedures and Information for Fusible PVC™, including Fusible C-900®, Fusible C-905®, and FPVC™

1 Introduction

Stock lengths of Fusible PVC™ products, including Fusible C-900®, Fusible C-905®, and FPVC™ are handled in the same manner as traditional bell and spigot PVC with consideration for the 40 foot shipping lengths. They need to be loaded, off-loaded, strapped, moved, pulled and otherwise handled in the exact manner that bell and spigot PVC piping is handled.

There are several unique aspects of these products that do need to be considered, however. These include the 40 foot lengths that Fusible PVC™ is shipped in, as well as how the nature of the fusion joint used affects the handling of the pipe itself. Actual installation methods and parameters are discussed in Underground Solutions™ procedural document TP - 1 - 020 - Recommended Installation Procedures.

Underground Solutions™ Fusible Pipe Handling and Storage Instructions are based on industry experience and the recommendations as described in AWWA M23 Manual of Supply Practices PVC Pipe—Design and Installation, Second Edition.

2 Shipping and Receipt of Shipment

Inspection of each load of pipe, prior to unloading, is the first step when the shipment arrives. After the shipment has been verified, it can then be unloaded and prepped for installation or temporary storage.

2.1 Inspection of the Shipment

Each pipe shipment should be inspected prior to unloading for appropriate quantity, pipe size and pipe type. Each pipe shipment should also be checked to see if the load has shifted or otherwise been damaged during transit. The bill of lading will list quantities and sizes of pipe being delivered.

Each piece of pipe will be marked with the following information: pipe size; DR or wall thickness; ”fusible” designation; UGSI or Underground Solutions, Inc. trade name; and the drinking water certification (if applicable). The pipe is color coded based upon intended application.

If there are discrepancies, quality issues beyond immaterial shipping and/or loading damage, or missing inventory, please contact Underground Solutions within 24 hours of receipt of the shipment. Any damage, missing material, etc., should be noted on the shipping bill of lading.

Please call the Underground Solutions, Inc. at (724) 353-3000and ask for Crystal Davis.

2.2 Off-Loading of Pipe Shipment

Remove restraints from the top unit loads. Beware of boards that may have come loose during shipment creating a potential hazard.

Use a forklift with chisel forks. The fork chisel should be checked to be sure it is not thicker than the gap between the units of pipe strapped together for shipping and handling purposes. The spread of the forks should be set at the maximum distance apart. Extend forks to remove each top unit from the truck.

Do not run forks too far under the units, as fork ends striking adjacent units may cause damage. Insure that the forks are fully engaged. If left bundled in units, unloading can be done with a single forklift so long as it is of sufficient capacity to handle the load. If sag exceeds recommendation (see Table 2.3 for allowable sag), then each piece of pipe should be unloaded individually.

When unloading individual pieces of pipe, the pipe should be supported at approximately the 1/3 point measured from each end of the pipe.

If a forklift is not available, a spreader bar with fabric straps capable of handling the load should be used. Recommended lift points when using fabric slings are at the points approximately 1/3 of the length measured from each end of the unit.

Care shall be exercised when handling the pipe to not cut, gouge, scratch or otherwise abrade the piping in any way. Use of hooks, chains, wire rope or any other handling device which might damage the pipe is strictly prohibited.

During removal and handling, be sure that the pipe does not strike anything. Significant impact could cause damage (particularly during cold weather).

To unload lower units, repeat the above unloading process.

If appropriate unloading equipment is not available, pipe may be unloaded by removing individual pieces. Care should be taken to insure that pipe is not dropped or damaged. Pipe should be carefully lowered, not dropped, from trucks.

In preparation for pipe installation, placement of the unloaded pipe should be as close to the area where fusion will take place as practical.

2.3 Sag Check

	Segment Height (Sag)	
Nom. Pipe Size	30' Length	40' Length
(DIPS)	(inches)	(inches)
4	13	23 1/2
6	9	16 1/2
8	7	12 1/2
10	5 1/2	10
12	4 1/2	8 1/2
14	4	7 1/2
16	3 1/2	6 1/2
18	3	5 1/2
20	2 1/2	5
24	2 1/2	4
30	2	3 1/2
36	1 1/2	3
42	1	2 1/2
48	1	2

	Segment Height (Sag)	
Nom. Pipe Size	30' Length	40' Length
(IPS)	(inches)	(inches)
3	18	32 1/2
4	14	25 1/2
6	9 1/2	17
8	7 1/2	13
10	6	10 1/2
12	5	9
14	4 1/2	8
16	4	7
18	3 1/2	6
20	3	5 1/2
24	2 1/2	4 1/2
30	2	3 1/2
36	1 1/2	3
42	1 1/2	2 1/2
48	1	2

Table 2.3 - Allowable Maximum Sag in Pipe Lengths During Unloading and Moving

Sag is the measurement of the pipe ends relative to the pipe center (see Figure 2.3). This can be accurately measured using string and a tape measure. With a pipe raised with the lifting device, stretch the string on the bottom of the pipe from one end to the other. Using the tape measure, measure the distance from the string to the bottom of the curved pipe section at the midpoint. This distance is the 'sag' of the pipe in its current configuration, and the distance should not be greater than what is listed in Table 2.3. A quick check is to take a 4 or 5 foot level and place it against the bottom of the pipe at the point of the most curvature. You should not be able to see a gap between the level and the pipe of more than about $1/64^{th}$ of an inch. If a large gap exists, a full length measurement of sag, as described below, should be performed.

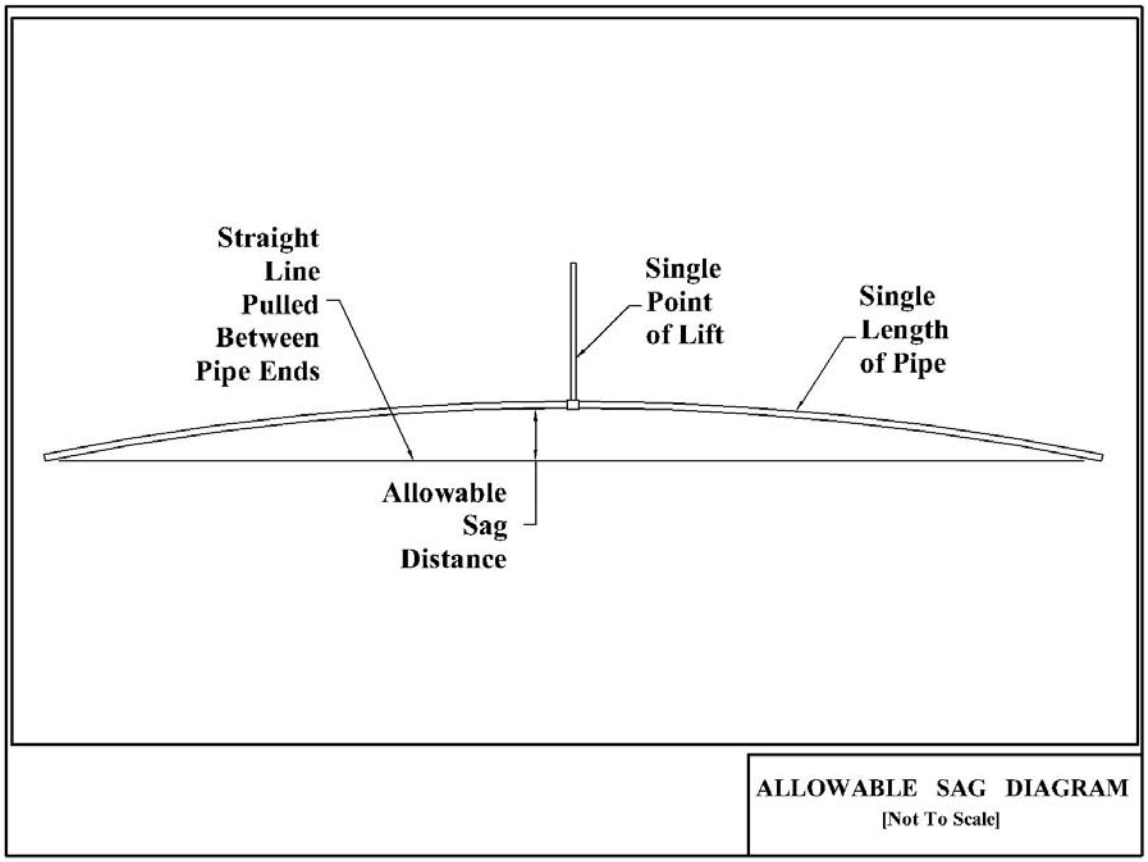

Figure 2.4 – Sag Illustration

If the sag is greater than the allowable sag, as indicated in Table 2.3, reconfigure your lifting mechanism with a wider spread, if it is a two point lifting device, or utilize a two point lifting device, if using a single point lifting device.

3 Storage Requirements

Pipe units should be stored and placed on level ground. Pipe should be stored at the job site in the unit packaging provided by the manufacturer, if possible. Caution should be exercised to avoid compression, damage, or deformation to the ends of the pipe. Use racks or dunnage to prevent damage to the bottom during storage and to support the pipe or pipe unit. Supports should be spaced to prevent pipe bending. The pipe shall be stored in stacks no higher than that given in the following Table 3.1:

Pipe Diameter (inches)	Max. No. of Rows Stacked
8 or less	5
12 to 21	4
24 to 30	3
33 to 48	2

Table 3.1 – Stacking Parameters for Fusible PVC™

When exposure in excess of one year to direct sunlight is unavoidable, the pipe should be covered with an opaque material while permitting adequate air circulation above and around the pipe as required to prevent

excess heat accumulation. The interior of the pipe, as well as all end surfaces, should be kept free from dirt and foreign matter until the pipe is ready to be fused.

4 Summary

The proper handling, moving, and storing of Fusible PVC™ will assure the integrity of the pipe and provide the foundation for a successful project.

Recommended Installation Procedures for Fusible PVC™

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Recommended Installation Procedures for Fusible PVC™, including Fusible C-900®, Fusible C-905®, and FPVC™

1 Introduction

In most cases Fusible PVC™ is assembled at existing grade on the project site in long lengths prior to installation. This is the most efficient method for the butt-fusion procedure. As a result, the pipe must be moved from the layout at-grade assembly, to the final alignment for installation, normally below grade.

The insertion point is normally in a pit that provides access to the exit point of a horizontal directional drill (HDD) or the end of an existing pipeline for sliplining or pipe bursting type installations. Movement of the at-grade assembled Fusible PVC™ pipe from the surface to the prepared sub-base is also required in direct bury type installations.

This document will review the basic procedures Underground Solutions recommends to perform these installations with Fusible PVC™.

2 Pulling Parameters and Requirements for Fusible PVC™

All of the general installation methods with which Fusible PVC™ can be installed include some means of moving the assembled Fusible PVC™ pipe into final alignment in the ground. These installation procedures all rely on the allowable tensile pull force of the plastic pipe to accomplish this task.

2.1 Allowable Bend Radius

The safe allowable bending radius for Fusible PVC™ is a very important factor in the installation of the assembled pipe. This parameter dictates how much the pipe may be bent, not only during the installation phase and handling, but in the final alignment as well, which has a limiting effect on installation methods such as HDD and direct bury.

Underground Solutions has a document which explains the basis for the allowable bending radius in detail, but for the purposes of this document, allowable bending radius is based on the tensile properties of the plastic as described below. This information for each type of Fusible PVC™ pipe, as well as the document which describes the basis for this parameter, is available by contacting your Underground Solutions representative.

2.2 Safe Pulling Force

The amount of tensile load to be put into the pipe during a pull-in is called the safe pulling force. This value is a function of the cross-sectional area of the PVC pipe times a safe tensile stress. A requirement of PVC plastic used for AWWA C900 and AWWA C905 piping is to have a minimum tensile stress capability of 7000 psi. A safety factor of 2.5 is applied to this to derive the safe pulling stress. This value is 2800 psi. This is multiplied by the pipe area to come up with the Safe Pulling Force. The most common way to calculate the pipe area is to calculate the areas of the circles defined by the OD of the pipe and the ID of the pipe. The ID is arrived at by subtracting twice the minimum wall thickness from the OD. This information for each type of Fusible PVC™ pipe is documented; please contact your Underground Solutions representative for more details.

During installation there are multiple potential stresses on the pipe beyond the straight axial pull. There can be frictional resistance over ground and in the alignment, there could be bending stress, drag on the pipe due to buoyancy considerations, and so on. There also is the element of the unknown

within the alignment. These all are additive in their occurrence requiring this significant safety factor to account for the possibility of them.

2.3 Temperature Effects on Safe Pulling Force and Bend Radius

Fusible PVC™ pipe properties, like all PVC pipe properties are defined at a standard ambient temperature of 73.3°F. As temperature rises above this, two key properties relative to pull are affected. These are tensile strength and modulus of elasticity.

The tensile strength of thermoplastics drops as temperature rises. This means that on especially warm days with longer pulls, the temperature at the time of pull-in may lower the overall safe pull force. The temperature impacts are defined in the following Table 2.3.1:

Temperature (°F)	% of Recommended Pull Force
73.3	100
80	95
90	87
100	78
120	63
140	58

Table 2.3.1 – Temperature Impact on Safe Pull Force

As temperature rises, the modulus of elasticity is also affected. It too decreases as the temperature goes up. The effect of this decrease is that as the pipe warms it becomes more flexible. The change in modulus directly reflects the increase in flexibility. This can be applied to the bend radius used for bending limitations. The following Table 2.3.2 defines the change:

Temperature (°F)	% Change in Modulus
73.3	100
80	98
90	94
100	88
120	78
140	70

Table 2.3.2 – Temperature Impact on Modulus of Elasticity

The change in modulus can be directly applied to the bend radius. For a given pipe size, the bend radius can be reduced by multiplying the % based on temperature times the base bend radius. At 100ºF, for example, the bend radius would be reduced by 12%, meaning that it becomes more flexible.

2.4 Pulling Mechanism Connections

All installation methods, including HDD, pipe bursting, sliplining, and direct bury, must utilize a pulling mechanism to accomplish the installation. There are several methods available to attach the pulling mechanism to the pipe as reviewed below:

2.4.1 Nylon Strap

For open cut or movement on the surface, if the length is short and a minimum force is needed, the pipe can be pulled with a nylon strap. The tensile capability of the strap needs to

be known to compare to the relative force it may take to move the pipe.

2.4.2 Through-bolt with Linkage

In the case of sliplining short lengths in dry conditions, round head carriage bolts can be used to connect a chain link internally, to allow attachment of a cable for pull-in.

Care must be taken to make the bolted connection at least 12" from the end of pipe. This distance controls the amount of pipe wall in shear. If the connection is too close to the pipe end, it will rip out.

This method is only good for relatively short lengths in dry conditions. The connection, when under higher load, will tend to pull in toward the center of the pipe putting it into an oval shape. This also introduces pull out forces on the bolts and stress in the pipe wall that could lead to connection failure. In longer lengths a pull head must be used.

2.4.3 Pull-Head

For HDD and long pulls in all other methods, pull heads have been designed and fabricated for Fusible PVC™. The pull head is sized to take and effectively transfer the recommended safe pulling force from the head to the pipe.

Because PVC is a relatively hard thermoplastic compared to other plastics used with the heads, serrated grip type heads don't bite into the PVC with enough force to effectively transfer the full safe pulling stress of the Fusible PVC™. As a result these types are not recommended for use with Fusible PVC™. The pulling heads for use with Fusible PVC™ are designed with through bolts located to accommodate the recommended safe pulling forces. The bolts are smooth shank to eliminate stress concentrations caused by the edges of a threaded bolt or all-thread. The bolts are countersunk to provide a smooth pulling surface on the outside of the head. The bolts are made to connect inside the pulling head to allow double shear loading of the bolts at the pipe wall.

The pulling heads are sized to accommodate a specific pipe OD. The pipe OD plus the out-of-round tolerance are used to set the ID of the pull head. This assures a tight fit and also accommodates the allowable variances in the pipe OD. With larger pull heads (greater than 12-inches in diameter) an additional gap allowance of approx .05" is added due to the stiffness of the pipe. It is recommended that the pull head be removed and re-installed on the Fusible PVC™ pipe after each pull-in.

Pull-heads are available for rent or purchase from Underground Solutions, Inc. Please contact your Regional Sales Manager or our main office at 858-679-9551 about rental rates or sell price.

Figure 2.4.1 – Pull Head for Use with Fusible PVC™

The pull head should also be used when fusing long lengths together prior to installation. As the pipe gets longer and heavier, a strap may slip. The pull head provides support of the wall and will prevent ovaling and folding of the pipe if a through connection is needed for the pulling.

In most cases it is recommended that a swivel be placed between the pull head and the pulling mechanism to eliminate any torsion forces being transferred to the pipe. In the case of pipe bursting, additional isolations are recommended to prevent any compression forces being transmitted to the pipe.

For HDD installations and any other methods requiring a sealed pull head, several steps can be taken. Rubber hose washers or "O" rings can be placed under the bolt heads to act as a sealing gasket at these locations. The back end of the pull head can be sealed with a silicone caulk. Another preventive step is to close the end of the PVC pipe prior to installation of the pull head. This can be done with plastic sheeting and/or tape. See Figure 2.4.2 below:

Figure 2.4.2 – Sealing of Pipe End Prior to Pull Head Installation

3 Installation by Sliplining or Pipe Bursting Methods

In sliplining installation the pipe is normally fused on the surface. The insertion point is at a removed section of the host pipe. The host pipe, in most cases, is generally at a horizontal grade.

In pulling a fused pipe from at-grade to below grade and the final alignment, the pipe must bend generally in an "S" configuration, with two separate, but equal bending radii. The recommended bend radius for the pipe being inserted (shown as 'R_B' in Figure 3.1) is the parameter that defines the length of the insertion pit (shown as 'L' in Figure 3.1).

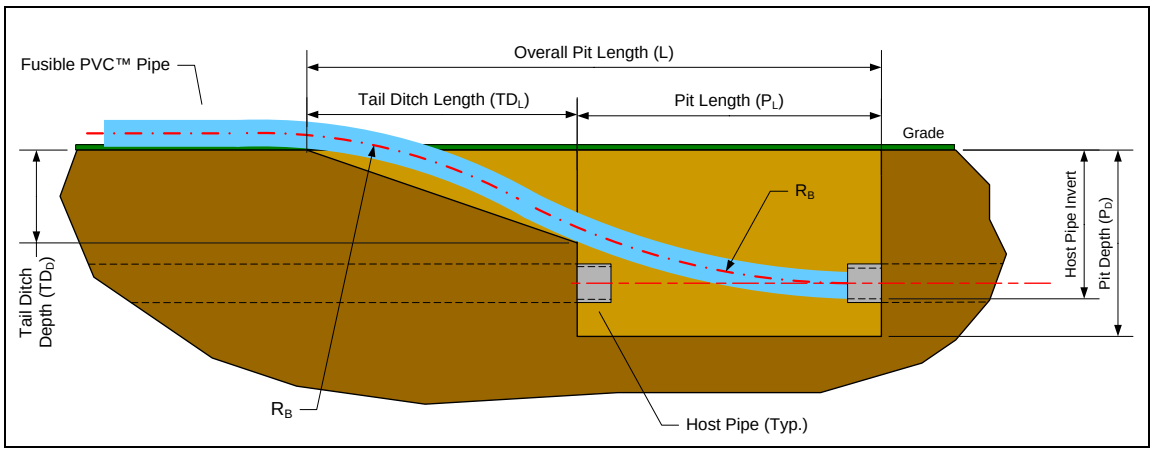

Figure 3.1 – Sliplining or Pipe Bursting Insertion

The reality of the installation may not dictate such a straightforward 'S' curve of the Fusbile PVC. A portion of the bending could happen above grade by supporting the pipe on pipe stands. This allows the bending to start prior to reaching the start of the pit. If the grade of the host pipe is greater than 0 %, sloping downward away from the installation, a lesser bend to enter the host pipe could be required. Also, if the host pipe is substantially larger than the Fusible PVC™ to be inserted, a portion of the bending could be accomplished inside the host pipe. Factors such as the sharp lip of a host pipe entrance or host pipe fragments leftover from pipe bursting may scratch the surface of Fusible PVC™. If a scratch in the surface of the Fusible PVC™ pipe is made greater than 10% of the pipe wall thickness, then you should contact your Underground Solutions representative immediately to determine the next course of action. **It is highly recommended that the installation of the new Fusible PVC™ pipeline be closely monitored.** Other issues that can influence the length needed for making such a transition are the ambient temperature (higher temperatures reduced the modulus of elasticity making the pipe more flexible). Contact your Underground Solutions representative for information regarding the parameters of your particular sliplining or pipe bursting installation.

4 Installation by Horizontal Directional Drill Methods

In HDD installations the pipe is normally joined at-grade. The insertion point is at the exit pit of the HDD bore.

In HDD applications, the entry point of the Fusible PVC™ is often defined by an entry angle. This is expressed in degrees from the horizontal. A typical entry angle is between 6º and 15º. The length of Fusible PVC™ required to make the transition from the horizontal fused alignment to the point of entry is shorter than for sliplining and pipe bursting insertions because there is a single curve involved and not a full 'S' curve. As in some slipline and pipe bursting applications, sometimes for an HDD where the drilled alignment is greater in diameter than the pipe being inserted, a portion of the bending can take place as the pipe enters the bore

hole. **As previously mentioned, it is highly recommended that the installation of the new Fusible PVC™ pipeline be closely monitored.**

The following Table 4.1 provides a factor to be used times the Fusible PVC™'s bend radius to determine the length required to make the transition into the bore hole:

Degree of entry point	Factor
6	.1
8	.14
10	.17
12	.21
14	.24
15	.26

Table 4.1 – HDD Bend Radius Factors

Contact your Underground Solutions representative for information regarding the parameters of your particular HDD installation.

5 Installation by Direct Bury Methods

The final installation method for Fusible PVC™ reviewed here is direct bury, or "Open Cut" method. Direct bury installations can be completed primarily in two ways.

5.1 Pull-in Method

The first is to perform a pull-in from the end of the trench. The pipe is fused ahead of the trench excavation in approximate alignment with the trench. In this approach, the insertion trench is the transition from the at-grade pipe fusion location to the cut trench bottom. The insertion trench follows the same geometry shown in the insertion configuration section for sliplining or pipe bursting (Section 3) of this document, as well as Figures 3.1 and 3.2. This technique works well when there is not enough room in the trench easements for fusion and lay-down area next to the trench. In many cases the spoils from the trench take up available room adjacent to the trench. The governing factor on insertion of this type is the insertion trench, and making sure the allowable bend radius of the pipe is not exceeded from the at grade elevation down to the final alignment elevation.

5.2 Placement Method

The second method is moving the pipe from *next* to the trench, *into* the trench and final alignment. In this case, the bend radius of the pipe is used to determine the location of the bends required to relocate the pipe. The distance to be moved is determined from the initial at-grade alignment location, and the final installed alignment location of the pipe.

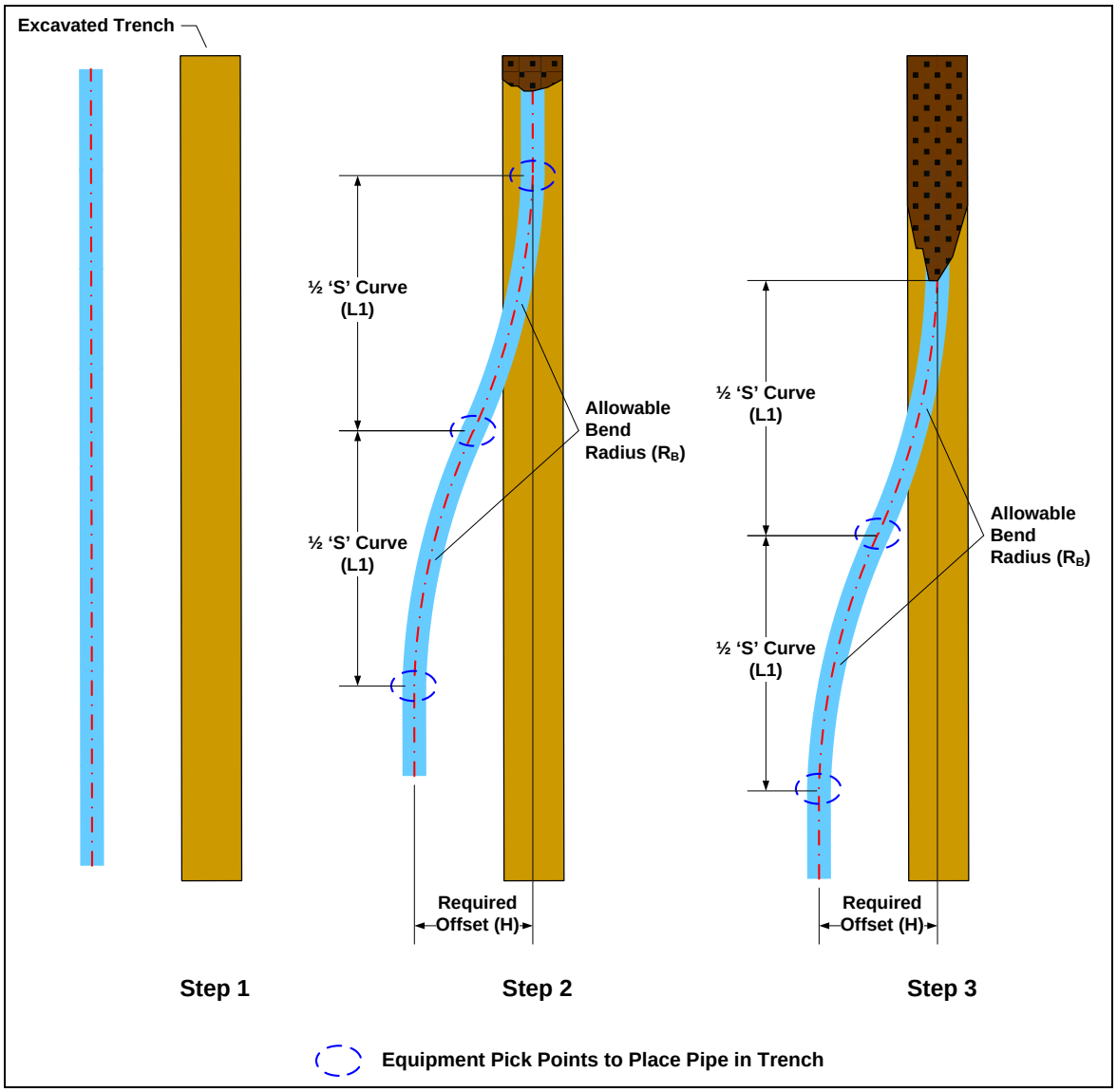

Figure 5.2.1 – Direct Bury Pipe Placement Installation Steps

The starting point for installation is the Fusible PVC™ laying next to an excavated trench (Step #1). The end of the pipe is lifted and placed in the trench and anchored or held for the initial pipe insertion (Step #2). After some length is placed the pipe will no longer need additional hold back from sliding. Two machines are then used to move the pipe into the trench (Step #3). The spacing of the machines are at the midpoint of the curve and the end as determined by the 'S' curve for the size of Fusible PVC™ being installed. The machines then leap frog down the alignment taking positions at the changes in the bend direction to move the pipe into the trench.

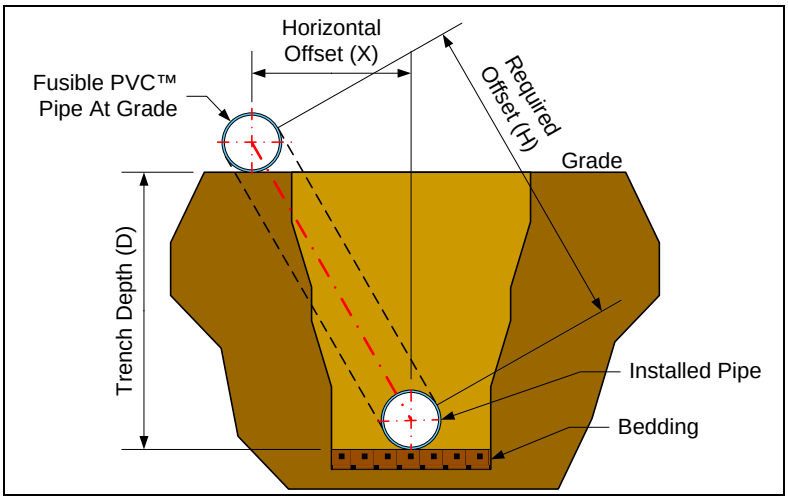

Figure 5.2.2 – Pipe Installation Cross Section with Theoretical 'S' Curve Determination

To determine the total length of the 'S' curve, the distance the pipe will move from the at-grade alignment to the trench and final installation alignment must be known. This can be determined from the depth of the trench and the distance from pipe to the center of the trench. Using the Pythagorean Theorem to determine the length of the hypotenuse of a right triangle, and using the 'depth of trench' and the 'horizontal offset distance' as the legs of the triangle (see Figure 5.2.2), provides this 'required offset distance' the pipe will be moved. This is then used to calculate the length of the 'S' curve for a particular size of Fusible PVC™.

Contact your Underground Solutions representative for specific information regarding your direct bury project and installation.

Recommended Tapping Procedures and Information for Fusible PVC™ Pipe

13135 Danielson Street, Suite 201, Poway, CA 92064 Tel: (858) 679-9551 Fax: (858) 679-9555 www.undergroundsolutions.com

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Recommended Tapping Procedures and Information for Fusible PVC™ Pipe, Including Fusible C-900®, Fusible C-905®, and FPVC™

1 Introduction

Tapping of a pressure pipe is a critical and necessary operation for the installation and continued operation of a pressure pipe system. Tapping is the process of adding a branch line to a previously installed pressure line.

2 Background

There are four basic categories of tapping:

2.1 Direct Tapping

Direct tapping is the method of installing the branch tap directly into the pipe wall. In this method, the shut-off valve, or corporation stop, is threaded into the pipe wall. The extra step of cutting the threads adds a level of difficulty to this method.

Underground Solutions does NOT recommend direct tapping into Fusible PVC™ pipe.

2.2 Saddle or Sleeve Tapping

In this method, the pipe to be tapped is supported by a tap saddle or sleeve. The saddle/sleeve contains the threaded connection for the corporation stop. This results in a smooth bore into the tapped pipe. The saddle/sleeve is sized to fit the PVC pipe exactly and is made specifically for use with PVC pipe.

Underground Solutions requires the use of either a saddle or sleeve made specifically for PVC pipe when tapping Fusible PVC™ pipe.

2.3 Wet Tapping

This is the method of installing the tap while the line is under pressure. This means that the line can stay active and does not need to be drained. A tapping valve is installed on the sleeve/saddle to allow shut off of pressure once the tap is made.

Fusible PVC™ pipe IS able to be wet tapped.

2.4 Dry Tapping

This is the practice of tapping the pipe while not under pressure or full of liquid. With the line empty (or “dry”), the tapping is made and then pressurized after the tap is completed.

Fusible PVC™ pipe IS able to be dry tapped.

3 Equipment

Tapping machines normally come in two types: manually driven machines for 1" and smaller saddle taps and motor driven machines for larger taps. There are many manufacturers of tapping machines, and some will perform better than others.

In the ¾" to 1" tap size, a PVC cutter bit must be used. Both Reed Manufacturing and Mueller Co. make good quality tapping machines and bits in theses sizes.

For the Reed tapping equipment, Model DMPVC or DM2100 have proven to work well on PVC when using the proper cutter. Reed manufactures a PVC cutter for a standard ¾" and 1" corporation. The Reed catalog # is PL688 and the item # is 04385.

Fusible PVC™ pipe IS NOT TO BE tapped with hand held drills using wood drill bits or hole-saws.

Reed has various combinations of tap machines, as noted below. The critical feature is the proper PVC cutter tool. While older models could likely work properly with PVC, it is important to consult with the equipment supplier to be sure the PVC cutter bits are adaptable to the bit connection or arbor. If there is any question regarding the applicability of the PVC cutter tool, please contact your Underground Solutions, Inc. representative.

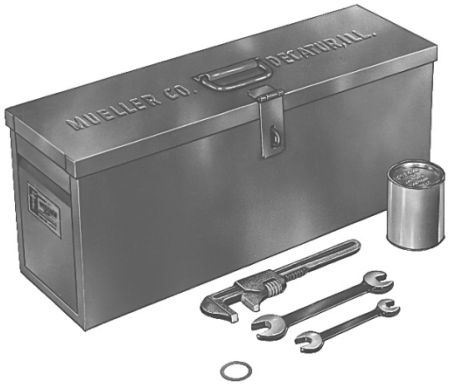
Reed Information: PVC Drilling Machine Shell Cutter

Shells cut through service saddles on PVC only. For use with Reed's DMPVC Drilling Machines. They also fit Mueller D® and PL-2 Machines.

Catalog No.	Item Code	Shell Size (in)	Nom. Corp. Size
PL688	04385	$^{11}/_{16}$	¾" NPT & AWWA
PL875	04386	$^{7}/_{8}$	1" NPT & AWWA

Figure 3.1 – PVC Drilling Machine Shell Cutters

Mueller Information: Mueller® E-5™ Drilling Machine



$^{7}/_{16}$" to 1-$^{7}/_{8}$" Inclusive

- Catalog number E-5 (Part No. 39330)
- Hand or power operation
- Used to drill through ½" to 2" corporation stops and service saddles
- 12-$^{1}/_{8}$" (308 mm) boring bar travel
- Has boring bar locking mechanism
- Use on cast iron or ductile iron pipe • cement-line cast iron or ductile iron pipe • cast iron OD PVC pipe • steel pipe • concrete pipe
- 500 psig (3447 kPa) maximum working pressure at 100°F (38°C)
- 250°F (121°C) maximum working temperature at 375 psig (2586 kPa)

Figure 3.2 – Drilling Machine

4 Large Diameter Tapping Equipment

Mueller Information: Mueller® Cl-12™ Drilling Machine

- Catalog number CL-12 (Part No. 39295)
- Hand or power operation
- Designed to use on pressurized or dry mains
- Used to cut 1-½" to 12" holes
- Use on cast iron or ductile iron pipe • cement-line cast iron or ductile iron pipe • cast iron OD PVC pipe • steel pipe • concrete pipe • A-C pipe
- Will make cuts through tapping valves from 2" to 12"
- 250 psig (1724 kPa) maximum working pressure at 100°F (38°C)
- 500°F (121°C) maximum working temperature at 150 psig (1034 kPa)

Size	Shell Cutter	Pilot Drill	Pilot Drill Extension
4"	537061	681919	537068
6"	537062	681919	537069
8"	682581	681919	537069
10"	682583	681919	537070
12"	682585	681919	537070

Mueller PVC Shell Cutters and Support Hardware

*Note: Cutter Hub P/N 83671 is needed with all sizes

Figure 4.1 – Mueller CL-12 Drilling Machine

The Mueller CL-12 is the preferred machine for taps larger than 2". This is primarily because of the PVC cutter bits available. Other machines with large diameter capacity do not have PVC cutter bits and rely on hole saws or standard metal bits to cut PVC.

The shell cutters and parts (indicated above) fit directly to the CL-12 arbor. They can also be adapted to larger Mueller tapping machines with additional arbor adapters.

The following table summarizes the equipment recommendations by size.

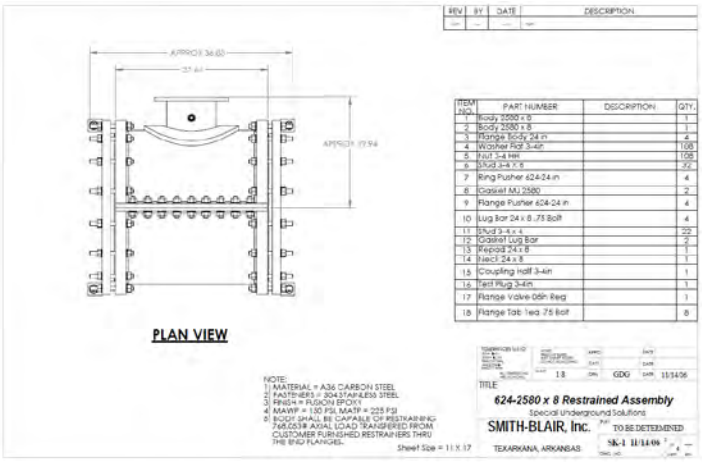
Tap Size / Pipe size	¾”	1”	1 ½”	2”	4”	6”
4”	X					
6”	X	X				
8”	X	X				
10”	X	X				
12”	X	X				
14”	X	X				
16”	X	X	X	X		
18”	X	X	X	X		
20”	X	X	X	X	X	
24”	X	X	X	X	X	
30”	X	X	X	X	X	X
36”	X	X	X	X	X	X

Table 4.2 Tap Size by Pipe OD

The Table above represents taps that can be made routinely with no additional precautions taken in the sizes of pipe shown. This applies to both pressure and non-pressure applications.

Tap sizes are limited due to the potential axial stress that can be present as a result of trenchless installation methods. There are several ways to increase the tap size by providing a means to transfer axial stress around the tap area. These methods include:

- Cutting the pipe and inserting a Tee fitting connected to the pipe using standard PVC restraints.
- Using a restrained tapping sleeve. These sleeves are a split design that surrounds the pipe to be tapped and is restrained connected back to the pipe. This sleeve also allows for equalization of pressure across the pipe wall. Because the tap sleeve will carry the entire axial loading, almost any size can be tapped into the pipe as a result.



- A restraining harness can be used to transfer the axial loading around a tap saddle. The size that can be utilized in this manner is limited to the space between connecting rods. The tap saddle is installed first then the restraining harness is placed around the tap area and tightened. The tap is then performed after axial load is transferred to the harness.

A split connection grip must be used on each side. The tap is done in the prescribed manner in this document.

Because the tapping provisions included here are a function of axial loading, they apply equally to non-pressure installations. However, in non-pressure installations, there are options to increase the tap size not applicable for pressure taps:

- An “Inserta Tee” type connection can be made when a restraint harness is used.
- A “Y” fitting can be cut into the line and restrained at each end.

Tapping Saddles

Figure 5.1 – Typical PVC Tapping Saddle

Tapping saddles are used for the installation of a corporation stop in a tapped pipe. Typically this is done on pipe sizes in the 4" to 12" range. The tap saddle is made to a specific inner diameter to match the outer diameter of the pipe. It fully supports the pipe and is sized so that the parts when bolted together cannot be over tightened on the pipe. The manufacturer's installation instructions must be followed. Tap saddles do not have U-bolt type configurations, which do not adequately support PVC pipe. **Tapping saddles MUST BE DESIGNATED FOR USE ON PVC PIPE.**

An example of manufacturer's materials description for tap saddles follows:

S90 Brass Saddle Features

- All brass conforms to AWWA Standard C800 (ASTM B-62 and ASTM B-584, UNS No. C83600-85-5-5-5)
- Style A Saddle body and strap permanently held together with silicon bronze pin for saddles sized 2" thru 8"
- Bolt is 5/16" slotted hex head silicon bronze for saddles size 2" thru 8"
- A three-piece bolted design is used for S90 Saddles sized 10" and 12" with 1-½" and 2" taps, two-piece for ¾" and 1" taps
- All 10" and 12" saddles are held together with ½" silicon bronze bolts (¾" hex head)

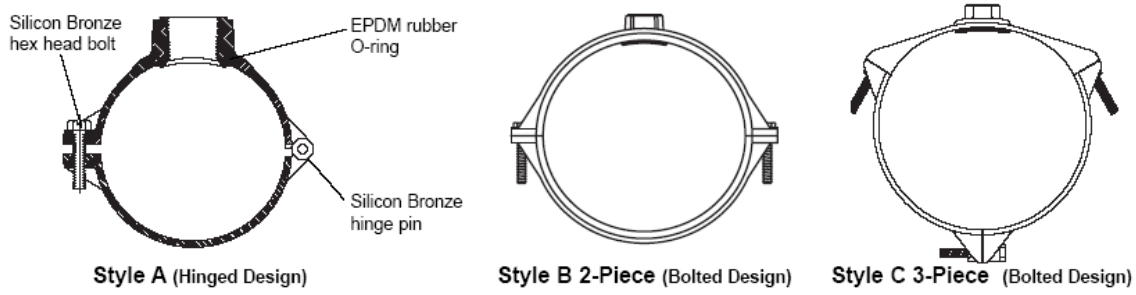
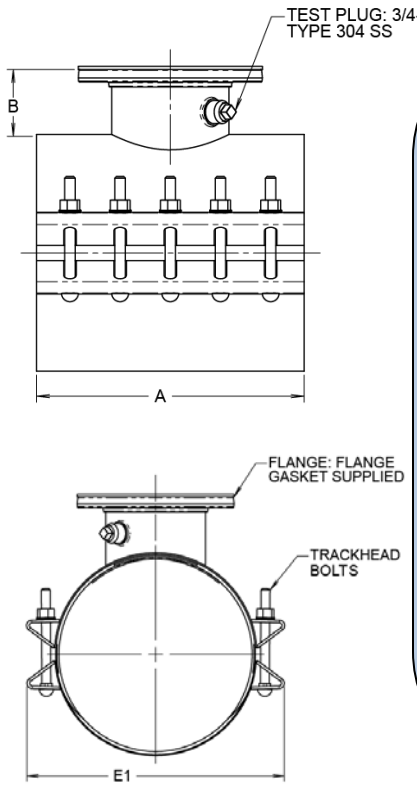


Figure 5.2 – S90 Brass Saddles with AWWA Taps for C900 PVC Pipe

5 Tap Sleeves

Tap sleeves are used for larger diameter taps and larger diameter pipe. The sleeve is a two-part assembly that bolts together and grips the pipe to be tapped. Because of this, the installation is different than the tap saddle. The bolts must be installed per manufacturer's torque requirements. The tap sleeve can be over-tightened, placing excess stress on the pipe and tap. **Over-tightening MUST BE AVOIDED for the tap sleeve to function properly.**



Material Specifications

Body:	Carbon Steel ASTM A283 Grade C. Optional: All 304 stainless steel.
Flanges:	AWWA C207 Class D. ANSI 150# drilling. Recessed for Tapping Valve per MSS-SP 60. Optional: Other types of Flanges, threaded outlets; MJ outlets.
Gasket:	Nitrile (Buna-N) NSF61 listed. Concave wedge gasket—compounded to resist water, oil, acids, alkalies, most (aliphatic) hydro-carbon fluids, and many chemicals.
Bolts, Nuts, Washers:	High strength low-allow steel with heavy semi-finished hex nuts to ASTM A-307 (ANSI A21.11) standards. Optional-type 304 stainless steel bolts and nuts are coated to prevent galling.
Finish:	Fusion bonded Flexi-Coat® epoxy, coated to an average of 12 mil thickness.

Figure 6.1 – Tap Sleeve and Material Specifications

6 Tap Procedure Using a Tap Saddle and Hand Operated Tap Machine

Tapping with a hand operated tap machine using a tap saddle, the following steps are normally followed:

1. Locate the tap saddle on the pipe and evenly tighten it to the pipe. Care should be taken not to over-tighten or exceed the torque recommendations of the tap saddle. Follow the manufacturer's recommendations. In locating the saddle on Fusible PVC™ pipe, the recommendation is to tap at least 12" from a fusion joint. This assures that the tap will seal properly around the pipe and is not interfered with by the fusion bead.
2. Screw the inlet side of the corporation stop into the saddle threads using the appropriate sealing aids on the threads (pipe dope, Teflon tape, etc,). Open the stop after installation.
3. Install the specified PVC cutter bit on the drilling machine.
4. Using the appropriate adapter and gasket, attach the drilling machine to the stop outlet threads. Follow the manufacturer's instructions.
5. Lower the boring bar to the pipe to be tapped.
6. Rotate the cutter while exerting finger pull pressure on the feed handle. The amount of pressure used should be approximately equal to pulling out a desk drawer. The rotation of the cutter to feed should be 1 full rotation of the cutter to 1/8 turn of the feed yoke.
7. Upon completion of the tap, withdraw the cutter.
8. Close the stop valve.
9. Remove the drilling machine.

7 Tapping Procedure Using a Tap Sleeve

When tapping a larger diameter pipe size, tap sleeves are used, and in most cases, used with a power operated tapping machine. The tap machines can be operated by hand, air motor, or hydraulic pump. The manufacturer's instructions must be followed. The steps to be followed are:

1. Install the tap sleeve on the pipe per manufacturer's instructions. The tap sleeve is normally a two-piece assembly with a ring gasket at the tap outlet providing the seal to the external surface of the pipe. The tap sleeve is made to fit tightly around the pipe but is not a fully supporting device like the tap saddle. It is extremely important to torque the mounting bolts to manufacturer's requirements. Over-tightened bolts can induce stress into the pipe being tapped.
2. Connect the tap valve to the tap sleeve. The tap valve is normally a specialty valve with a gasket-flanged connection to the tap outlet and an MJ type connection to the tap machine side. Flange adapters are made to connect the tap machine to a flanged valve arrangement.
3. Support the tap sleeve and valve independently from the pipe. Supports should be left in place after tapping.
4. Install the required PVC cutter and support hardware (pilot cutter, pilot adapter, etc.).
5. Attach the drilling machine to the tap valve or adapter.
6. Install temporary supports under the tap machine to support it independently from the pipe, sleeve, and valve.

7. Open the tapping valve.
8. Advance the cutter to the pipe being tapped.
9. Engage the cutter and cut the tap hole. On power operated tap machines, the advance rate and the cutting rate are set per manufacturer's recommendations. The travel distance is also set to prevent the cutter from gong through the pipe wall too far and cutting into the opposite side pipe wall. If using a hand-operated model, assure the proper advance rate, cutter rate and travel distance.
10. At completion of the tap, retract the cutter and close the tap valve.
11. Remove the tap machine.
12. Attach the new line.

8 Tap Results

The tap coupon should have a smooth straight side wall when removed from the tap machine. A rough side with the presence of striations are indications of a poor tap.

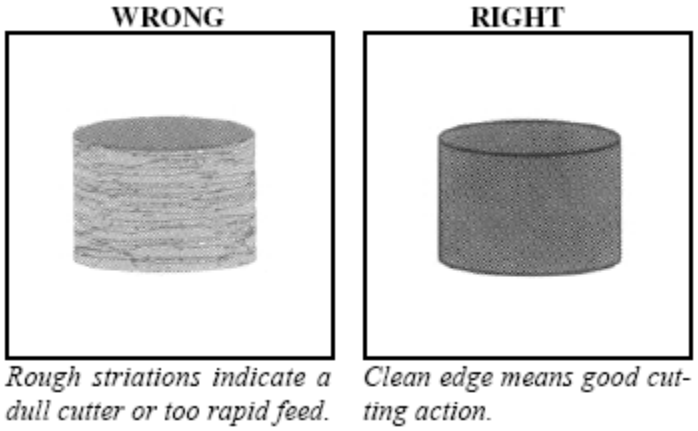


Figure 9.1 – Illustrated Tap Results