# Installation Guide for PVC Water Pipe

January 1999 Edition

PWPipe

# Preface

This booklet is intended for use by installers, supervisors, and inspectors responsible for the installation of PWPipe's PVC water pipe. It is not a design manual. Rather it is intended as a guide for the proper handling, installation, and testing of PVC pressure water pipe. If used properly, this information can maximize product performance and minimize the possibility of field problems.

This guide is not intended to assume the authority of the engineer. Because system requirements and actual field conditions may vary significantly, the sole responsiblity for all design and installation decisions lies with the project engineer.

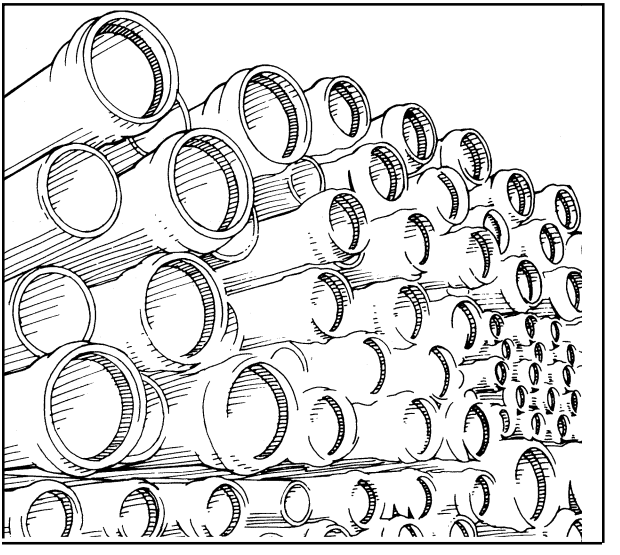
# Table of Contents

# Chapter I

## ■ General Information

# Specifications

PWPipe produces PVC municipal water (Cast Iron Pipe Size) pipe in conformance with AWWA C900 and C905, IPS (Iron Pipe Size) pipe in conformance with ASTM D 2241 and D 1785 and PIP (Plastic Irrigation Pipe) in conformance ASAE and SCS specifications. PWPipe recommends that pipe be installed according to this guide, AWWA 605, AWWA Manual M23, and ASTM D 2774.



# Warranty

PWPipe warrants that its PVC pipe products were manufactured in accordance with applicable materials and product specifications, and that the pipe is free from all defects in materials and workmanship using the applicable specifications as a standard.

Every claim under this warranty shall be deemed waived unless presented in writing and received by PWPipe within sixty (60) days of the date the defect was, or should have been discovered or within two (2) years of the date of PWPipe's shipment of the product, whichever occurs sooner.

**PWPipe makes no other warranty or representation of any kind, expressed or implied, in fact or in law, including without limitation the warrant of merchantability or fitness for a particular purpose, other than the limited warranty set forth above.**

# Limitation of Liability

It is expressly agreed that the limit of PWPipe's liability is the replacement of defective product with the same quantity of non-defective product, and that PWPipe shall have no such liability unless the claim results solely from breach of PWPipe's warranty.

**In no event shall PWPipe be liable for any incidental or consequential damages of any kind, including without limitation, any expense or removal or reinstallation resulting from any defect.**

Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you. This warranty gives you specific legal rights, and you may have other rights which vary from state to state.

# Chapter II

## Receiving, Unloading, Storage,and Handling

# Receiving

When receiving a pipe shipment, the contractor or purchaser should exercise established precautions. Each pipe shipment should be inventoried and inspected upon arrival. The pipe was inspected and loaded with due care at the factory using methods acceptable to the carrier. It is the carrier's responsibility to deliver the shipment in good condition, and it is the receiver's responsibility to ensure that there has been no loss or damage.

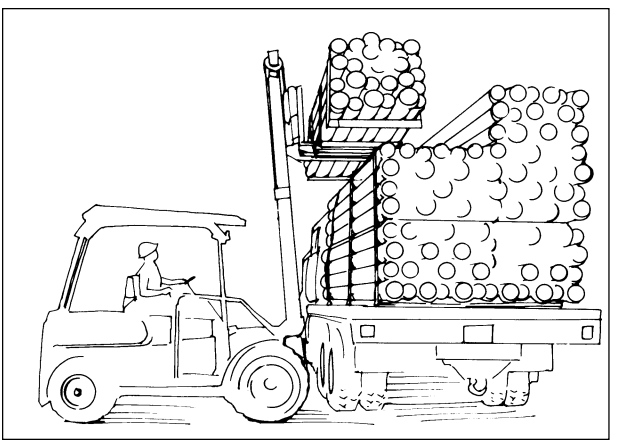
The following procedures are recommended for acceptance of delivery:

1. Make overall examination of the load. If the load is intact, ordinary inspection while unloading should be sufficient to ensure that the pipe has arrived in good condition.
2. If the load has shifted, has broken packaging, or shows rough treatment, carefully inspect each piece for damage.
3. Check total quantities of each item against shipping records.
4. Note any damaged or missing items on the delivery receipt.
5. Notify the carrier immediately and make a claim according to his instructions.
6. Do not dispose of any damaged material. The carrier will notify you of the procedure to follow.
7. Shortages and damaged materials are not re-shipped without request. If replacement materials are needed, reorder from PWPipe or your distributor.

# Unloading

The means by which the pipe is unloaded in the field is the decision and the responsibility of the receiver. These recommendations should be followed:

1. Remove restraints from the top unit loads. These may be either straps, ropes, or chains with padding.
2. Remove any boards on the top or sides of the load which are not part of the pipe packaging.
3. Using a fork lift with thin chisel forks (or a front-end loader equipped with forks), remove the top units one at a time from the truck.
4. If a fork lift is not available, use a spreader bar with fabric straps capable of carrying the load. Space straps approximately



eight feet apart. Loop straps under the load. Cables may be used only if they are cushioned to prevent damage to the pipe.

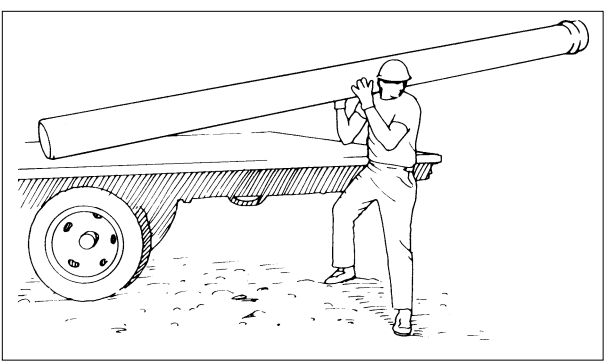
5. During the removal and handling, ensure that the units do not impact anything (especially in cold weather).
6. Place pipe package units on level ground.
7. Do not handle units with individual chains or single cables, even if padded.
8. Do not attach lifting cables to unit frames or bands.
9. Do not stack package units more than eight feet high.

10. Protect units with packing materials the same way they were protected while on the truck.
11. To unload lower units, repeat the unloading process described above.
12. Do not unload by hand.
13. WARNING: DO NOT STAND OR CLIMB ON CRATES OR CONTAINERS.

# Storage

The following procedures are recommended to prevent damage to the pipe:

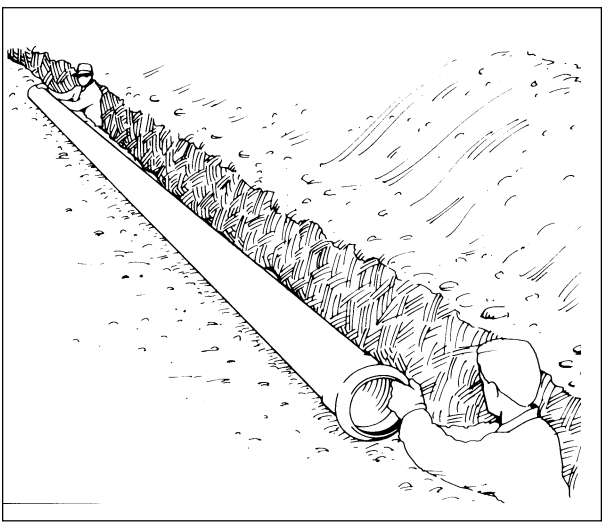
1. Store the pipe at the site in unit packages.
2. Avoid compression, deformation or damage to bell ends of the pipe.
3. When unit packages are stacked, ensure that the weight of upper units does not cause deformation to pipe in lower units.
4. Support pipe unit packages on wood blocking to prevent damage to the bottom surfaces during storage. Space supports to prevent pipe bending.
5. Store solvent cement in tightly sealed containers away from excessive heat.
6. Do not store pipe where gaskets may be exposed to ozone, grease or oil.
7. Protect pipe interior and sealing surfaces from dirt and foreign matter.
8. When unit packages are stacked, ensure that the stack remains stable.



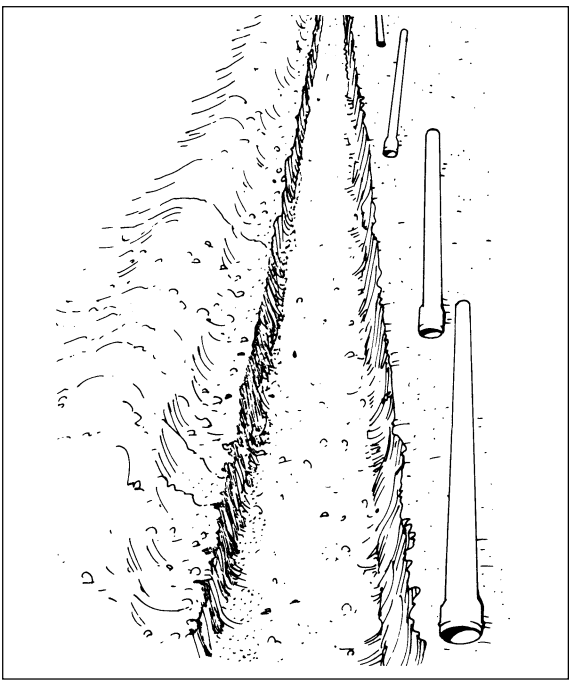
# Handling

The following procedures are recommended:

1. When using mechanical equipment, exercise care to prevent damage to the pipe.
2. Lower pipe carefully from trucks and into trenches. Do not drop pipe.
3. In subfreezing temperatures, use caution to prevent impact damage. Handling methods considered acceptable for warm weather may be unacceptable during very cold weather.



4. When distributing pipe along a trench (stringing), place pipe on the opposite side of the trench from the excavated earth. Place pipe with bell ends in the direction of the work progress. **Note: Hydraulic flow is not significantly affected by the direction of the bell ends.**



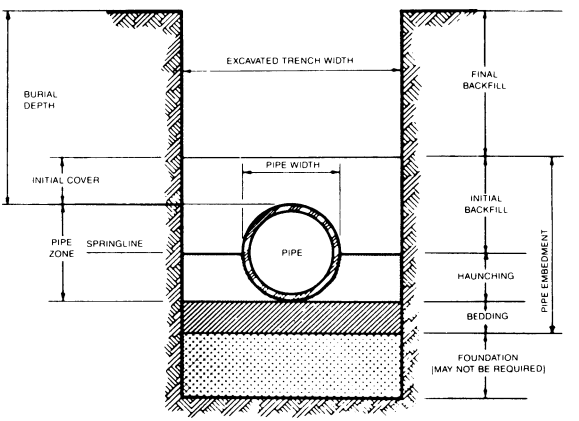
# Chapter III

## Trench Construction

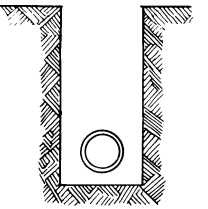
# General

1. Trench excavation should comply with all applicable laws and regulations.
2. Excavated material such as debris and removed pavement is not suitable for trench backfill.
3. Where dewatering is necessary, water should be removed until the pipe has been installed and the backfill has been placed to a sufficient height to prevent flotation of the pipeline.
4. The maximum earth load on flexible pipe is the weight of the material directly over the pipe (prism load). Unlike rigid pipe, the width of the excavated trench does not affect pipe loading. Trench width is based solely on practical and economical construction.
5. See Figure 3.1 for trench terminology.

FIGURE 3.1
TRENCH CROSS-SECTION SHOWING
TERMINOLOGY



# Narrow, Unsupported, Vertical-Walled Trench

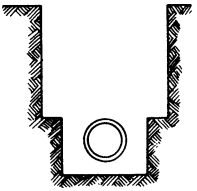


1. See Figure 3.1 for unsupported vertical-walled trench cross-section.
2. The width of narrow trenches is the minimum working room required for a worker to place haunching material. See Table 3.1.
3. In narrow trenches, pipe embedment should be compacted all the way to the trench wall.

**TABLE 3.1**

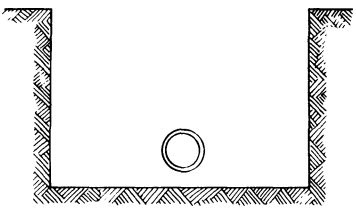
| NARROW TRENCH WIDTHS, MINIMUM | | |
|---|---|---|
| NOMINAL PIPE SIZE | TRENCH WIDTH, MINIMUM | |
| Diameter (Inches) | No. of Pipe Diameters | Inches |
| 4 | 4.3 | 18 |
| 6 | 2.9 | 18 |
| 8 | 2.9 | 24 |
| 10 | 2.5 | 26 |
| 12 | 2.4 | 30 |
| 15 | 2.0 | 30 |
| 18 | 1.8 | 32 |
| 21 | 1.6 | 34 |
| 24 | 1.5 | 36 |

## Sub-Ditch Trench



The width of the subditch below the top of the pipe should meet the minimum dimensions of Table 3.1.

## Wide Trench



1. In some soil conditions it may be more cost effective to use wide trench construction.
2. Wide trenches are trenches where the width at the top of the pipe is greater than six pipe diameters (2.5 diameters on each side of the pipe.)
3. Compaction requirements:
   a. Up to 10" pipe – Compact to 2.5 pipe diameters both sides of pipe.
   b. 12" to 24" pipe – Compact to two feet on both sides of pipe.
4. Where trench widths are less than six pipe diameters, compact to full trench width.

# Supported Trench

1. This type of trench is used where unstable or flowing soil conditions are present in the trench walls.
2. Methods of support include sheeting, bracing, trench jacks, or trench box.
3. If conditions are extremely severe, it may be necessary to grout the soil adjacent to the trench to prevent migration between pipe embedment materials and trench wall soils.
4. See Table 3.2 for minimum trench widths.

**TABLE 3.2**

| SUPPORTED TRENCH WIDTHS, MINIMUM | | |
|---|---|---|
| NOMINAL PIPE SIZE | TRENCH WIDTH, MINIMUM | |
| Diameter, Inches | No. of Pipe Diameters | Inches |
| 4 | 8.5 | 36 |
| 6 | 5.7 | 36 |
| 8 | 4.3 | 36 |
| 10 | 4.0 | 42 |
| 12 | 3.4 | 42 |
| 15 | 3.1 | 48 |
| 18 | 2.7 | 48 |
| 21 | 2.4 | 50 |
| 24 | 2.2 | 52 |

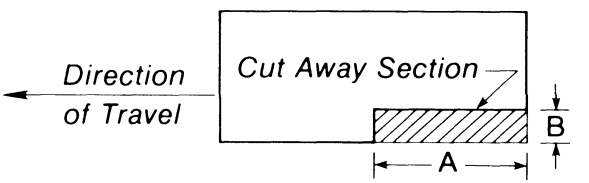
The table values assume trench support thickness of six inches at each wall. Where thicker supports are used, the values should be varied accordingly.

5. Where timber sheeting is used below the top of the pipe, the sheeting should extend 2 feet (60 cm) below the bottom of the pipe and be left in place 1.5 feet (45 cm) above the top of the pipe.
6. Compaction requirements: Compact the foundation and embedment materials all the way to the trench wall or to the sheeting left in place.

# Movable Trench Support

1. When trench supports are being moved, care should be exercised to prevent disturbing the pipe or its embedment.
2. Use of movable trench boxes should be limited to:
   a. wide trench construction, where at least 2.5 pipe diameters exist on either side of the pipe.
   b. a shelf above the top of the pipe with the pipe installed in a narrow, vertical-wall subditch.
3. To avoid these location restrictions, a modified box may be used which allows compaction of bedding at bottom cutouts. See Figure 3.2.

FIGURE 3.2




4. Any voids left in embedment material by support removal should be carefully filled and compacted.
5. Removal of bracing between sheeting should be done only where backfilling proceeds and bracing is removed in a manner that does not relax trench support.

# Trench Depth

1. Where frost depth is a consideration, pipe burial should be 6 inches deeper than the record frost penetration.
2. Where frost is not a concern and live loads are not anticipated, a minimum cover of 12 inches is adequate.
3. Where live loads are significant, the design engineer should consider such factors as size and type of equipment, impact, type of soil, and soil compaction in determining cover requirements.

# Trench Bottom

1. The trench bottom should provide a uniform, stable support for the pipe.
2. The soil surface at the bottom of the trench should be free of any irregularities that could cause point loads on the pipe or bell.
3. Where an unstable trench bottom condition occurs, special foundations may be required. A layer of bedding material should be placed between foundation and pipe.
4. Where rock subgrade or stones larger than 1.5 inches are encountered, a minimum of 4 inches of bedding should be placed under the pipe above the rock.

# Embedment Materials

1. See Table 3.3 for soil classifications.
2. The high void ratio of Class I material limits its use to areas where side support will not be lost due to migration of fines from the trench walls and bottoms. Where such migration is possible, the minimum size range should be reduced and the gradation designed to limit void size.
3. Class II material should be well graded (not uniformly graded or gap graded) to prevent loss of side support as described in item 2.
4. For Class IV materials, caution should be exercised in the design and method of compaction due to difficulty in controlling moisture content in field conditions.
5. Class V materials are not recommended for bedding, haunching, or initial backfill.
6. See Table 3.4 for degree of compaction information for various compaction methods and embedment materials.
7. For PVC pipes 6 inches in diameter and greater, limit particle size in the embedment zone to 1 1/2 inches or less. For pipe diameters less than 6 inches, limit particle size in the embedment zone to 3/4 inch or less.

## TABLE 3.3
## Description of Embedment Material Classifications

| SOIL | SOIL TYPE | DESCRIPTION OF MATERIAL CLASSIFICATION |
|---|---|---|
| CLASS I SOILS* | —— | Manufactured angular, granular material, 1/4 to 11/2 inches (6 to 40 mm) size, including materials having regional significance such as crushed stone or rock, broken coral, crushed slag, cinder, or crushed shells. |
| CLASS II SOILS** | GW | Well graded gravels and gravel-sand mixtures, little or no fines. 50% or more of coarse fraction retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean. |
| | GP | Poorly graded gravels and gravel-sand mixtures, little or no fines. 50% or more of coarse fraction retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean. |
| | SW | Well-graded sands and gravelly sands, little or no fines. More than 50% of coarse fraction passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean. |
| | SP | Poorly graded sands and gravelly sands, little or no fines. More than 50% of coarse fraction passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean. |
| CLASS III SOILS*** | GM | Silty gravels, gravel-sand-silt mixtures. 50% or more of coarse fraction retained on No. 4 sieve. More than 50% retained on No. 200 sieve. |
| | GC | Clayey gravels, gravel-sand-clay mixtures. 50% or more of coarse fraction retained on No. 4 sieve. More than 50% retained on No. 200 sieve. |
| | SM | Silty sands, sand-silt mixtures. More than 50% of coarse fraction passes No.4 sieve. More than 50% retained on No.200 sieve. |
| | SC | Clayey sands, sand-clay mixtures. More than 50% of coarse fraction passes No. 4 sieve. More than 50% retained on No. 200 sieve. |

| SOIL CLASS | SOIL TYPE | DESCRIPTION OF MATERIAL CLASSIFICATION |
|---|---|---|
| CLASS IV SOILS | ML | Inorganic silts, very fine sands, rock flour, silty or clayey fine sands. Liquid limit 50% or less. 50% or more passes No. 200 sieve. |
| | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. Liquid limit 50% or less. 50% or more passes No. 200 sieve. |
| | MH | Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts. Liquid limit greater than 50%. 50% or more passes No. 200 sieve. |
| | CH | Inorganic clays of high plasticity, fat clays. Liquid limit greater than 50%. 50% or more passes No. 200 sieve. |
| CLASS V SOILS | CL | Organic silts and organic silty clays of low plasticity. Liquid limit 50% or less. 50% or more passes No. 200 sieve. |
| | CH | Organic clays of medium to high plasticity. Liquid limit greater than 50%. 50% or more passes No. 200 sieve. |
| | PT | Peat, muck, and other highly organic soils. |

* Soils are as defined in ASTM D 2487, except for Class I material which is defined in ASTM D 2321.

** In accordance with ASTM D 2487, less than 5% pass No. 200 sieve.

*** In accordance with ASTM D 2487, soils with 5% to 12% passing No. 200 sieve fall in a borderline classification that is more characteristic of Class II than of Class III.

# Compaction

1. Saturation — If saturation methods are used for compaction, the following recommendations should be followed:
   a. Prevent flotation of the pipeline.
   b. Do not use saturation during freezing temperatures.
   c. Exercise care to prevent erosion at pipe sides and bottom caused by water jetting.
   d. Apply only enough water to provide complete saturation.
   e. Allow each layer to dewater and solidify until it will support the weight of workers.
2. Compaction equipment
   a. Avoid contacting the pipe with compaction equipment.
   b. Do not use compaction equipment directly over the pipe until sufficient backfill has been placed to prevent damaging or disturbing the pipe.

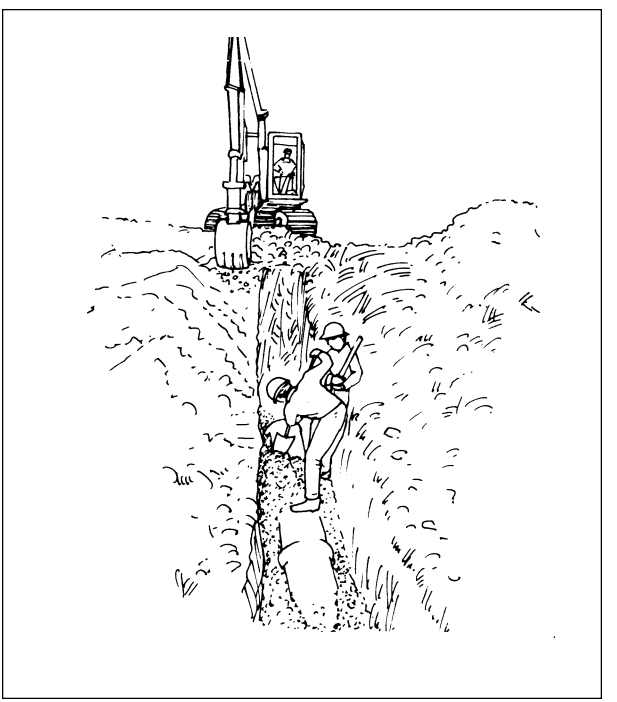


TABLE 3.4

Approximate Guide for Estimated Range of Degree
of Compaction versus Embedment Class and Method of Placement
as Percent of Standard Proctor Density

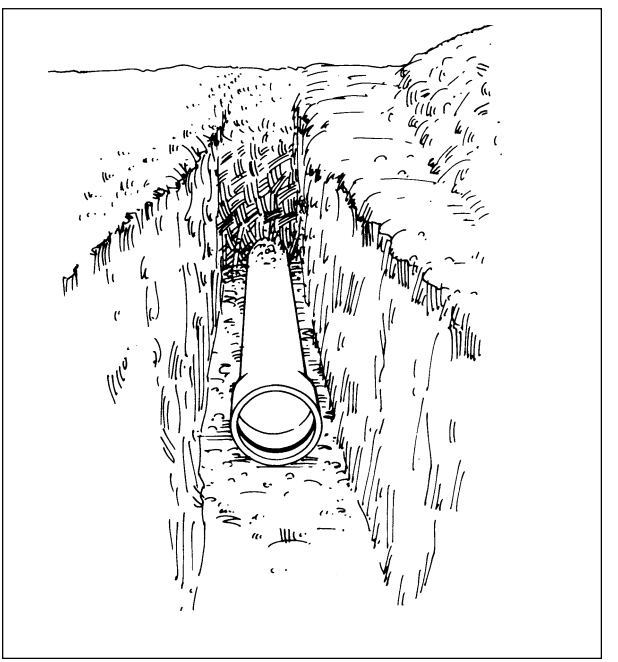
| CLASS OF EMBEDMENT | I | II | III | IV |
|---|---|---|---|---|
| MATERIAL DESCRIPTION | Manufactured Granular Materials | Sand & Gravel Soils - Clea | Mixed-Grain Soil | Fine Grain Soil |
| Optimum moisture content range limit % of dry weight | — | 9 - 12 | 9 - 18 | 6 - 30 |
| Soil Consolidation Met | % of Proctor (or Relative) Density Range | | | |
| Compact by power tamper or rammer | 95 - 100 | 95 - 100 | 95 - 100 | 90 - 100 |

| | | | | |
|---|---|---|---|---|
| Density by portable vibrators | 80 - 95 | 80 - 95 | 80 - 95 | 75 - 90 |
| Consolidate by saturation | 80 - 95 | 80 - 95 | — | — |
| Place by hand | 60 - 80 | — | — | — |
| Tamp by hand | — | 60 - 80 | 60 - 80 | 60 - 75 |
| Dump | 60 - 80 | 60 - 80 | 60 - 80 | 60 - 75 |

Note: This table serves as an approximate guide defining average Proctor densities attained through various methods of soil consolidation in different classes of soil. The table is intended to provide guidance and is not recommended for design use. Actual design values should be developed by the engineer for specific soils at specific moisture contents.

# Bedding

1. Bedding is required to bring the trench bottom up to grade and to provide longitudinal support under the pipe. Blocking must not be used to bring the pipe to grade.
2. Bell holes are necessary at each joint to maintain continuous support for the pipe.
3. Bedding thickness of 4 to 6 inches of compacted material is usually adequate.
4. Use of well-graded material is recommended where trench native soil is fine-grained.



## Haunching

1. Haunching provides side support to the pipe. **This area is the most important for controlling pipe deflection.**
2. Haunching material should be worked under the sides of the pipe to ensure side support.
3. Where coarse materials have been used for bedding, the same materials should be used for haunching.
4. Haunching should extend to the springline of the pipe.

## Initial Backfill

1. Initial backfill is placed to protect the pipe from impact damage during final backfill.
2. Since initial backfill provides little additional structural support, special compaction is not required.

## Final Backfill

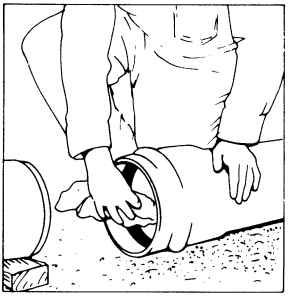
1. Material - The material used for final backfill need not be as carefully selected as material in the embedment zone, but should not contain boulders, frozen clumps or rubble which could damage the pipe.
2. Compaction - Under open fields, natural compaction should be adequate. Under improved surfaces, special compaction (as specified by the design engineer) is required.

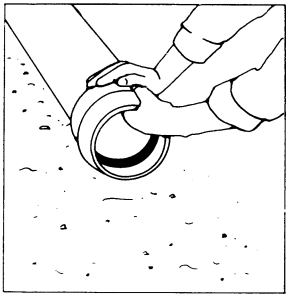
# Chapter IV

- Pipe Assembly

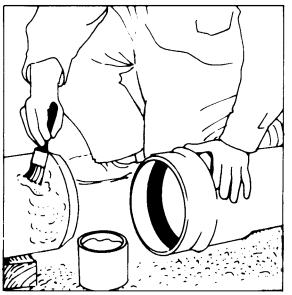
# Gasketed Pipe

PWPipe gasketed pipe is an integrally belled product. All gaskets are installed at the factory. The joint is engineered to provide problem-free service for the life of the pipe, but proper procedures must be followed to ensure its effectiveness.

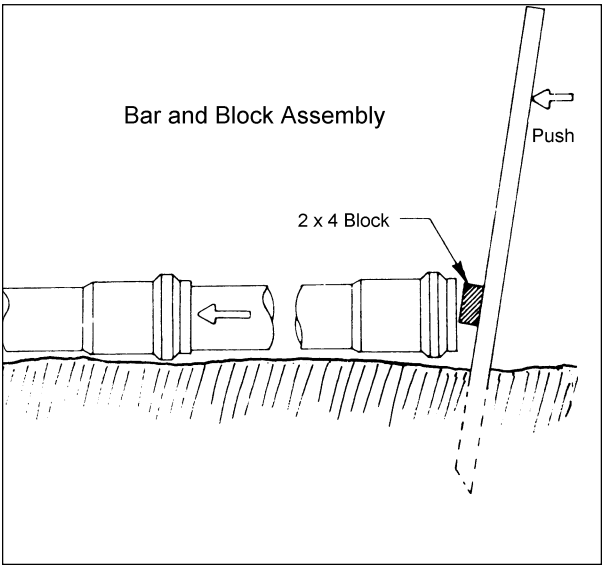




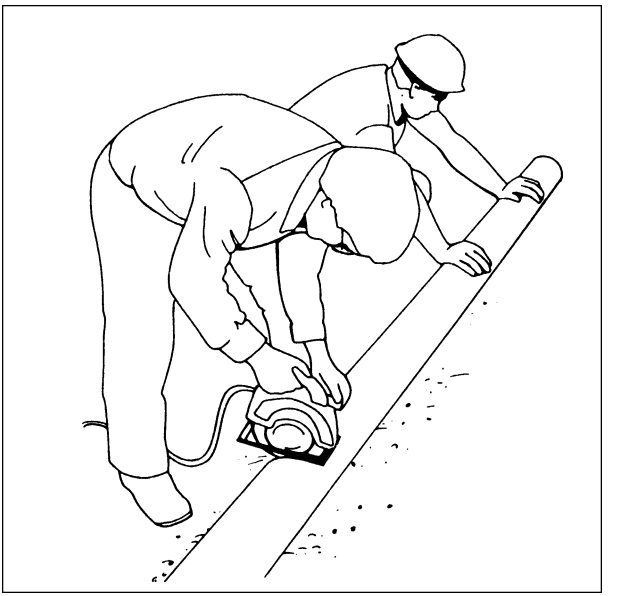
1. Clean the gasket area. Remove sand, dirt, grease, and debris. Do not remove gaskets from bells — removal could cause improper reinstallation.
2. Check the gasket. Make sure the gasket is seated uniformly in the groove by running your finger around the inner edge of the gasket.
3. Clean the spigot. Use a rag to wipe the spigot clean.
4. Lower the pipe into the trench. Lower carefully to avoid getting dirt into the bell or spigot.
5. Lubricate. Apply lubricant to the bevel of the spigot end and approximately midway back to the stop 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. WARNING: use only those lubricants supplied by PWPipe - the use of other lubricants may cause deterioration of pipe or gasket.



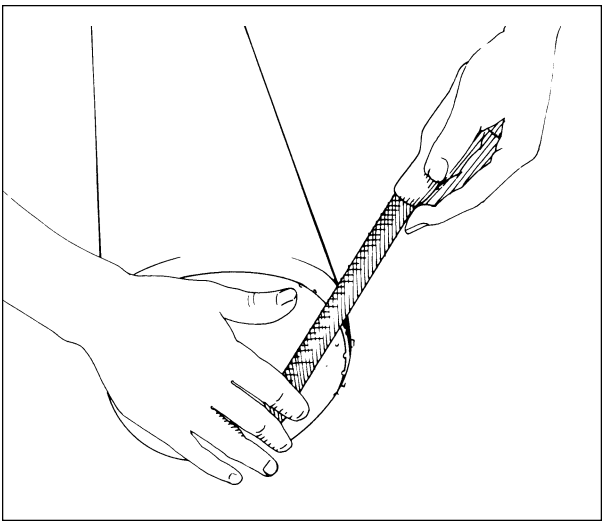
6. Keep lubricated areas clean. If dirt or sand adhere to lubricated areas, clean and re-lubricate.
7. Assemble pipe. Insert the spigot end into the bell until it contacts the gasket uniformly. **Straight alignment is essential for ease of assembly.** Apply steady pressure by hand or by mechanical means (bar and block, come-along, hydraulic jack) until the spigot slips through the gasket. Insert the pipe until the stop line is flush with the bell end. For some job conditions and sizes of pipe, use of heavy equipment (such as a backhoe bucket) may be necessary for assembling the pipe. When this equipment is used, extra care must be taken because the installer loses the "feel" of the assembly. Conditions such as improper spigot alignment, rolled gaskets, or overinsertion (overbelling) could go unnoticed during assembly because of the large force generated by the equipment. The following precautions should be followed:
   a. Position the spigot carefully in the bell to ensure straight alignment both horizontally and vertically.
   b. Exercise caution to prevent damage of the bell lip due to rough contact by the equipment.
   c. Be careful that the action of the equipment does not move the pipe out of straight alignment.
   d. Do not insert the spigot past the stop line. When the equipment has pushed the spigot far enough to overcome the initial resistance of the gasket, use a bar and block to finish pushing the pipe to the stop line. This procedure not only prevents overinsertion but also identifies rolled (fishmouthed) gaskets at a time when they can still be easily corrected.




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.
   a. If the gasket has been dislodged from the race, inspect the pipe and gasket for damage, replace damaged items, clean the components, and repeat the assembly steps, assuring **straight** alignment.
   b. 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 pipe insertion than do pipe bells. If the pipe still cannot be inserted properly, call PWPipe for assistance.



9. If the pipe must be field-cut, mark the entire circumference of the pipe to ensure a square cut. The pipe can be cut with a hacksaw, handsaw, or power handsaw with a steel blade or abrasive disc.



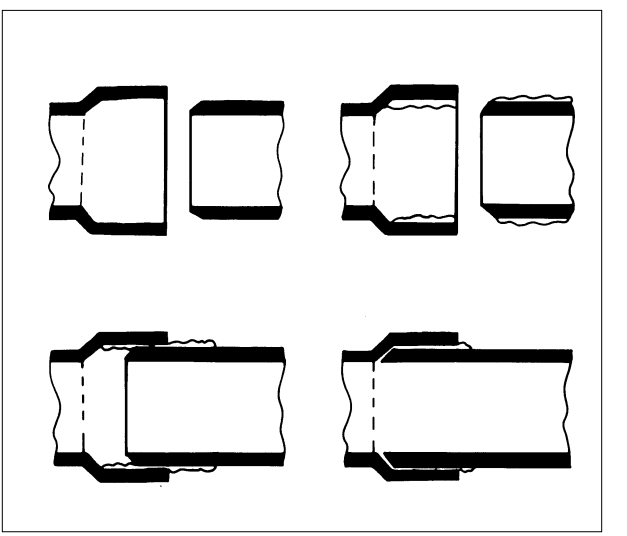
10. Bevel the cut end using a pipe beveling tool or a portable sander or abrasive disc. Round off any sharp edges on the leading edge of the bevel with a pocket knife or a file. Mark cut end with an insertion line similar to uncut pipe.

Bevel requirements may vary with different joint types:

| JOINT | BEVEL |
|---|---|
| a. PVC pipe Bell | Same as factory bevel |
| b. PVC push-on fitting | Same as factory bevel |
| c. Other pipe bell/push-on fitting | Shorter bevel length |
| d. Mechanical joint fitting | No bevel |

# Solvent-Cemented Pipe

1. Specifications
   Solvent-cemented joints should be made in accordance with ASTM D 2855 "Standard Recommended Practice for Making Solvent-Cemented Joints with Polyvinyl Chloride (PVC) Pipe and Fittings." The solvent cement should conform to ASTM D 2564 "Standard Specification for Solvent Cements for Polyvinyl Chloride (PVC) Plastic Pipe and Fittings," and the primer should conform to ASTM F 656 "Specification for Primers for Use in Solvent Cement Joints of PVC Plastic Pipe and Fittings." The handling of solvent cements should be in accordance with ASTM F 402 "Standard Recommended Practice for Safe Handling of Solvent Cements Used for Joining Thermoplastic Pipe and Fittings."
2. Basic principles of solvent-cemented joints:
   a. The joining surfaces must be clean and dry.
   b. The joining surfaces must be softened and made semi-fluid.
   c. Sufficient cement must be applied to fill the gap between male and female ends.



d. The assembly must be made while the surfaces are still wet and fluid.
e. Joint strength develops as the cement dries. In the tight part of the joint, the surfaces will fuse together. In the loose part, the cement will bond with both surfaces.
f. Completed joints should not be disturbed until they have cured sufficiently to withstand handling.

3. Selection of Solvent Cement

PVC solvent cements are available in a variety of viscosities and wet film thicknesses to cover a wide range of pipe sizes, and for interference-fit joints as well as non-interference joints. The solvent cement manufacturer's recommendations should be followed for selection of proper cement.

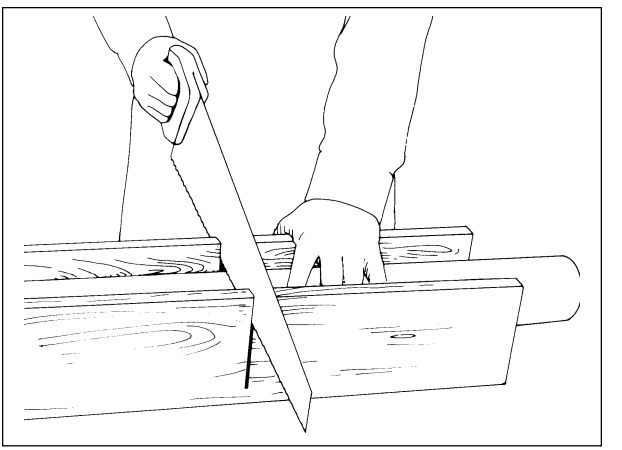
4. Storage

PVC solvent cements should be stored in a cool place except when actually in use at the job site. Cements have a limited shelf life when not stored in hermetically sealed containers. (Screw-top containers are not considered to be hermetically sealed.) Consult the cement manufacturer for specific recommendations on storage conditions and shelf life. The cement is unsuitable for use if it exhibits an appreciable change from the original viscosity, or if there is any sign of gelation. **Warning: Do not add solvent or thinners to the cement.**

5. Procedure

a. Cutting the Pipe - Cut pipe square with the axis, using a fine-tooth saw with a miter box or guide. Wood-working blades may be used. A rotary cutter may be used if the cutting blades are specifically designed for cutting plastic pipe in such a way as not to raise a ridge (flare) at the cut end of the pipe. The use of a standard rotary metal pipe cutter is not recommended.

b. Joint Preparation — Remove all burrs and break the sharp lead edges.
c. Test Dry Fit of the Joint — The solvent cement joint is designed so that there will generally be interference of pipe wall with the fitting socket before the pipe is fullly inserted.



Insert the pipe into the fitting and check that the interference occurs about 1/3 to 2/3 of the socket depth. Sometimes, when the pipe and fittings are at their tolerance extremes, it may be possible to fully insert the dry pipe into the fitting socket until it bottoms. If this occurs, extra care must be taken to apply sufficient cement to fill the gap between pipe and fitting in order to obtain a strong leak-free joint.

d. Cleaning — Surfaces to be joined must be cleaned and free of dirt, moisture, oil, and other foreign material.

e. Handling Cement — Keep cement can closed and shaded when not actually in use. **Discard the cement when a noticeable change in viscosity occurs, when the cement does not flow freely from the brush, or when the cement appears lumpy and stringy.** Keep the brush immersed in cement between applications.

f. Application of Primer and Cement — PVC solvent cement is fast drying and therefore should be applied as quickly as possible, consistent with good workmanship. It may be necessary for two workers to perform this operation for larger sizes of pipe.

First apply primer to the inside surface of the female end. Use a scrubbing motion to ensure penetration. Repeat applications as necessary.

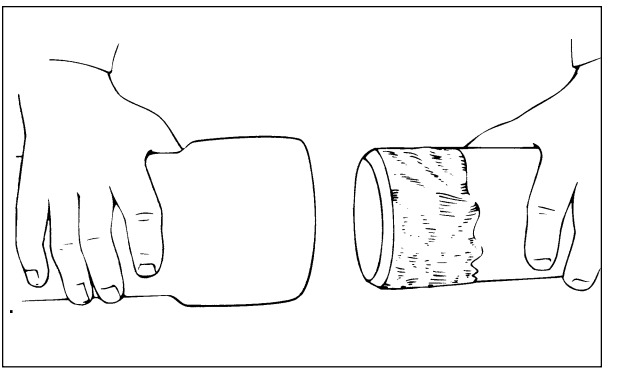
Apply primer to the outside surface of the spigot end to the depth of insertion. Be sure that the entire surface is softened.

Reapply primer to the inside surface of the female end. Immediately apply cement to the pipe spigot end.

Apply a light coat of cement to the inside of the socket. To prevent solvent damage to the pipe, do not apply an excess of cement and do not apply cement to the pipe/bell transition.

Apply a second coat of cement to the pipe spigot end.

g. Assembly of Joint — Immediately after applying the last coat of cement to the pipe, while both the inside socket surface and the outside surface of the male end of the pipe are SOFT and WET with solvent cement, forcefully bottom the male end of the pipe in the socket. Turn the pipe or fitting 1/4 turn during assembly (but not after the pipe is bottomed) to distribute the cement evenly. Assembly should be completed within 20 seconds after the last application of cement.



If there is any sign of drying of the cement surfaces, carefully recoat the surfaces and assemble. Care should be taken not to disturb or apply any force to previously assembled joints, which can be adversely affected by rough handling.

After assembly, wipe excess cement from the pipe at the end of the socket. Any gaps in the cement bead around the pipe perimeter may indicate a defective assembly.

h. Set Time — Handle the newly assembled joints carefully until after the set period as follows:

| Temperature Range | | Minimum Set Time |
|---|---|---|
| ºF | ºC | |
| 60 to 100 | 15 to 40 | 30 minutes |
| 40 to 60 | 5 to 15 | 1 hour |
| 20 to 40 | -5 to 5 | 2 hours |
| 0 - 20 | -20 to -5 | 4 hours |

i. Weather Precautions
   a. High humidity — Quick application of primer and cement is essential to minimize condensation of moisture.
   b. High temperatures — Temperature of PVC surfaces should not exceed 110º F (45º C) at the time of assembly.
   c. Low temperatures — At temperatures below freezing, solvents penetrate the PVC surfaces more slowly than in warmer weather. Testing on scrap pipe is recommended.
   d. Store cements and primers between 40º F (5º C) and 70º F (21º C) when not in use.
   e. Allow for adequate expansion and contraction with proper shading methods or with expansion couplings.

6. Installation
   After the set period, the pipe may be carefully laid in a prepared ditch. For temperature considerations see page 71, "Thermal Expansion and Contraction."

7. Cure Period
   The cure period before testing depends on the specific cement, the size of the pipe, the ambient temperature, and the joint tightness. Cure time may vary from minutes to days. Consult cement manufacturer for information.

8. Safe handling of Primers and Solvent Cements
   a. Keep solvent cements and primers away from all sources of ignition.
   b. Provide adequate ventilation to reduce fire hazard and to minimize breathing of vapors.
   c. Avoid contact with skin and eyes.
   d. Refer to ASTM F 402 for more information.

# Chapter V

- Testing

# General

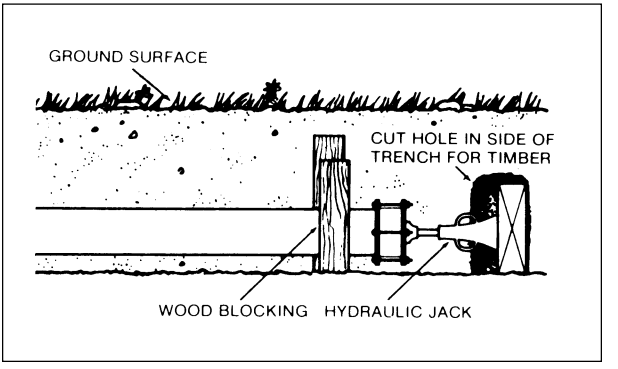
This chapter gives PWPipe's recommendations for project testing, but the final authority on testing requirements is the project engineer.

Water pipe installations are tested for pressure and leakage. PWPipe recommends simultaneous pressure and leakage tests. If the tests are to be done separately, the pressure test should be done first.

It is good installation practice to test portions of a line as they are completed. Sections that fail to pass testing should be located, repaired, and retested until tests are passed.

Prior to the start of testing, the following steps are required:

1. The pipe to be tested should be backfilled to prevent movement while under test pressures. Where possible, leave joints uncovered during testing to allow for easier inspection.
2. At fittings, permanent thrust restraint is required sufficient to withstand test pressures. If concrete thrust blocks are used, the concrete must be allowed to cure before testing begins.
3. Test ends are to be capped and braced to withstand forces developed by test pressures.



## Filling The Line

These precautions should be followed during filling:

1. The line should be filled slowly, with flow velocity not to exceed 2 fps (0.6 m/sec).
2. If possible the line should be filled at its lowest point.
3. During filling, all air should be expelled through permanent air vents at all high points. If permanent air vents are not required, the installer should install corporation stops at all high points to expel air during intial filling and during pressure testing.

## Pressure and Leakage Testing (Combined)

1. Purpose — Pressure test: to locate any defects in materials or workmanship so that repairs may be made; leakage test: to establish that the section of the line tested will not leak, or that leakage is within acceptable limits.
2. Test Pressure and Duration — A test pressure of 150% of working pressure is recommended. In no case shall the test pressure be allowed to exceed the design pressure for the pipe, appurtenances, or thrust restraints. Test duration should be 2 hours for a combined pressure and leakage test. For additional test pressure information, see the Technical Bulletin "Test Pressure for C900 / C905".
3. Method — The system should be raised to specified pressure by means of a pump connected to the pipe. The test pressure is maintained by additional pumping (if necessary), and all fittings, valves, and hydrants carefully examined for leakage.

4. Allowable Leakage — Leakage is defined as the quantity of water that must be supplied to maintain pressure within 5 psig of the specified pressure after the pipe has been filled, vented, and raised to test pressures. Allowable leakage may be calculated from:

$$\text{Design Basis } L = \frac{ND\sqrt{P}}{7{,}400}$$

Where L = allowable leakage (gal/hr)
N = number of joints in the tested line (pipe and fittings)
D = nominal diameter of pipe (in.)
P = average test pressure (psi)

**WARNING: DO NOT USE AIR PRESSURE FOR TESTING PVC WATER PIPE. INJURY OR DEATH MAY RESULT DUE TO THE CATASTROPHIC NATURE OF PIPE FAILURE SHOULD FAILURE OCCUR. (RAPID EXPANSION OF COMPRESSED AIR COULD EXPEL SHARP FRAGMENTS OF PIPE MATERIAL AT HIGH VELOCITY.)**

# Chapter VI

## Service Connections

# General

Service connections range in size from 5/8-inch lines for single-family homes to large lines for fire service or industrial use. Connections may be made by tapping directly into the wall of the pipe, by tapping through service saddles, or by using tapping sleeves.

Much of the information in this chapter is taken from the Uni-Bell PVC Pipe Association's "Tapping Guide for PVC Pressure Pipe." Contact PWPipe for a copy of the guide. Another source of information is a short video made by Uni—Bell titled "Tapping PVC Pressure Pipe."

The illustrations used in this chapter depict specific tooling for the sake of clarity. It is not the intent of PWPipe to promote specific types of equipment or the equipment of a particular manufacturer.

# Direct Tapping

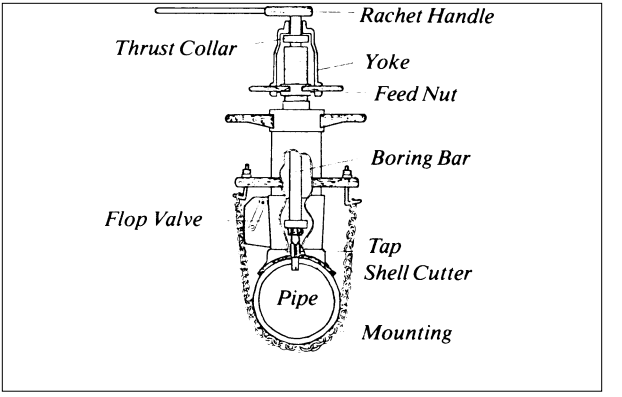
## General

Direct tapping involves the tapping of threads into the pipe wall and the insertion of a corporation stop. Direct tapping is recommended for PVC water distribution pipe manufactured in accordance with AWWA C900 in nominal sizes 6 inch through 12 inch (150 mm through 305 mm) in pressure classes 150 (DR I8) and 200 (DR 14).

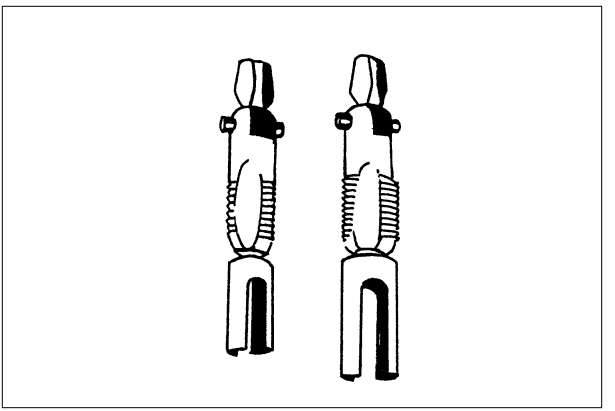
Direct tapping is not recommended for 4 inch pressure class 150 or 200 pipe. In these cases, service clamps or saddles should be used.

## Equipment

1. Tapping Machine: Mechanical device used to install the direct tapped connection into water mains. The tapping machine may vary in design and operation depending on the specific machine manufacturer. The machine must operate with a cutting/tapping tool which is classified as a core cutting tool (either with internal teeth or with double slots) of the shell design which retains the coupon cut while penetrating the wall of the water main. The tapping machine shall provide the



standard ratchet handle on the boring bar. The tapping machine shall be of a design where cutting and tapping is controlled and accomplished with a feed nut or feed screw and yoke.



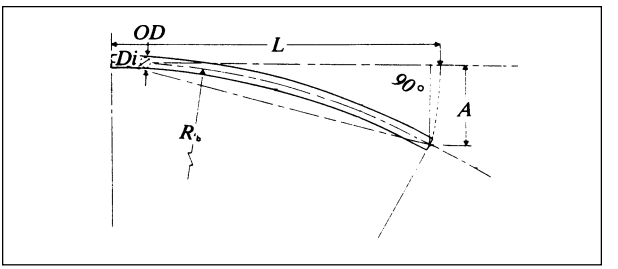
2. Cutting/Tapping Tool: These two combination drill and tap tools illustrate the recommended features of the cutter. A core drill is essential. It may be plain or slotted. Slotted core drills allow an easier cut, but not a faster cut. DO NOT DRILL A HOLE IN PVC PIPE WITH A TWIST DRILL OR AUGER BIT. The core drill must retain the plug of material removed from the pipe wall (the "coupon"). A simple means of removing the coupon from the core drill should be provided. The core drill must be designed to accommodate walls as heavy as DR 14 (pressure class 200, AWWA C900). Sufficient throat depth is required. The shank of the cutter must be adaptable to the tapping machine being used.
   The tap must cut AWWA C800 tapered threads. Iron pipe threads are not recommended for the pipe wall. The depth of travel of the cutter as the threads are cut must be carefully adjusted (to ensure the proper insertion of the corporation stop—with 2-3 threads showing after an insertion torque of 27–35 ft. lbs. (36.6–47.5 newton meters)).

3. Corporation Stop: The corporation stops should be AWWA tapered with thread complying with AWWA C800 in sizes 5/8, 3/4 and 1 inch. When sizes larger than 1 inch are required, tapping saddles or sleeves should be used.

# Procedures

1. Planning the Direct Tap:
   a. Only AWWA C900 Class 150 and 200 PVC pipes 6" (150 mm) through 12" (305 mm) can be direct tapped.
   b. Taps up to 1 inch max. can be made directly (i.e. 5/8", 3/5" and 1").
   c. Wet taps (pipe filled) or dry taps (pipe empty) are allowed. Wet taps are preferred.
   d. The maximum allowable pressure in the pipe at the time the wet tap is being completed is the rated pressure class of the pipe (i.e. DR 18, PC 150; DR 14, PC 200).
   e. Corporation stops must have AWWA C800 thread. Iron pipe threads are not recommended for the pipe wall.
   f. Use a combination core drill and tap when tapping direct. Do not use twist drills designed for tapping hard wall pipes.
   g. Recommended temperature limits:
      Dry taps: 0º F (-18º C) to 100º F (38º C)
      Wet taps: 32º F (0º C) to 90º F (32º C)
      These temperatures refer to the temperature of the pipe itself, which is closely related to air temperature in most cases.
   h. Placement
      - Tap no closer than 24 inches (600 mm) from the ends of the pipe.
      - Stagger multiple taps and keep them at least 18 inches (450 mm) apart lengthwise.
      - Avoid tapping into a discolored surface.

i. Tap a curved pipe only if the radius of the bend is 300 times the pipe outside diameter (or more). The offsets which result from a minimum bending radius of 300 OD are as given below.



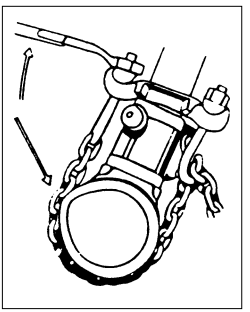

**AWWA C900, 20 foot lengths**

| Nominal Pipe Size | 6” | 8” | 10” | 12” |
|---|---|---|---|---|
| A (inches) | 14.0 | 11.0 | 8.5 | 7.0 |

j. Do a test tap in the shop before starting field tapping.
– Do a couple of dry bench taps to establish the mark on the boring bar corresponding to the correct tapping depth.
– Firmly seat the cutter in the holder of the tapping machine. Secure it well. Any wobbling or looseness of either the cutter or the boring bar will cause problems.
– Make a final check of thread compatibility. AWWA threads are required for both the tap and the corporation stop.
k. Observe the basic tapping precautions when tapping pressurized pipes:
– Have a second person close by.
– Wear protective goggles.
– Provide a quick exit from the ditch.
– Cover the pipe area with a protective blanket (without obstructing machine operation).
– Follow local regulations.

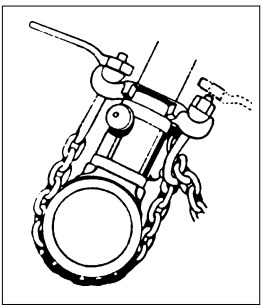
l. When tapping pressurized pipes, the personnel on the surface should have a clear understanding of the valve operation necessary to isolate the tapping site, if required to do so.

WRONG



*Over-tightening only one side may distort wall and stress pipe. Never use wrench extensions.*

RIGHT



*Both sides evenly tightened using only the wrench supplied.*

2. Mounting the Machine:
   a. Make sure the outside diameter of the pipe (listed below) falls within the range of O.D.'s for which the tapping machine saddle is designed.

| **Nominal Pipe Size** (inches) | **Pipe O.D.** (inches) |
|---|---|
| 6 | 6.90 |
| 8 | 9.05 |
| 10 | 11.10 |
| 12 | 13.20 |

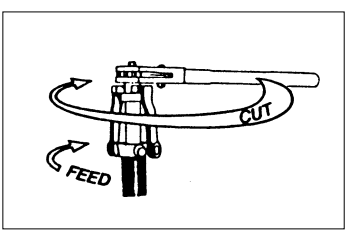
   b. The machine should sit on the drilling site firmly, but not in a way that will set up wall stresses by distorting the pipe. The actual placement of the tapping machine on the pipe is to be done in accordance with the recommendations of the machine manufacturer.

c. Even when taps are being made on the horizontal plane (the preferred location because it keeps the gooseneck of the service pipe as far below the frostline as possible), it is important that the tightening nuts be turned down evenly on each side.
   Follow this procedure:
   – Adjust the nuts on the chain hooks so that they are even with the tops of the threads.
   – Position the chain hooks on the machine and loop the chain links into the hooks snugly.
   – Tighten nuts A and B alternately so that the same number of threads are showing when the machine is correctly and firmly mounted.
   – During the process, make sure the machine remains correctly seated in the saddle and saddle gasket. Overtightening on only one side may distort the wall and set up wall stresses.

d. Wrench extenders should not be used.

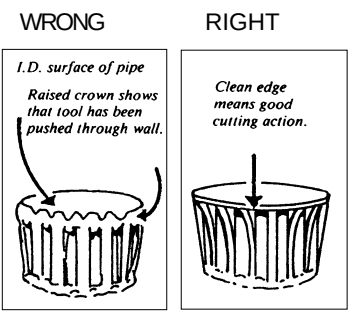
3. Cutting the Hole and Tapping the Threads:
   a. Since PVC is easy to cut, there is a temptation to overfeed the cutter because it is comparatively easy to turn the ratchet handle. The principle is to allow the cutter to work as a cutter. Rotate the ratchet handle one complete turn for every 1/8 turn of the feed yoke (approx. 1-in. (25 mm) movement of feed nut to each 1/4 turn of ratchet handle).

RIGHT




Feed lightly — just enough to keep the cutter engaged.

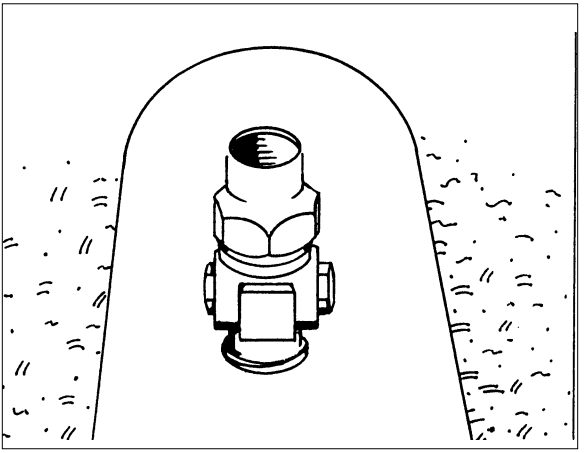
b. The feed rate should be less in cold weather. Judge the correct feed rate by "finger pull" — the effort should be about the same used to open a desk drawer. This rule of thumb applies in any temperature.
c. Upon wall penetration, the upward thrust on the boring bar (assuming a pressurized pipe) will be about 1 lb.-force per 1 psi of water pressure.
d. Use the feed yoke to engage the first few turns of the tapping tool in the hole. After this, the tap is self-feeding and the feed yoke can be disengaged from the boring bar.
e. The "Cast Iron" mark on the boring bar is not a reliable indicator of how deep to tap. Tapping to the correct depth is important and should be determined by performing bench tests in advance and carefully noting the position of the threaded feed sleeve (relative to the thrust collar or other datum point) when the corporation stop is correctly inserted.
f. As the tapping tool is reversed out of the hole, re-engage the feed yoke or hold the boring bar until the tap clears the threads. Release the bar slowly so as not to damage the threads, or injure the machine operator.
g. Examine the coupon of PVC after it is knocked out of the cutter head. A clean edge means good cutting action. A raised crown means the cutter was fed through too fast.




*If the cutter is fed too fast, a plug of material is pushed out of the I.D. of the pipe where the tool emerges. The condition of the "coupon" provides a check of correct tapping procedures.*

*At the first sign of a "crown" on the coupons, the tapping procedure or the condition of the tools should be re-examined and corrected before more taps are attempted.*

4. Inserting the Stop:
   a. Attach the E-Z screw plug to the end of the boring bar. Screw the corporation stop into the E-Z release plug. The exposed end of the main stop will be the inlet end with tapered (AWWA) threads. Check to BE SURE THE STOP IS CLOSED.
   b. Apply two spiral wraps of "Teflon" tape clockwise to the AWWA threads. Other thread lubricants are not recommended. Do not use liquid sealants (even though they may contain Teflon).
   c. Replace the boring bar assembly in the machine and insert the stop into the main. Use care to start the first few threads in the hole so that they are not forced or punched. Using the feed yoke for this operation requires only light finger pressure on the feed nut while the ratchet handle is rotated.
   d. Disengage the feed yoke and remove the ratchet handle as soon as the stop has firmly engaged the threads in the pipe wall. Complete the insertion using a torque wrench.
   e. Tighten the stop to 27 foot-pounds (36.6 newton meters).
   f. Snap the wrench counterclockwise to release the E-Z plug from the stop. Remove the tapping machine in the usual way. If there is leaking past the threads, tighten the stop to 35 foot-lbs (47.5 newton meters). At correct insertion, one to three threads should be visible.
   g. If leaking past the threads persists, remove pressure from the line, unscrew the main stop to clear away cuttings and replace the stop to 27 foot lbs. (36.6 newton meters), making sure the "Teflon" thread lubricant has been restored.

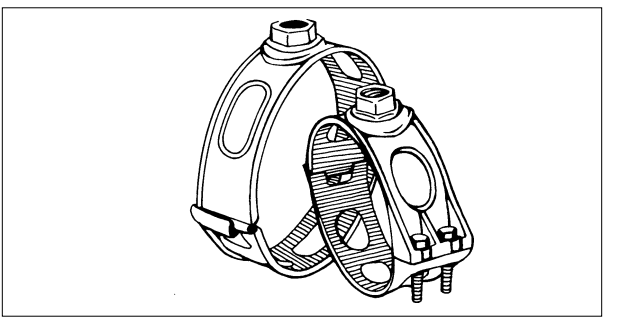


5. Direct Dry Tapping: When direct tapping AWWA C900 DR 18 Pressure Class 150 or DR 14 Pressure Class 200 PVC pipe 6" - 12" that is empty, or not in service, or not yet under pressure, the procedure given for making wet taps under pressure should be followed with a few exceptions:
   a. Remove the machine from the pipe after the hole has been drilled and tapped. Carefully remove the cuttings from the hole before inserting the main stop.
   b. Prepare the stop as described in "Inserting the Stop" and insert it by hand. Caution: Take special care not to crossthread the fine, "Teflon" wrapped AWWA threads.
   c. Tighten the stop to the point where 1–3 threads are showing at 27 foot-lbs. (36.6 newton meters).

# Saddle Tapping

## General

The use of saddles to make taps in PVC pressure pipe is recommended for any size or class of pipe. Service connections may be made using a service clamp or saddle. Maximum outlet size recommended with service clamps or saddles is 2 inches (50 mm). When making this type of connection, equipment is used



which attaches to the corporation stop permitting a cutting tool to be fed through the corporation stop to cut a hole in the pipe. No tapping of the pipe wall is required since the corporation stop is threaded into the service clamp.

## Equipment

1. Service Clamps or Saddles
   a. Service clamps or saddles used for attaching service connections to PVC water pipe should:
      – Provide full support around the circumference of the pipe.
      – Provide a bearing area of sufficient width along the axis of the pipe, 2 inch (50 mm) minimum, insuring that the pipe will not be distorted when the saddle is tight-

b. Service clamps should not:
   – Have lugs that will dig into the pipe when the saddle is tightened.
   – Have a U-bolt type of strap that does not provide sufficient bearing area.
   – Have a clamping arrangement that is not fully contoured to the outside diameter of the pipe.

2. Tapping Machine: A number of tapping machines are available which will cut through a corporation stop. The tapping machine may vary in design and operation depending on the specific machine manufacturer. The machine must operate with a cutting tool which is classified as a core cutting tool (either with internal teeth or with double slots) of the shell design which retains the coupon cut while penetrating the wall of the water main. The tapping machine shall provide the standard ratchet handle on the boring bar. The tapping machine shall be of a design where cutting is controlled and accomplished with a feed nut or feed screw and yoke.
3. Cutting Tool: It is important that the cutting tool be a shell type (hole) cutter which will retain the coupon and be designed to accommodate walls as heavy as DR 14 (pressure class 200, AWWA C900). Many shell cutters are designed only for thin walled PVC. Consequently, they do not have sufficient throat depth to handle the heavier-walled pipe. DO NOT DRILL A HOLE IN PVC PIPE WITH A TWIST DRILL OR AUGER BIT. The shank of the cutter must be adaptable to the cutting machine being used.
4. Corporation Stop: Because the corporation stop is inserted into the service clamp or saddle, it must have threads which match that of the clamp or saddle, which may be either IPS OD or CIPS OD.

   The maximum size of corporation stop which may be used with a service clamp or saddle is 2 inches. If a tap larger than 2 inches is required, a tapping sleeve and valve are required.

## Procedure

1. Evenly tighten the saddle to the pipe. Do not overtighten the bolts. (If the bolts are overtightened, stresses will be introduced into the wall of the pipe.) The torque required is generally approximately 20 ft. lb.
2. Screw the inlet side of the main stop into the saddle threads. Retain the stop hardware as supplied.
3. Open the main stop.
4. Using the appropriate adapter and gasket, attach the drilling machine to the main stop outlet threads. Use a machine with an operator-controlled feed rate. Be sure to follow the machine manufacturer's instructions.
5. The use of a core drill is essential. The key to tapping PVC pipe lies in advancing the feed nut slowly enough to allow the core drill to **cut** the pipe rather than forcing it through the pipe wall.
6. Lower the boring bar to the main and rotate the cutter while exerting finger-pull on the feed handle. Rotate the ratchet handle one complete turn for every 1/8 turn of the feed yoke.
7. After the cutter has penetrated the pipe wall, withdraw the cutter, close the main stop, and remove the drilling machine.
8. After the machine has been removed, tighten the saddle bolts to ensure that the saddle gasket will seal.

# Tapping Sleeve and Valve

## General

Tapping sleeves and valves are used when service connections larger than 2 inches (50 mm) must be made in PVC water mains. Tapping sleeves may be used for making large taps under pressure. The use of tapping sleeves and valves to make taps in PVC pressure pipe is recommended for any size or class of pipe. When making this type of connection, equipment is used which attaches to the valve permitting a cutting tool to be fed through the valve to cut a hole in the pipe. No tapping of the pipe wall is required since the valve is attached to the tapping sleeve.

## Equipment

1. Tapping Sleeves and Valves:
   a. When tapping sleeves are ordered from the manufacturer, the outside diameter of the pipe being tapped, the size of the outlet desired and the working pressure (or test pressure, if higher) should be specified to insure that the sleeve furnished will be satisfactory. Lead-joint sleeves should not be used.
   b. Tapping sleeves should:
      – Provide full support around the circumference of the pipe.
   c. Tapping sleeves should *not:*
      – Distort the pipe when tightened.
      – Have lugs that will dig into the pipe when the sleeve is tightened.
      – Have a clamping arrangement which is not fully contoured to the outside diameter of the pipe.
   d. When ordering tapping valves, dimensions and attaching mechanisms consistent with the tapping sleeves should be specified.
2. Cutting Tool: A toothed core cutter which retains the coupon, similar to those used for other materials, should be used. The

cutter should have sufficient throat depth to cut heavy walled PVC such as DR 14. DO NOT DRILL A HOLE IN PVC PIPE WITH A TWIST DRILL OR AUGER BIT.

3. Tapping Machine: A number of tapping machines are available which will cut through a tapping valve. The tapping machine may vary in design and operation depending on the specific machine manufacturer. The tapping machine must be attached to the valve and must be ordered according to the valve specified. Tapping equipment can be purchased or rented from sleeve manufacturers who also furnish instructions and/or instructors trained in making such taps. (Contractors who specialize in this type of work are also available in some areas.)

## Procedures

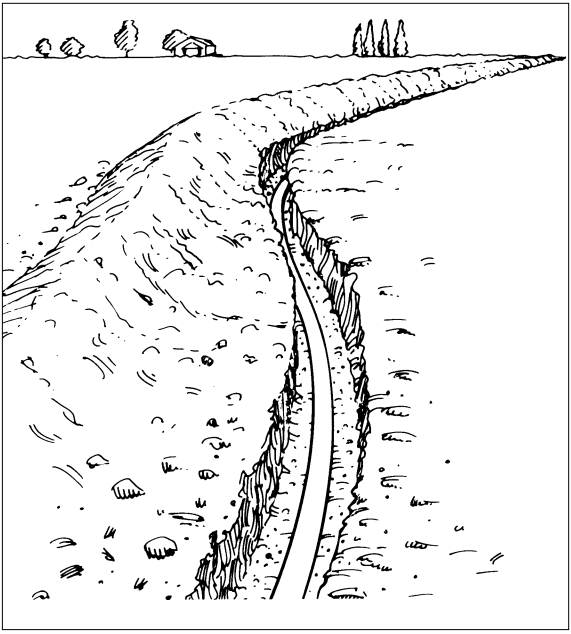
1. The tapping sleeve should be assembled on the pipe in accordance with the manufacturer's directions, insuring that no pipe distortion occurs. The tapping valve is then connected to the sleeve.
2. Tapping sleeves should be well supported independently from the pipe during the tapping. Support used should be left in place after tapping. Thrust blocks should be used as with any other fitting or appurtenance.
3. Attach the drilling machine and adaptor to the valve outlet flange. Position the necessary support blocks. Open the tapping valve, advance the cutter and cut the hole into the main through the sleeve. Retract the cutter and then close the tapping valve. Remove the drilling machine and attach the new line or lateral.

# Chapter VII

# Special Considerations

# Longitudinal Bending

1. The ability of PVC pipes to bend is a signficant advantage over rigid pipes.
2. Longitudinal bending may be done deliberately during construction or may be the result of changes that occur in the pipe-soil system after construction.

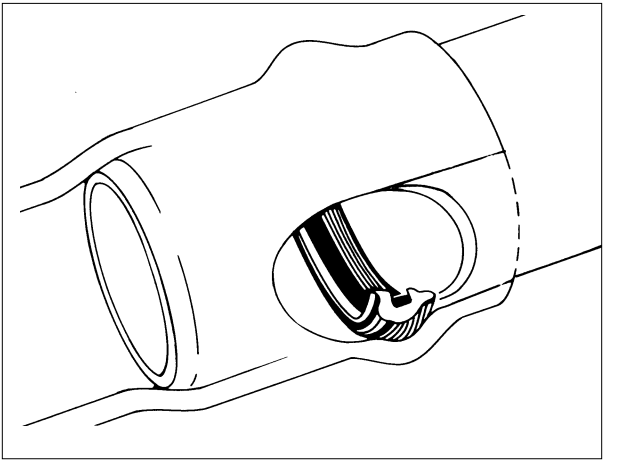


3. Gasketed Pipe Joint Deflection: Gasketed PVC pipe joints allow a small amount of deflection. The maximum allowable deflection in gasketed PWPipe products is one degree.

4. Pipe Body Longitudinal Bending: The bending radii of PVC water pipes must be limited to the following:
   Pressure Rated Pipes (ASTM D 1785, ASTM D 2241, AWWA C905, all PIP pipes): 200 times OD or greater.
   OD = Pipe outside diameter in inches — divide result by 12 to get bending radius in feet.
5. Bending should be done manually, with a bar if possible. If mechanical equipment is used, extreme care should be taken to prevent damage to the pipe and the adjacent joint. Some large-diameter pipe may be too stiff to be curved.
6. Fittings should be used for radii tighter than those recommended above.
7. More information can be found in the PWPipe Technical Bulletin "Longitudinal Bending of PVC Pipe". Contact PWPipe for a copy.

# Thermal Expansion and Contraction

1. All materials expand and contract with changes in temperature. Linear expansion of pipe in the longitudinal direction is dependent on:
   a. Variation in temperature.
   b. Coefficient of thermal expansion of the material. It is important to note that the rate of thermal expansion and contraction is not dependent on pipe size or wall thickness.
2. The coefficient of thermal expansion for PVC is $3.0 \times 10^{-5}$ in/in/ F ( 5.4 x 10 -5 mm/mm/ ºC).
3. Allowance for the movement:
   a. 0.36 inch of length variation for every 100 feet of pipe for each 10º F change in temperature.
   b. 5.4 mm of length variation for every 10 meters of pipe for each 10º C change in temperature.



4. Gasketed Joints — When gasketed joints are used, thermal movement is not a significant design factor as long as:
   a. Pipe temperatures are kept within accepted limits for PVC pipe.
   b. Joints are properly installed with the pipe spigots inserted into the bells to the insertion line.

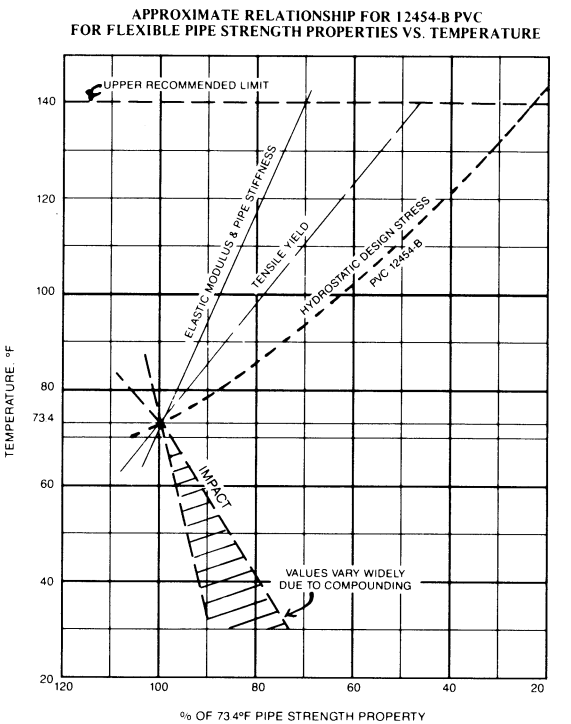
   **WARNING**: IF PIPE SPIGOTS ARE INSERTED PAST THE INSERTION LINE, THERMAL EXPANSION MAY CAUSE SIGNIFICANT STRESSES IN THE PIPE BELLS.

5. Solvent Cemented Joints — When solvent cemented joints are used, thermal movement cannot be accommodated in the pipe joints. The following installation procedures are recommended (after the joints are properly cured):
   a. Small diameter pipes (1/2 inch to 2 1/2 inch) — When installation temperature is substantially lower than operating temperature, the pipe should be installed with straight alignment and brought up to operating temperature. This procedure will permit expansion of the pipe to be accommodated by snaking action. When installation temperature is substantially above operating temperature, the pipe should be installed by snaking in the trench.
   b. Large Diameter Pipes (3 inch and larger) — Pipe should be installed in straight alignment. Before backfill to the extent that restricts longitudinal movement, the product temperature should be adjusted to within 15º F (8º C) of operating temperature.
6. Where the operating temperature cannot be closely controlled, the stresses resulting from extreme temperature variations must be considered in the design. The design engineer should be consulted for guidance.

# Thermal Effects on PVC Properties

The physical properties of PVC vary with changes in temperature. The rated values for PVC properties are established at 73.4º F (23 C).

1. As temperature decreases below 73.4º F, pipe stiffness and tensile strength increase while impact strength decreases. This decrease in impact strength requires that more care be taken during installation in cold temperatures.
2. Conversely, as temperatures increase, pipe stiffness and tensile strength decrease while impact strength increases. Decreases in pipe stiffness require that more care be taken during installation in hot weather.



# Ultraviolet (UV) Radiation

Like most plastics, PVC can experience degradation when exposed to UV radiation. This degradation occurs only on surfaces exposed to the sun and penetrates only about .001 inch into the pipe wall. The affected areas often turn a yellow color. When the pipe is no longer exposed to the sun, further degradation does not occur.

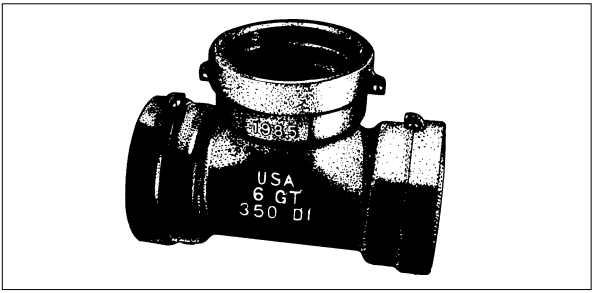
Ultraviolet exposure does not significantly affect pipe stiffness or tensile modulus properties. However, there is a measurable reduction in values for impact strength.

PVC pipe's high initial impact strength means that reductions in impact properties due to UV radiation are of little concern. If good construction practice is followed in unloading, handling, and installation, pipe breakage due to impact loads will not be a problem.

See the PWPipe Technical Bulletin "The Effects of Sunlight Exposure on PVC Pipe and Conduit" for more details.

# Appurtenances

1. Valve and fitting weights should not be carried by PVC pipe. Most valves and fittings may be supported on properly compacted bedding, but in some soil conditions, concrete cradles may be required for heavy valves.
2. AWWA C900 and C905 pressure pipe is produced in cast-iron pipe size (CIPS). This means that ductile iron valves and fittings are compatible with CIPS PVC pipe.
3. Similarly, iron pipe size (IPS) PVC pipe is compatible with appurtenances used for steel pipe.



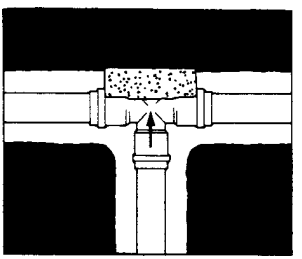

4. Butterfly valves may not function properly on some heavy-walled PVC pipe because wall thickness may interfere with disc movement. Special adapters may be required.
5. Most fittings do not allow as much spigot insertion depth as do pipe bells and couplings. When assembling a PVC pressure pipe to an iron fitting (push-on or mechanical joint), remove all but 1/4 inch of the factory made bevel from the spigot end of the pipe. Bottom the pipe in the bell of the iron fitting.

# Thrust Restraint

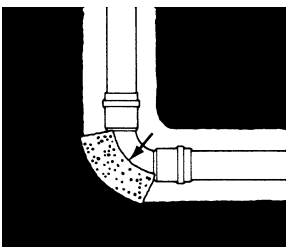
The large thrust forces exerted in water distribution systems require thrust restraint designed to resist test pressures as well as peak operating pressures.

1. When concrete thrust blocks are used, the size and type of blocking must be based on the maximum thrust force expected and the load-bearing capacity of the soil.

THRUST BLOCKS



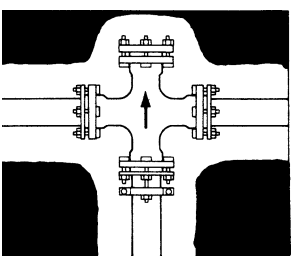
Through line connection, tee



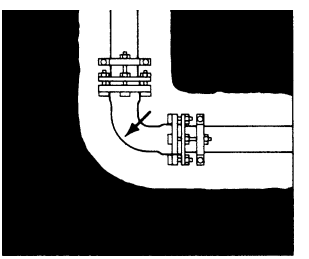
Direction change, elbow

2. When mechanical thrust restraint devices are used, they must be a type that is specifically designed for use with PVC pipe. The devices should conform to Uni-Bell's UNI-B-13 "Recommended Performance Specification for Joint Restraint Devices for Use with PVC Pipe."

THRUST RESTRAINERS



Through line connection, cross used as tee



Direction change, elbow

# Application Precautions

1. Entrapped air — During filling of pipe with water for testing or operation, air should be allowed to escape through valves or corporation stops at the high points of the line. Removal of entrapped air reduces surge pressures (water hammer) in the line.
2. Pressurized air — PWPipe's pressure water pipe is not intended for air pressure testing or service.
   **WARNING: Do not use PWPipe products for pressurized air applications, as injury may result.**
3. Safety — All applicable federal, state, and local safety regulations should be followed.

# Index

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