NEXT

Municipal PVC Pipe Installation Guide

Table of Contents

About This Guide 1

Shipping, Handling and Storing PVC Pipe 2
- Receiving and Handling 2
- Unloading and Stacking 2
- Unloading and Stockpiling Units 3
- Storage 3
- In Cold Weather 4
- In Excessive Heat or Sunlight 4
- Transferring Pipe 4

Preparing the Trench 5
- Pipe Installation Terminology 5
  - Foundation 5
  - Bedding 5
  - Pipe Embedment 5
  - Haunching 6
  - Backfill 6
  - Cover 6
- Excavating and Preparing the Trench 6
  - Flotation, Line and Grade 7
  - Trench Width 8
  - Trench Depth 8
- Bedding the Trench 9
  - Embedment Materials 9
  - Selection of Embedment Materials 10

Installing the Pipe 12
- Inspection 12
- Lowering Pipe and Fittings into Trench 12
- Cutting the Pipe 13
  - Cutting 13
  - Beveling 13
  - Reference mark 13
- Cleaning and Lubricating the Pipe 14
  - AQUALOC and DURALOC 14
- Joining the Pipe 15
- Curving AQUALOC Pressure Pipe 16
- Deflecting DURALOC Sewer Pipe Joints 18

Installing Fittings and Accessories 19
Fittings 19
AQUALOC 20
Mechanical Joints 20
DURALOC 20
Service Connections 21
AQUALOC 21
DURALOC 21
Cut-in fittings 21
Manhole Connections 21
Wye or Tee Saddles 23
Gasketed Saddles 24
Thrust Restraint for AQUALOC 25
Thrust Blocking AQUALOC 25
Planning for Thrusting 25
Calculating Thrust Block Area Required 26
Mechanical Thrust Restraints 27
Installing Tapping Sleeves and Valves for AQUALOC 28

Backfilling, Haunching and Tamping 29
Haunching 29
Initial Backfill 30
Tamping Equipment and Methods 31
Tamping Bars 31
Mechanical Tampers 32
Water Jetting 32
Sheeting and Trench Boxes 33
Final Backfill 33

Special Installation Conditions 34
Anchorage of Pipe on Slope 34
Cold Weather Installation 34
Deep Sewer Chimney or Risers 35
Installing Pipe through Casings 35

Testing Pipelines 36
Pressure Testing AQUALOC 36
Testing DURALOC 38
Deflection Testing 38
Air Testing 39
Minimum Time Requirements 39
Relieving Air from Pipeline 39
Allowable Infiltration 40
Allowable Exfiltration 40

Repairing Pipelines 41

About This Guide

This booklet will guide you through each phase of pipe installation at a given site, from receipt of your materials to final testing of the completed system. It does not provide design specifications, site suitability recommendations or similar information which should have been collected prior to the installation. The instructions in this guide are based on the assumption that there are no unusual site conditions requiring further engineering consultation; however, if such consultation becomes necessary, the engineer's instructions should prevail.

How To Use This Guide

This guide applies to three types of pipe manufactured by NEXT POLYMERS. Some steps are relevant to all pipes, while others may apply to one or two. The following symbols have been used throughout the guide to reference which pipes each section refers to.

AQUALOC® Pressure PVC Pipe

Made to withstand extreme pressure without leaking or corroding, this tough pipe is the product of choice for municipal waterworks applications.

DURALOC® Sewer PVC Pipe

Made to withstand extreme soil loads without leaking, this corrosion-proof pipe is lighter to handle and easier to install making it very cost effective.

Shipping, Handling and Storing PVC Pipe

Receiving and Handling

As the person receiving the pipe materials, you are responsible for determining that the delivery is complete and undamaged. Follow the steps below before you sign the delivery receipt:

1. Compare the delivery to the tally sheet to check total quantities of all parts and pieces.
2. Report any error to the transportation agent and note it on the delivery receipt.
3. If the load seems intact on the delivery bed, inspect it as you unload; if it has shifted or appears to have been roughly handled, unload it (see **Unloading and Stacking**) piece by piece for a thorough inspection.
4. Note on the delivery ticket any problems you find and return the ticket to the transportation company.
5. Notify the carrier immediately to make a claim.
6. Do not discard damaged or incorrect material; the carrier will let you know what to do with it.
7. Reorder whatever you need replaced or added to your order.

Note: Smoke tarps should be in place to protect potable water pipe from diesel exhaust during transport. The odor can be extremely difficult to remove, and residue may appear as a contaminant upon installation.

Unloading and Stacking

To prevent damaging the pipe, unload it carefully. PVC pipe has very good impact resistance, but at very low temperature it becomes stiffer and may be brittle. General guidelines to follow to prevent the pipe from scratching or cracking are to avoid dragging it over rough surfaces, throwing it off the side of the delivery truck or dropping it onto the ground. If you use mechanized unloading systems such as slings or forklifts, secure the pipe to the transport so there are no overhanging pieces to fall or cause injury, and use rubber hose sleeving or similar material to cushion the pipe in such a way that steel cables, straps or abrasive truck beds don't damage it as it's being lifted off and carried to the storage site. Proper handling will protect the pipe from damage.

Unloading and Stockpiling Units

Unload the pipe in the units or modules in which it was shipped; if you use a forklift or a front-end loader with a fork, be sure you don't drive the forks so deeply under the unit that you damage an adjoining unit. To prevent the underlying units from shifting as you unload the top unit, support those underneath with wooden chocks. If you're unloading single pieces by hand, be especially careful not to jostle other lengths of pipe. Begin at the topmost layer and carefully unload the units one at a time, stacking them no more than two units deep on level ground. Use whatever shipping material (dunnage) the carrier used to support the units during shipment so that the pipe isn't supporting its own weight.

Storage

It is best to store your stockpile as closely as possible to the trench where you will use it. Lay the pipe on the side of the trench opposite the excavation, where it is less likely to be in the way of traffic and equipment, and where it can easily be lowered into the trench with a minimum of handling.

Safety should always be a concern when stacking unsupported pipe modules on a job site. If the pipes are not stored in module units, use the original shipping supports. If this is not possible, store the pipe with supports that prevent the bells, spigots, couplings or any other joint surface from any contact. Use chocks (with or without fabric or rope tie downs) to prevent the pipe from rolling due to high winds, sloping ground, wash outs, flash flooding or mischief-makers. Pipes separated from original modules and stacked using supports and chocks should never be piled more than 5' high.

Pipes should be protected from sunlight if it is to be stored for more than six months. The exterior of PVC pipe may become discolored when left exposed to sunlight. The discoloration may mean the impact strength of the pipe has been reduced; however, the tensile and structural strength are generally unaffected.

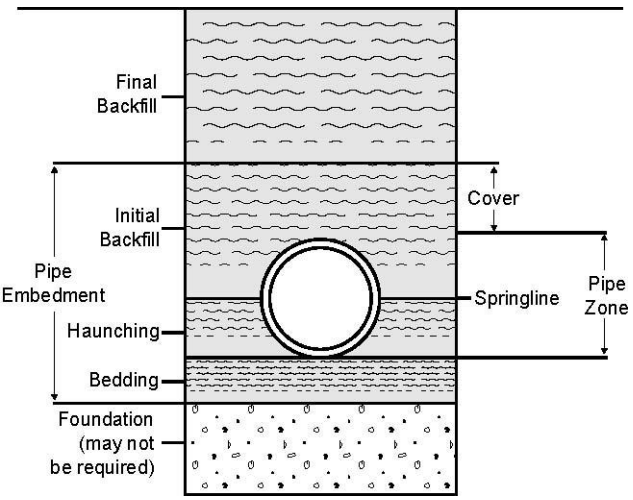
Any covering over the pipes should be opaque to reduce light penetration. To minimize heat build up, the covering should be light colored and provisions should be made for air circulation under the covering.

In Cold Weather
PVC pipe exposed to freezing temperatures becomes less impact resistant and flexible, so it's important to be especially careful handling it under these conditions. Also, you may find that pipes transported at the bottom of the shipment pile has become out-of-round due to the weight of other pipes on top of it. It will return to its original shape, but this will take longer in cold weather.

In Excessive Heat or Sunlight
Like cold temperature, excessive heat can also affect PVC pipe's flexibility, and while pipe so affected will retain its long-term performance properties, it should be handled with extra care. Avoid exposing the pipe to welding torches, heaters and, if possible, excessive sunlight, which will cause the pipe to discolor. If you anticipate storing the pipe outside under strong sunlight, we advise you to cover it with canvas or other opaque material, being sure to leave adequate air circulation underneath.

Transferring Pipe

When it's necessary to transfer pipe from one area to another, handle it carefully, observing the guidelines you followed to unload it. For the transport vehicle, be sure to use a truck with a long enough bed that the pipe can hang over the end no more than 2' (61 cm); or you may retrofit a short-bed truck with racks that will accommodate the pipe horizontally. Ensure that the bell end of the pipe hangs out the back of the truck bed, and that each layer's bell ends hang out beyond those of the layer below. Do not slide or drop the pipe onto the truck as protrusions or other irregularities in the truck bed could damage it.



Preparing the Trench

Pipe Installation Terminology

It is essential that you understand flexible conduit terminology. You'll find basic terms depicted in the illustration above, terms which you'll repeatedly encounter throughout this guide. A thorough grasp of this material as well as a comprehensive understanding of soil classes and densities, techniques of backfilling and haunching, and proper placement of pipe and accessories will help you ensure satisfactory results.

Foundation

The foundation is the material that is in the bottom of the trench. It may or may not have a layer of bedding soil placed over it. The foundation soil may be:

- undisturbed and remain in place;
- unsuitable and must be removed and replaced with another material;
- so wet and soft that it must be displaced by dumping rock into the trench; or
- removed from the trench, placed back in the trench and then compacted.

Bedding

The bedding is the soil placed in the bottom of the trench on top of the foundation soil and provides uniform support for the pipe.

Pipe Embedment

The embedment is the material placed around the pipe that *supports* the pipe.

Haunching
The haunch area is the portion of the embedment under the pipe from the bottom of the pipe up to the springline or horizontal center line of the pipe. This is the most critical area in providing support for the pipe.

Backfill
The backfill is the material placed over the pipe up to the ground surface. This consists of initial and final backfill; backfilling is discussed and illustrated beginning on page 30.

Cover
The cover is the depth of the backfill over the pipe and is measured from the top of the pipe to the top of the initial backfill.

Excavating and Preparing the Trench

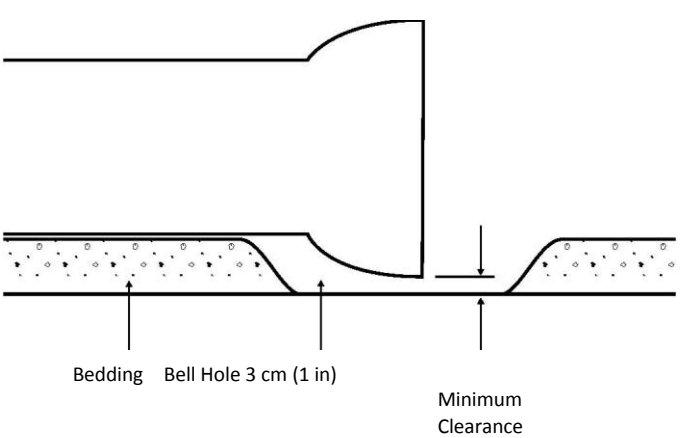
Trenches can be hazardous, so be sure to observe all safety regulations designed to protect workers and the public. If the trench bottom is unstable, you may have to over-excavate the trench and refill it back to grade with approved material as a bedding foundation. Pipe **bedding** should be at least 4" (100 mm) deep. It may or may not be compacted, but you will have to excavate for the pipe's projecting bells so that they're properly relieved in the trench bottom.

Flotation, Line and Grade

If the trench has standing water you cannot remove, hold the pipe at grade with a soil cover about twice the diameter of the pipe, to prevent flooding the pipe. Try to schedule pipe installation as soon after excavating as possible; this can help avoid the need for sheeting or pumping, and can help prevent unfavorable weather from freezing or collapsing the trench.

Undercut the trench bottom by machine and bring it to proper grade by using selected backfill of excavated soil; be sure the soil is free of large stones (larger than 1-1/2" [38 mm] in diameter), hard lumps and debris, and can be properly compacted by tamping. Soils containing large rocks, a high content of organic matter, lumpy clay and unstable muck should not be used; rocky or hard shale, selected backfill (not exceeding 3/4" [19 mm] in size to a depth of 4" to 6" [100 mm to 150 mm]) should be placed beneath the pipe to cushion it, but do not deposit such a thick or soft layer that pipe will settle and lose grade. Contour the bedding to allow for the projecting bells (refer to figure below). Your goal should be to provide firm, stable, uniform support for the pipe. If it sits on rock, it is subject to breakage under the weight of backfill load, surface load or earth movements, so you will need to excavate deeper and fill with the approved material, compacted to at least 85% Proctor density.

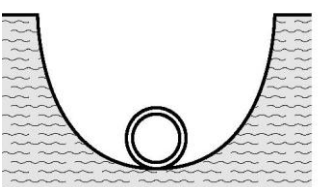
Bedding Bell Hole 3 cm (1 in)
Minimum Clearance



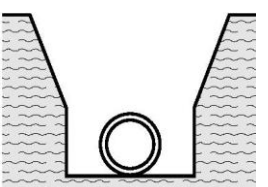
Trench Width

Local conditions will determine the width at the top of the trench, but this should be kept to a minimum. In the **pipe zone,** sufficient space must be allowed for proper placement and compaction of haunching material. Allow not less than 8" (200 mm) on either side of the pipe for work in the pipe zone.

The general rule is that the maximum trench width at the top of the pipe should not exceed the outside pipe diameter plus 2' (600 mm). If the trench width cannot be adequately kept to the above minimum, then compacted backfill must be provided up to 2-1/2 pipe diameters from either side of the pipe for pipes up to 10" diameter (254 mm). For larger diameter pipes, the compacted material should be placed one pipe diameter or a minimum of 2' (600 mm) on either side of the pipe.



Wrong

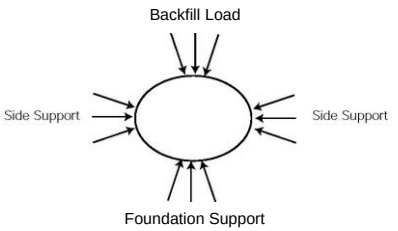


Right

Trench Depth

For water pipe installations, the trench should be deep enough so that when you install the pipe, you will have at least 6" (150 mm) between the pipe crown and the known frost line. When frost is not a problem, the minimum should be 18"-24" (450 mm-600 mm) where surface loads will be encountered. Before vehicles pass over the line of pipe under shallow cover, be sure backfill compaction has been completed.

Note: Contact your local NEXT POLYMERS office for additional reference material and testing of PVC pipe under shallow cover.



Bedding the Trench

Preparing the trench bottom correctly is crucial to laying the pipe properly. You must first be sure the trench bottom is smooth and free of large stones, rocks, boulders, construction debris, clods or frozen material. Bed the trench with loose or granular soil such as coarse sand, crushed stone or shale. If you use heavy equipment to place bedding material into the trench, shape the material by hand afterwards to eliminate any pockets and, above all, to ensure that the pipe is supported uniformly along its entire length.
Concrete may be specified for use in specific spots for pipe support and anchorage.

Embedment Materials

There are a number of processed materials plus the soil types listed under USCS Soil Classification System (FHA Bulletin No. 373 or ASTM D2487), which are grouped into five broad categories according to their suitability for this application.

Class I. Angular, 1/4" to 1-1/2" (6.25 mm to 38 mm) graded stone, including a number of fill materials that have regional significance, such as coral, slag, cinders, crushed stone and crushed shells.

Class II. Coarse sands and gravels with maximum particle size of 1-1/2" (38 mm), including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry. Soil types GW, GP, SW and SC are included in this class.

Class III. Fine sand with clayey gravels, including the fine sands, sand-clay mixtures and gravel-clay mixtures. Soil types GM, GC, SM and SC are included in this class.

Class IV. Silt, silty clays and clays, including inorganic clays and silts of medium to high plasticity and liquid limits. Soil types MH, ML, CH and CL are included in this class.

Class V. This class includes the organic soils OL, OH and PT as well as soil containing frozen earth, debris, rocks larger than 1-1/2" (38 mm) in diameter, and other foreign materials. These materials are not recommended for bedding, haunching or initial backfill.

Note: The performance of a flexible conduit does not depend only on the class of embedment materials used but, more importantly, on the density achieved in compacting the haunching material.

Selection of Embedment Materials
Bedding material and its placement is of critical importance to installation and performance of both water and sewer pipes. It is essential that resident and imported materials are properly classified before use in bedding.

Proper selection of haunching material is essential to PVC pipes' ability to support vertical loads, and is frequently a special material with sizes not exceeding 3/4" (19 mm). Many jurisdictions have their own bedding specifications which call for special material to completely cover the pipe; care must be taken to clarify these requirements. Soil to be placed for bedding and used in the pipe zone must maintain the specified soil density. If a coarse, granular Class I material is used for bedding the pipe, it should also be used for haunching to, at least, the spring line of the pipe. Otherwise, side support may be lost due to the migration of Class II, III or IV material into the bedding.

When selecting embedment materials, make sure that native soil migration from the trench walls cannot occur. A well-graded compacted granular material will prevent this. In trenches subject to ground water inundation, the granular material should be compacted to a minimum of 85% Proctor density.

Designing Sewer Pipelines with Duraloc – Long-Term Deflection
When designing sewer pipelines, planners must give consideration to long-term deflection, which should not exceed 7.5%. Table 1 relates depth of bury to bedding materials and compaction when used with 46 psi (320 kPa) stiffness solid wall DR35 pipe. See section on **Deflection Testing,** Table 9, p. 39 for test mandrel sizing.

Table 1

Maximum Long-term Deflections of Duraloc (DR35)

ASTM embedment material classification		Density Proctor AASHO T-99	Height of cover (feet) 3	5	8	10	12	14	16	18	20	22	24	26	28	30
Manufactured granular angular	CLASS I		0,2	0,3	0,4	0,5	0,6	0,7	0,9	1,0	1,1	1,2	1,3	1,4	1,5	1,6
Clean sand and gravel	CLASS II	90%	0,2	0,3	0,5	0,7	0,8	0,9	1,1	1,2	1,3	1,4	1,6	1,7	1,8	2,0
		80%	0,9	1,4	2,3	3,2	3,6	4,1	5,0	5,5	6,0	6,4	7,3	7,7	8,2	9,1
Sand and gravel with fines	CLASS III	90%	0,2	0,4	0,6	0,8	0,9	1,1	1,2	1,4	1,6	1,7	1,9	2,1	2,2	2,3
		85%	0,7	0,9	1,7	2,2	2,6	3,0	3,5	3,9	4,3	4,8	5,2	5,6	6,0	6,5
		75%	1,1	1,8	2,9	3,8	4,5	5,5	6,8	8,5	9,9	11,3	12,7	14,1	15,5	16,8
		65%	1,3	2,4	3,6	4,7	5,5	6,8	8,5	9,6	11,4	13,0	14,5	16,0	17,3	18,0
Silt and clay	CLASS IV	85%	0,7	0,9	1,7	2,2	20,6	3,0	3,5	3,9	4,3	4,8	5,2	5,6	6,0	6,5
		75%	1,3	2,3	3,3	4,3	5,0	6,5	7,8	9,5	10,6	12,2	13,5	15,0	16,3	17,0
		65%	1,3	2,4	3,6	4,7	5,5	8,0	10,5	12,5	15,0	17,6	20,0	22,0	24,0	26,0

These Zones Not Recommended

1. No length of pipe installed under conditions specified will deflect more than is indicated; the pipe will deflect less than the amount indicated if specified density is obtained.
2. Embedment Material classifications are as per ASTM designation D2321-72 “Underground Installation of Flexible Thermoplastic Sewer Pipe.”
3. Deflections listed in table are maximum long-term values. Recommended maximum deflection is 7-1/2%.
4. Listed deflections are those caused by soil loading only and do not include initial out-of-roundness, etc. Source: Utah State University

Installing the Pipe

Inspection

You should inspect the pipe's exterior and interior, and accessories, for defects, foreign matter or dirt; then clean, replace or repair any unsound material before lowering it into your trench.

Lowering Pipe and Fittings into Trench

By hand, or using ropes and skids, slings on a backhoe, or other appropriate equipment, carefully lay the pipe and fittings into the trench. Never throw them or allow them to fall as heavy impact can cause indentations or cracking, which in turn can lead to splitting when the pipe is under pressure. Once the pipe and its accessories are properly laid, give them a final inspection to be sure they sustained no damage.

Cutting the Pipe

Be certain to wear protective eyewear during any cutting operation, ***particularly*** *if you're using power tools.*

Cutting AQUALOC Pressure Pipe and DURALOC Sewer Pipe
You can easily cut PVC pipe with a fine-toothed hand saw, a portable Skil® saw with a steel blade or abrasive disks, a power saw or a hacksaw. You must cut ends squarely and remove any burrs. Do not force-feed the tool in a manner that causes burns. A better cut will be obtained if the saw blade has not previously been used to cut metal. With smaller diameter pipe, you may use a hand saw with a miter box. When you're working with larger pipe, roll the pipe on level ground to scribe a cutting line around the entire pipe circumference to ensure a square cut.

Beveling AQUALOC Pressure Pipe and DURALOC Sewer Pipe
AQUALOC and DURALOC pipe are supplied with the spigot ends beveled, because a joint cannot be made with an unbeveled spigot. If you find it necessary to bevel the pipe end, however, use a factory-finished beveled end as a guide to determine the angle and length of taper. You may bevel the end using a plastic pipe beveling tool which will cut the correct taper automatically, a coarse file or a rasp; you can also use a portable type sander or abrasive disc. Site-cut spigot ends must be similarly beveled with a 15º angle covering half of the wall thickness.

Reference Marks for AQUALOC Pressure Pipe and DURALOC Sewer Pipe
Pipes are supplied with a reference mark on the spigot end indicating the correct depth of insertion inside the bell. Note that when the pipe is used in conjunction with fittings, the depth of the fitting should be checked, because the reference mark on the pipe is applicable to the pipe bell only. If your PVC pipe is not supplied with a reference mark or if pipe has been cut, the reference mark can be re-established by measuring the distance from the spigot end to the factory-installed insertion mark on another length of AQUALOC Pressure Pipe or Duraloc Sewer Pipe of the same size.

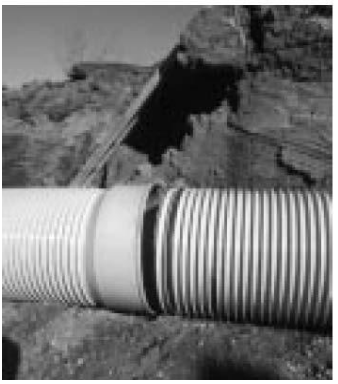
Cleaning and Lubricating the Pipe

AQUALOC Pressure Pipe and DURALOC Sewer Pipe

We supply NEXT POLYMERS DURALOC and AQUALOC pipe with state-of-the-art locked-in gaskets. Follow the steps outlined below to make this connection:

1. Use only NEXT POLYMERS lubricant, which has been tested and approved for use with potable water. We supply only one lubricant for use with both sewer or potable water pipes; therefore, there is no danger of contamination by mixing these up. The use of non-approved lubricant may cause damage to gaskets and increase insertion forces.
2. Make certain the spigot end, the bell end and the rubber gasket are clean and free of dirt or foreign material. Wipe the entire circumference of the spigot end until it's clean and dry to at least 1" (25 mm) beyond the reference mark.
3. With a cloth, sponge, glove or brush apply an even coat of NEXT POLYMERS lubricant around the whole circumference of only the spigot end. Don't apply lubricant too heavily; the coating should be just enough for good coverage, approximating the coating you'd get with one brush coat of enamel paint.

Caution: Be very careful not to allow the newly-lubricated spigot end to touch the bedding or other material that may stick to it, thus creating damage or an impediment that could prevent a tight seal to the gasket and thus cause leaking.



PS

Joining the Pipe

Deflection of the joint is possible with DURALOC but NOT recommended with AQUALOC.

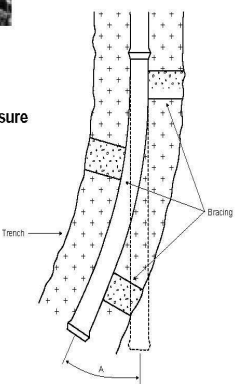
Any deflection must be taken only after joining. See section on **Deflecting DURALOC Sewer Pipe Joints** (page 19).

Align pipes before joining. Pipe assemblies can be made by hand; by using a bar and block, lever pullers or hydraulic jacks; or, if necessary, a backhoe bucket, but only with great care. (However, if you must use a backhoe, place a 4" x 4" [100 mm x 100 mm] board or plank between the backhoe bucket and the edge of the pipe. The backhoe operator will not be able to see if the assembly is complete, so a helper should be located at the joint to signal when proper assembly occurs.) In any case, you should not apply force directly to the edge of the pipe.

It is good practice to lay PVC pipe with bells forward (upstream) so you will pull the spigot into the bell; brace the bell end while you carefully push the spigot end into the bell up to the reference mark on the spigot. Upon completion of the joint, the reference mark should be flush with the bell end of the pipe and remain visible. **Do not assemble the joint beyond the reference point!** Over-assembly of the joint could damage the bell of this or adjacent pipe—the joint may lose its flexibility and leak, or the spigot may squeeze down into the neck of the bell and thereby reduce the pipe's internal diameter.

Curving AQUALOC Pressure Pipe

You may lay smaller diameters of AQUALOC (up to 12" [300 mm]) to the line of a curved trench manually, by bending the pipe barrel into the desired curved shape.



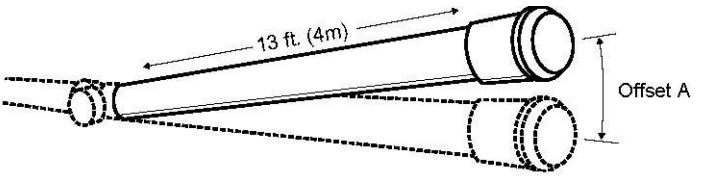
When the barrel is bent to establish the curvature, the minimum radius is approximately 250 times the nominal size of the pipe. Refer to Table 3 on the next page and follow these procedures:

- Make a concentric assembly as you normally would, keeping the spigot in straight alignment with the bell.
- To restrict joint movement while the curvature is being made, compact backfill around the assembled joint.
- Also compact backfill at the inside of the curve, at the midpoint of the pipe length, to form a fulcrum.
- Using manual effort only, move the leading bell of the pipe length to be curved by no more than the offset distance shown in Table 3.

Note: Do not attempt to heat and bend the pipe on site. No attempt should be made to deflect the pipe at the joint. Do not tap bent pipe for services.

Table 3. AQUALOC Pressure Pipe Maximum Recommended Offsets A to Achieve Minimum Radii of Curvature by Bending the Barrel of 20' (610 cm) Lengths

AQUALOC					DR 25, 18			SCR 26
Pipe Size	Maximum Offset A In	(m)	Resulting Angle of Deflection	Resulting Radius of Curvature	Maximum Offset A In	(m)	Resulting Angle of Deflection	Resulting Radius of Curvature
4	24	(610)	5.7°	100′	31	(787)	7.6°	75′
6	17	(432)	4.0°	144′	22	(559)	5.2°	110′
8	12	(305)	3.0°	189′	17	(432)	4.0°	144′
10	11	(279)	2.5°	231′	13	(330)	3.2°	179′
12	9	(229)	2.1°	275′	11	(279)	2.7°	213′



Deflecting AQUALOC and DURALOC Pipe Joints

Joint deflection is an acceptable means of achieving curvature in sewer pipelines; however, do not combine this with the above method of curving the pipe barrel. The close tolerances of the joints limit the amount of unstressed deflection that can be taken by simply offsetting a straight length of pipe. To deflect the pipe correctly:

- Make a normal concentric assembly, but push the spigot into the bell to a point only about 1/2" (13 mm) short of the reference line (push to the first reference line, if there are two). This incomplete assembly allows the end of the pipe more movement at the bottom of the bell.
- Immediately shift the loose bell end of the assembled length by no more than the following recommended offsets; again, use only manual effort:

Table 4

Maximum Recommended Offsets A to Achieve Minimum Curve Radius by Deflecting a Straight 14' (4.27m) DURALOC Pipe at the Joint

Pipe Size	Maximum Offset A		Angle at Bell
	In	mm	degrees
4'' (100mm)	8 1/8	207	3
6'' (150mm)	8 1/8	207	3
8'' (200mm)	8 1/8	207	3
10'' (250mm)	8 1/8	207	3
12'' (300mm)	6 7/8	174	2.5
15'' (375mm)	6 7/8	174	2.5

Maximum Recommended Offsets A to Achieve Minimum Curve Radius by Deflecting a Straight 20' (6.1 m) AQUALOC Pipe at the Joint

Pipe Size	Maximum Offset A		Angle at Bell
	In	mm	degrees
4'' (100mm)	12 3/8	315	3
6'' (150mm)	12 3/8	315	3
8'' (200mm)	12 3/8	315	3
10'' (250mm)	12 3/8	315	3
12'' (300mm)	10 1/4	260	2.5
14'' (350mm)	6 1/8	155	1.5
16'' (400mm)	6	153	1.5

Installing Fittings and Accessories

Fittings

A vast array of fittings are available from NEXT POLYMERS for both sewer and water pipe, all designed for use with PVC pipe with bell and spigot ends or bell-by-bell. For AQUALOC, they may be gasketed push-on in PVC or ductile iron or mechanical joint ductile iron. For DURALOC, a full line of molded and fabricated fittings as well as cut-in service fittings is available.

Use NEXT POLYMERS's recommendations for joining if you're using gasketed fittings. Check the fitting for the correct insertion depth. ***The reference mark on the pipe applies to the pipe bell only and may not be suitable for the fitting.***

If you're using solvent cement fittings, your joining method should be that recommended by the manufacturer or as prescribed in ASTM D2855: Standard Recommended Practice for Making Solvent Cement Joints with Polyvinyl Chloride (PVC) Pipe and Fittings.

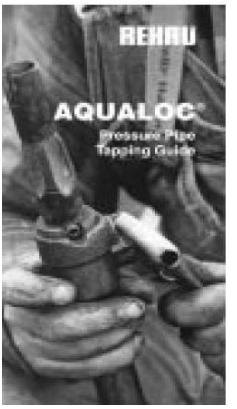
Special Considerations for AQUALOC Pressure Pipe
Fittings for AQUALOC pressure pipe are available in PVC, cast and ductile iron, mechanical joint and push-on ends.

Mechanical joints. Take care to individually support cast or ductile iron fittings or valves independently of the pipe to avoid differential settlement and deformation. To anchor valves and hydrants properly, use thrust blocks to prevent force from being transmitted to the pipe. The full weight of any metal fittings and valves used with PVC pipe should not be carried by the pipe.

When you're assembling PVC pipe to mechanical joint cast iron bells, the bevel on the pipe must be trimmed off to provide a square end. The plane of the cut must be at a right angle to the centerline of the pipe. Insert the plain end of the PVC pipe fully into the mechanical joint bell. For 4" through 12" pipes, tighten the mechanical joint tee-bolts to a torque 70 to 80 ft/lb (95-108 Nm). Do not attempt to deflect MJ joints.

Note: If you are assembling heavy-wall PVC pipe such as DR18 to butterfly valves, there's a slight possibility that the inside edge of the pipe may interfere with the disc's swing. If so, use a 1/2" (13 mm), 45º chamfer on the inside edge of the pipe spigot to provide the clearance you need.

Special Considerations for DURALOC Sewer Pipe
Long- and short-radius bends, adapters, and couplings may be purchased from numerous suppliers for connecting PVC sewer pipe. It is your responsibility to ensure that the material, dimensions and joining procedures are compatible with the pipe being used. Again, if you're in doubt, consult your NEXT POLYMERS Regional Sales Office.



Service Connections
AQUALOC Pressure Pipe Tapping
Please refer to NEXT POLYMERS's AQUALOC Pressure Pipe Tapping Guide, which is available by contacting any NEXT POLYMERS Regional Office.

Connecting to the Main with DURALOC Sewer Pipe
DURALOC requires that you make service connections to the main by PVC Wyes, Tees and gasketed saddles or insertable fittings. Generally, these fittings have gasketed bell-end outlets.

Special Considerations for DURALOC Sewer Pipe

Cut-in fittings. Cut-in fittings such as the Fowler Inserta Tee™ provide connections to DURALOC with similar installation procedures. These fittings provide for tight connections and make servicing of existing lines easy by reducing the amount of excavation required.

Certain precautions should be taken when making a field cut-in connection. Make every effort to prevent the entrance of foreign matter into the pipe opening either (1) during assembly of the sewer saddle and before connection is completed to sewer stub pipe, or (2) until the saddle inlet has been capped or plugged, should the stub pipe be connected later. Likewise, the sewer stub pipe should be capped or plugged at its terminating point where the house sewer line is to be installed later. Printed installation procedures are available with each fitting and any further information can be obtained by contacting your NEXT POLYMERS sales office.

Manhole connections. When you are connecting PVC sewer pipe to manholes by grouting in directly, we recommend a bell-ended manhole sleeve which has a coating of sand to allow for a proper bond to the concrete. As PVC pipe will not bond directly with concrete, this sleeve is coated with a granular material to provide the bond. You may install the sleeve in the manhole forms prior to

pouring the concrete or, if you're using prefabricated manholes, grout the sleeve in place at a later time—but some form of seal or water stop is required if there is to be a watertight connection between the pipe and concrete structures.

Manholes prefitted with gaskets are available for direct connection to DURALOC solid wall sewer pipe.

Flexible boot connections are available allowing connection to DURALOC. The procedure here can involve a manhole adapter with the profile wall pipe for connection to the boot.

Installing Saddles on DURALOC Sewer Pipe

Wye or Tee saddles. The steps for installing Wye or Tee saddles on DURALOC solid wall PVC pipe with solvent cement follow. Determine the saddle location. On the main, cut a hole whose shape and location you can mark by placing the saddle on the main as a template (without cementing).

1. Using the hole mark as a guide, drill the hole through pipe wall 1/2" (13 mm) outside the hole guide mark.
2. You may use a keyhole-, jigsaw- or shell-cutter to cut the entire piece out. If you use a saber saw with heavy duty blades, you should hold the blade horizontally across the pipe and press it downward until it penetrates the pipe wall. Then the blade can be brought to the vertical position and the hole cut completed. Remove the waste piece and smooth the edges with file or scraper.
3. Apply PVC cleaner with a clean rag or absorbent towel to the underside of the saddle and the area marked on the main. When the area is dry, apply a primer first and etch the surfaces.
4. While the surfaces are still wet, apply a liberal coat of PVC cement with a natural bristle brush (not nylon) to the area previously cleaned. Within one minute, locate the saddle firmly on the main and hold it in place for at least one minute.
5. Immediately position the saddle over the hole in the pipe and draw down with metal straps or other suitable means. Don't move the saddle once it makes contact with the pipe. Under normal conditions (temperature 70ºF [21ºC]) the joint, when properly made, will reach 50% of its ultimate strength in 24 hours.

Carefully select the appropriate backfill material (see **Selection of Embedment Materials**, page 10) and tamp it around the pipe and saddle to provide firm and continuous support for both.

Caution: When you're assembling solvent weld PVC sewer saddles onto PVC pipe, toxic fumes are given off. In confined areas, sufficient concentrations of these fumes can accumulate to cause nausea and/or dizziness.

Installing Saddles on DURALOC Sewer Pipe (cont.)

Because of this we recommend:

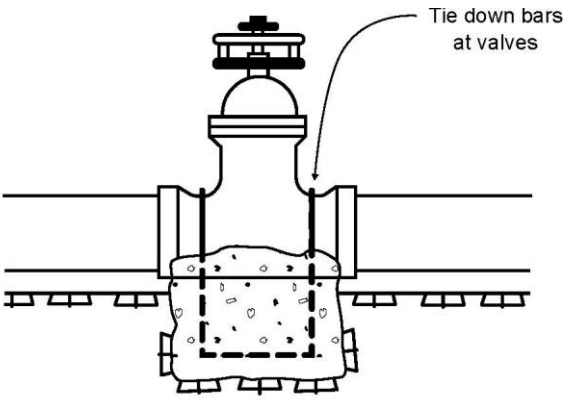
- that saddles be installed above ground where possible, or in areas with good air circulation, and
- that you use a blower in confined areas with poor natural air circulation.

If the above installation environmental conditions are not possible, wear a respirator; the proper one to use is one approved under the Bureau of Mines Schedule 23 as manufactured by MSA, American Optical Corp., Willson Products, Welsh Manufacturing, etc., for protection against organic vapors.

Gasketed saddles. The steps for installing gasketed saddles on DURALOC solid wall PVC pipe are similar to the procedures for installing Wye and Tee saddles.

1. Place saddle in position on pipe. Use the saddle as a template and mark guide for hole cut-in. Remove saddle from pipe.
2. Using hole guide mark, cut hole through pipe wall outside the hole guide mark by the thickness of the saddle stem. The diameter of the hole should not exceed the outside diameter of the saddle stem by more than 1/4" (6.5 mm). Use a hand keyhole or power saber saw to cut the hole. For most saber saws with heavy duty blades, the blade should be held horizontally across the pipe and pressed downward until it penetrates the pipe wall. Then the blade can be brought to the vertical position and the hole cut completed. For Wye saddles, cut or bevel the downstream end of the hole at a 45º angle to allow the saddle stem to fit.
3. Wipe clean and dry both the underside of the saddle and the mating surfaces of the pipe.
4. Position saddle over the hole. Place two stainless steel hose clamps around the pipe and through the slots at each end of the saddle skirt. Check to see that the saddle stem is recessed in the hole and that the straps are at right angles to the pipe surface.
5. Alternately tighten straps with a large screwdriver with a good grip until the maximum torque has been reached by hand. The minimum torque applied should be 5 ft/lbs (6.75 Nm).
6. Backfill should be carefully selected and tamped around pipe and saddle to provide firm and continuous support for both.

Note: If saddles are not properly positioned, the rubber gasket may not be in full contact with the pipe, possibly resulting in a leak.



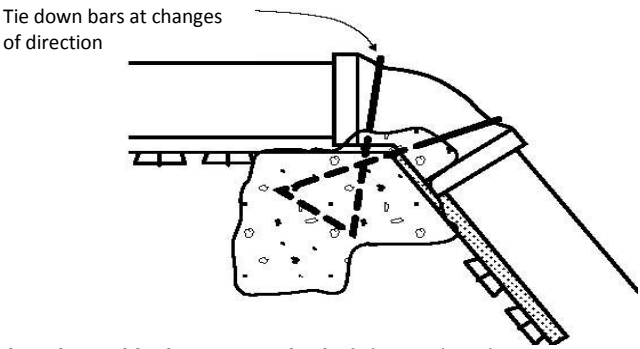
Thrust Restraint for AQUALOC Pressure Pipe Thrust Blocking

Thrust is affected by and related to the size of the pipe. It is caused by the pressure and velocity of the fluid flowing through the pipe. Wherever it is expected to occur, thrust should be blocked or restrained, usually under the following conditions:

- ***at valves***—all valves should be anchored, regardless of their location or frequency of use, by installing anchoring rods around the valve body or through the mounting lugs. The rods can then be embedded into concrete poured under the valves themselves;
- ***under high pressure conditions***—whenever a valve is closed, thrust is created, which again dictates that all valves be anchored;
- ***at changes in direction (vertical or horizontal)***—at any fitting that allows water to change its course—at tees or elbows, for example— you will need to restrain internal pressure and the effects of velocity. If upward thrust is expected to occur, the fitting should be anchored like a valve, using a concrete pour to firmly affix it to surrounding soil; and
- ***at reductions in size***—any thrust occurring here depends on the amount of the reduction, so you will need to restrain it accordingly.

Planning for thrusting. The size and type of the thrust block depends on several factors: the maximum pressure to which the pipe will be subjected, the kind of soil in the trench and the types of fittings you are using. For instance, if you expect thrusts due to high pressure, anchor the valves as shown.

At vertical bends, anchor to resist outward thrusts. Where a fitting is used to make a vertical bend, anchor the fitting to a thrust block braced against undisturbed soil. The thrust block should have enough resistance to withstand upward and outward thrusts at the fitting.



Calculating thrust block area required. If the engineering specs don't call for a specific size thrust block, the block size is determined as follows:

Calculate the total area that the block must cover—i.e.:

$$A = \frac{\text{Total thrust}}{\text{Safe bearing load of soil}}$$

Table 5
Thrust at Fittings at 100 psi Water Pressure

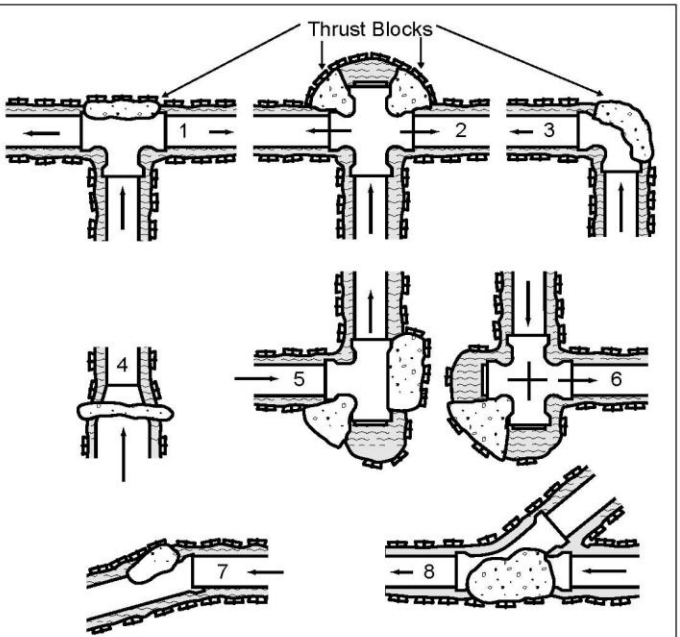
Pipe Size In	90° Bend lbs	45° Bend lbs	22.5° Bend lbs	Tee or Dead End lbs
4	2560	1390	635	1810
6	5290	2860	1370	3740
8	9100	4920	2320	6430
10	13680	7410	3610	9680
12	19350	10470	5080	13690

Table 6
Safe Bearing Load of Soils (lb/sq ft)

Muck, peat and similar	0
Soft clay	500
Sand	1000
Sand and gravel	1500
Sand and gravel cemented with clay	4000
Hard shale	5000

For example, assume 90º bend for 4" pipe and a pressure test of 150 psi. The soil is sand.

1. Refer to Table 5. The thrust block pressure at 100 psi for 4" pipe at a 90º bend is 2560 lbs.
2. Refer to Table 6. The safe bearing load for sand is a minimum of 1000 lbs/sq ft.
3. Thrust equals 150 psi/100* 2560 lbs = 3840 lbs
4. The area of the thrust block required is 3840 ÷ 1,000 lb/sq ft = 3.84 sq ft



1. Tee
2. Cross used as tee
3. Direction change, elbow
4. Reducer or taper
5. Direction change, tee used as elbow
6. Direction change, cross used as elbow
7. Direction change
8. Wye

Arrow indicates direction of flow

Typical Thrust Block Arrangements for AQUALOC Pressure Pipe

Where AQUALOC pressure pipe passes through soils with limited bearing attained, adequate thrust resistance may be concrete or corrosion resistant tie rods to connect fittings to concrete thrust blocks.

Using mechanical thrust restraints with AQUALOC Pressure Pipe.

These devices will usually provide all the thrust restraint you need in sizes up to 12" (300 mm). Some clamp to the wall of the pipe and tie back to a matching collar on the fitting or the pipe bell. As we mentioned above, you will probably need to use mechanical thrust restraints in conjunction with a concrete pour in sizes over 12" (300 mm), or you could group several thrust restraints to join two or three lengths of pipe on either side of the fitting, a technique utilizing the clamping effect of the backfill around the pipe barrel. If you use a thrust restraint device, be sure the maximum pressure in the pipeline does not exceed the pressure rating of the device. UNIFLANGE™ and EBAA IRON™ are two manufacturers producing restraint fittings which are rated for use with PVC pipe.

Installing Tapping Sleeves and Valves for AQUALOC Pressure Pipe

Tapping sleeves can be used for making large taps under pressure. AQUALOC PVC pressure pipe can be tapped size to size, i.e., 6" (150 mm) outlet in 6" (150 mm) pipe, 8" (200 mm) outlet in 8" (200 mm) pipe, etc.

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 should be specified to assure that the sleeve furnished will be satisfactory.

Tapping sleeves should be assembled in accordance with the manufacturer's directions. Drilling equipment can be bought 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.

Tapping sleeves should be well supported independently of the pipe during the tapping, and the support used should be left in place. Thrust blocks should be used as with any other fitting. The following table gives the recommended minimum laying lengths of tapping sleeves for the various main and tap sizes of PVC class water pipe.

Table 7 Recommended Minimum Lengths of Tapping Sleeves for AQUALOC Pressure Pipe

Main and Tap Size	Approximate Laying Lengths	
In	In	mm
4 x 2, 4 x 3, 4 x 4	16	406
6 x 2, 6 x 3, 6 x 4, 6 x 6	18	457
8 x 2, 8 x 3, 8 x 4, 8 x 6	19	483
8 x 8	21	533
10 x 2, 10 x 3, 10 x 4, 10 x 6	19	483
10 x 8, 10 x 10	23	584
12 x 2, 12 x 3, 12 x 4, 12 x 6	19	483
12 x 8	21	533
12 x 10, 12 x 12	25	635

PS

Backfilling, Haunching and Tamping

Initial backfilling and haunching provide essential support to the sides of the pipe by allowing the pipe and the soil to handle load requirements, and they protect the pipe from damage. To backfill and haunch the trench properly:

- Use the proper backfill materials (see **Embedment Materials**, page 9) to fill and compact above the bedding, around the pipe along the sides up to the spring line, and out to the side walls of the trench.
- Be certain, when you finish, that you've backfilled the trench at least 12" (300 mm) over the pipe and fully between the trench walls, in accordance with the engineer's specifications.

Haunching

Haunching is most important in terms of limiting the deflection of a flexible pipe. This is the area that must be compacted to the required or specified density. Loose material should be placed in the trench alongside and, in particular, under the haunches of the pipe, in layers not exceeding 4" (100 mm). This material should be well laid and consolidated between the pipe and trench wall. Proceed upwards in 4" (100 mm) increments to the spring line of the pipe.

If you use self-compacting material like crushed stone, be certain that the material doesn't leave arched pockets on bridges beneath the haunch.

Initial Backfill

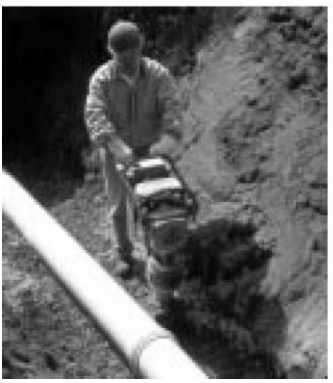
Follow your pipe assembly with backfilling as soon as you can to help protect the pipe from flooding, shifting or damage due to temperature extremes.

The first step in your bedding and haunching procedure is to tamp the embedment materials under the haunches and around the pipe to the spring line of the pipe; this step is critical to providing effective support for the pipe. Be sure you have met all ASTM D2774 requirements for embedment, and that you select backfill material that has good drainage properties and is free of sharp stones, rocks, clods and frozen material; the maximum particle size should be 1-1/2" (38 mm) although 3/4" (19 mm) is preferable. Granular material is ideal. Unless otherwise specified, you should backfill and compact trenches under pavements, sidewalks or roads to 90% density, as determined by the American Association of Highway and Transportation Officials Method T99 for State Compaction and Density of Soils.

By hand, consolidate the bedding by tamping layers around the pipe barrel to a height of 12" (300 mm) only above the crown of the pipe. After testing, cover the exposed joints in exactly the same way and with the same care that you covered the pipe body. After you have completed initial backfilling by hand, you may finish with machine backfilling.

Unless otherwise directed by the engineer, do not compact the initial backfill directly over the pipe, only on either side.

Note: If you use hydro-hammers, do so with great care; they may be used at distances greater than 3' (900 mm) above the top of the pipe if the soil has been compacted to a minimum of 85% Procter density. However, do not use rolling equipment until you have placed a minimum of 18" (450 mm) of backfill material over the top of the pipe.

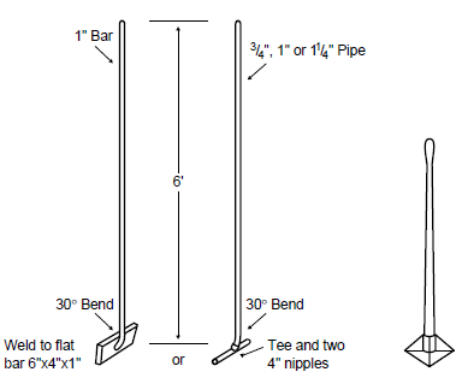


Tamping Equipment and Methods

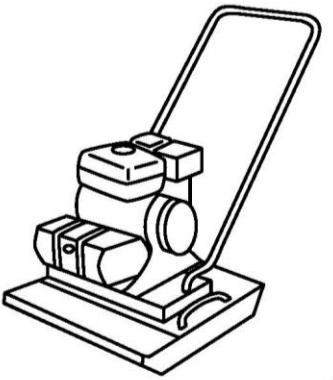
To consolidate your embedment material, you can use hand tamping bars or mechanical tampers. If you hand tamp, you'll find you get the best results if damp, loamy soil or sand makes up your embedment material. You'll find mechanical tampers better for more cohesive soils, and water tamping is best reserved for trenches from which water drains easily. However, regardless of the tamping method you use, remember it's important that you place the embedment material into the trench by hand, and simultaneously eliminate any voids or air pockets around the pipe.

Tamping Bars

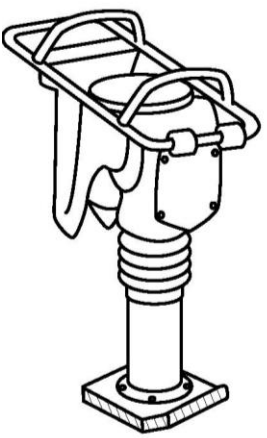
You'll need two tamping bars: one with a narrow head, for tamping under the pipe; the second with a flat head, for compacting soil out from the sides of the pipe to the trench edges. Use each tool only for the tamping job it's designed to do, or you won't get satisfactory results.



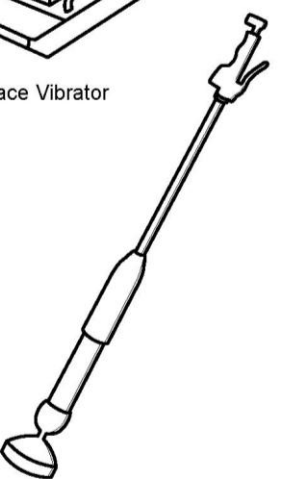
Haunching and compacting tools



Surface Vibrator



Wacker
(Courtesy Wacker Corp.)



Pogo Stick

Mechanical tamping equipment (Courtesy American Pneumatic Tool)

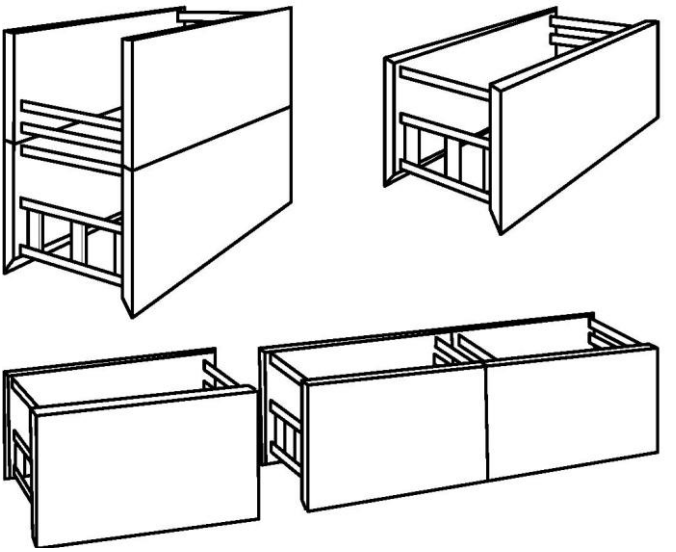
Mechanical Tampers

A danger in using a mechanical tamper is that it can damage the pipe, so be careful to avoid bringing the two in contact. It's a good idea not to tamp directly on the top of the pipe and to begin compacting only after enough backfill material is above and around the pipe to protect it from damage or deflection.

Impact compaction devices are often used in trenches to compact the space between the pipe and trench wall. Vibration compaction works best for clean fines and gravels.

Water Jetting

Do not use pressurized water to compact the embedment material of PVC pipe or of any other flexible conduit.



Sheeting and Trench Boxes

Note that wherever you use a trench box or sheeting around the pipe, you're likely to create voids or air spaces when you remove it; these must be filled so the pipe stays securely supported. Fill the spaces with bedding material and be sure to compact it sufficiently to restore adequate support to the pipe. If you use a trench box, it should be designed so that the back end of the box sides do not extend below the spring line of the pipe. Likewise, if you install the sheeting so that its bottom extends no lower than the spring line of the pipe, you should be able to pull it out without disturbing the embedment material that is providing side support for the pipe. If heavy wooden sheeting has to be pulled, however, place well graded granular material on each side of the pipe for a distance of at least two pipe diameters. The granular material should be compacted to at least 90% Proctor density.

Final Backfill

You needn't be as concerned with this backfill material as you were with the initial backfill. The final backfill has no appreciable effect on pipe performance, but you should be careful to do nothing above the pipe zone that will alter the previously compacted backfill.

Carefully inspect the trench before final backfilling to detect and remove any loose stones which may have fallen into it. After this and any other problems have been addressed and resolved, place the final backfill by mechanical means in a conventional manner. As always, take care to avoid including large stones (anything over 4" [100 mm] in diameter) which could damage the pipe by falling on it or by being forced down on it under the weight of the backfill. In wet conditions, place backfill immediately to prevent pipe floating.

Special Installation Conditions

Anchorage of Pipe on Slope

If you're backfilling with well-drained soil, carefully tamped in to at least 4" (100 mm) layers up to the top of the trench, you should not have any slipping problems on slopes up to 20º. On steeper slopes, however, you will need anchors at every third length of pipe. Place the bells facing uphill and anchor every third bell to the soil. There are several ways to do this:

- Use a mixture of cement keyed into the ground; the engineer can specify a different, special backfill material.
- Use solvent-welded joints for short sections of the pipeline.
- Lay the pipe with the bells facing uphill and pour a concrete block behind the bells which you then key into the sidewalls of the trench.

Cold Weather Installation

PVC pipes can be laid at low temperatures, even below zero, but take care—PVC's impact resistance lowers as temperature lowers. Since the lubrication stiffens at low temperatures, store it in a heated place when you're not using it—this could be the construction shack or the cab of the backhoe.

When you're installing PVC pipes at low temperatures, take extra care during the following procedures:

- handling, as excess impact can cause breakage;
- installing pipe on a frozen bed or backfilling with frozen material; or
- cutting, tapping and drilling pipe. Do not force the equipment. Use sharp drills and cutters.

Deep Sewer Chimney or Risers for DURALOC Sewer Pipe

The engineer should direct the final backfilling around chimneys or risers to prevent damage to these structures. Similarly, the engineer will direct your final backfill where anticipated surface loads may appear, since the final backfill's density must be consistent with those expected loads.

Installing Pipe through Casings for AQUALOC Pressure Pipe and DURALOC Sewer Pipe

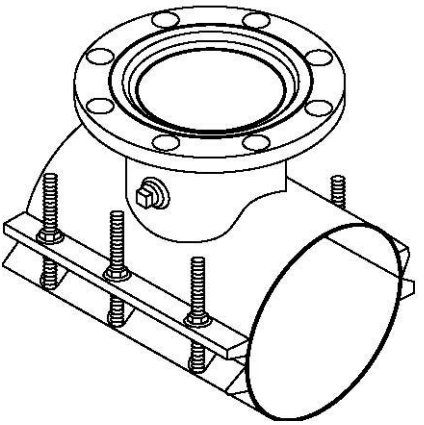
When crossing highways and railroads, PVC pipe should be installed inside a casing as directed by the project engineer. The pipe casing material must provide sufficient structural strength to support earth loads and live loads and keeps these from being transmitted to the PVC pipe. Because of its light weight, PVC pipe can be easily pushed or pulled into a casing.

The casing's inside diameter must be sufficient to accommodate the maximum outside diameter of the pipe bell without allowing any significant movement of the pipe once it is subject to pressure or head.

Note: For complete dimensional data on NEXT POLYMERS AQUALOC or DURALOC pipe, please refer to the latest version of the product brochures.

Proper installation and spacing of the pipe in the casing requires wooden skids or pre-manufactured casing spacers. Wooden skids should not be treated with any preservative materials which would damage the PVC pipe. Pipes over 12" (380mm) may require two skids to ensure that no part of the barrel or bell is in contact with the casing. The project engineer should provide a design for wooden skid-spacer arrangements which includes adequate spacers, strapping and blocking to properly support the pipe.

Over belling the pipe while it is being pulled through the casing one set of skids can be placed with their ends even with he insertion line on the spigot end of each pipe.



As an alternative to wooden skids and spacers, manufactured systems are available in standard sizes consisting of metal clamps with nylon spacers. Manufacturers of pipe restraint systems such as Uniflange may also offer attachments for restrainers for this purpose.

Testing Pipelines

Pressure Testing AQUALOC Pressure Pipe

Tests are necessary to verify that the pipeline can withstand normal pressures plus occasional excesses which, if the line has been designed properly, will be kept in check by automatic relief valves, slow closing and opening of valves, slow pump starting, and other controls. Unless the engineering specifications call for a greater pressure, 50 psi (330 kPa) above the normal working pressure should be sufficient in most cases. The test pressure should never exceed the maximum pressure rating of the pipe.

Maximum test pressure for DR 26 is 160 psi (1100 kPa). Hydrostatic testing is to be carried out at the direction of the engineer. Beware of where you locate your gauge. If it's too high in the line, it may give you a false low reading, and since the actual pressure will be higher than that, you may accidentally subject the line to too much pressure during testing. Before you actually begin filling the line with water (never use air), check that you have:

- checked pressure ratings of all fittings;
- backfilled enough (a minimum of one and one-half pipe diameters) to prevent movement during the test (try using a plumb bob over the pipe to detect movement as the pressure builds); for DR 18 and DR 25 it is 235 psi (1620 kPa) and 165 psi (1140 kPa) respectively;
- allowed the minimum three days to allow concrete thrust blocks to cure;
- provided for air to escape from the upper part of the line as the water fills it; and
- blocked the test cap or plug adequately (thrust forces that

can develop even at low forces are powerful).

The pipeline shall be placed in service only after it has been cleaned and disinfected in accordance with the engineer's specifications.

Begin filling the line at the preferred rate of 1' (300 mm) per second (but not in excess of 2' [600 mm] per second, because an overly-aggressive filling rate could cause water hammer effects from any available low pressure source. The following table shows the approximate volume of water required.

Table 8

Approximate Volume of Water Required in U.S. Gallons (Liters) per 100' (30.3 m) of AQUALOC Pipe

Pipe Size		U.S. Gallons	Liters
in	mm	per 100'	per 100'
4	100	70	265
6	150	153	579
8	200	259	980
10	250	405	1533
12	300	573	2169

Testing DURALOC Sewer Pipe

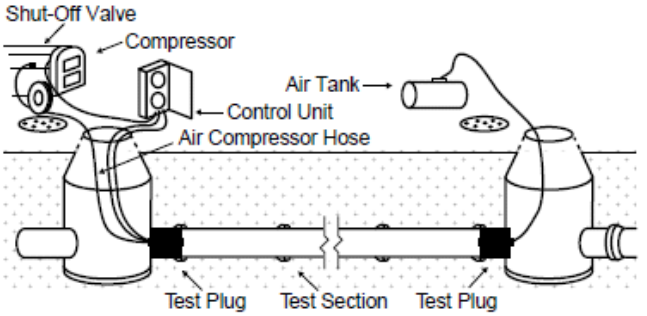
Deflection Testing

Unless the engineer specifies otherwise, do not allow long-term pipe deflection (reduction in base inside diameter) to exceed 7.5%. Deflection testing is unnecessary when using proper construction practices and inspection during installation, but the engineer may require the contractor to perform random deflection tests between successive manholes. Recommended mandrel dimensions based on 7.5% deflection are as shown in Table 9.

Table 9
Recommended Mandrel Dimensions
(DURALOC)

Pipe Diameter		Mandrel O.D.	
in	mm	in	mm
6	1542	5.31	135
8	203	7.09	180
10	254	8.84	225
12	305	10.51	267
15	381	12.86	327
18	457	15.70	399
21	533	18.5	470
24	610	20.8	528
27	686	23.44	595

Note: Derivation of these values is shown in ASTM D3034 and ASTM F679.



Air Testing for DURALOC Sewer Pipe

Minimum time requirements. If the engineer or site conditions indicate that an air test be performed, the engineer should oversee it. We recommend that the minimum allowable time requirements for a 0.5 psig pressure drop from 3.5 psig to 3.0 psig be in accordance with Table 10.

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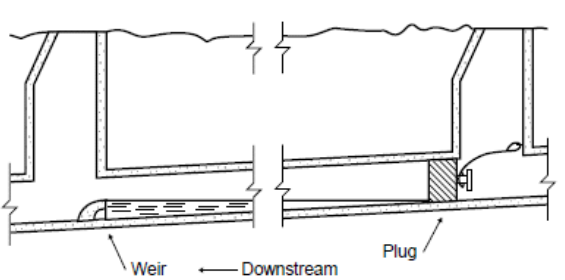
Pipe Size (in)	Pipe Size (mm)	Time
4	100	1 min., 53 sec.
6	150	2 min., 50 sec.
8	200	3 min., 47 sec.
10	250	4 min., 43 sec.
12	300	5 min., 40 sec.
15	375	7 min., 05 sec.
18	450	8 min., 30 sec.
21	525	9 min., 55 sec.
24	600	11 min., 20 sec.
27	675	12 min., 45 sec.

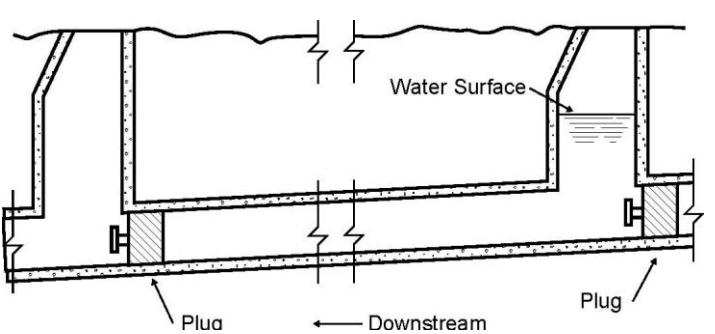
Relieving air from pipeline. You should vent air from all high spots in the pipeline before making either pressure or leakage tests. We recommend automatic air release valves, because compressed, entrapped air makes pumping to the required pressure for a test very difficult; in addition, the pipeline could leak compressed air when it is actually watertight, leading to confusing test results.

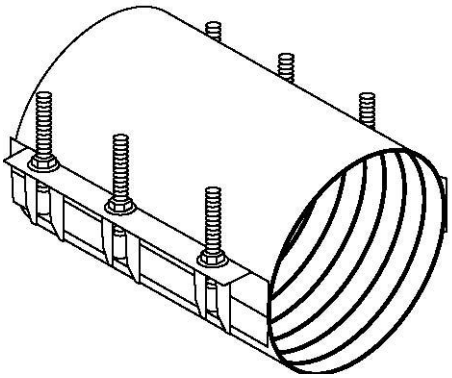


Allowable infiltration. When high ground water exists and the infiltration test is permitted, the engineer shall give explicit instructions for conducting the test. The maximum allowable amount of infiltration rate measured by test shall be 50 U.S. gallons per inch of pipe diameter per mile per 24 hours. Should any test on any section of pipeline disclose an infiltration rate greater than permitted, the contractor shall locate and repair defective joints or pipe sections. After repairs are completed, the lines shall be retested until the infiltration is within specified allowance.

Allowable exfiltration . When an exfiltration test is required, the engineer shall give explicit instructions to be followed in carrying out the test. The maximum allowable exfiltration rate measured by test shall be 50 gallons per inch of pipe diameter per mile per 24 hours. The average internal pressure in the system under test shall not be greater than 5 lbs per square inch (11.6' head [354 cm]), and the maximum internal pressure in any part of the system under test shall not be greater than 10.8 lbs per square inch (25' head [762 cm]).

Should any test of any section of pipe disclose an exfiltration rate greater than permitted, the contractor must locate and repair defective joints or pipe sections. After repairs are completed, the line shall be retested until the exfiltration rate is within the specified allowance.





Repairing Pipelines

Customary Repair Procedures

1. Excavate the area extending 5' (152 cm) on each side of the break.
2. Cut out the break, ensuring that no damaged pipe remains.
3. Measure the gap, then cut a replacement piece of pipe, allowing 1/4" (6 mm) clearance on each side.
4. **For DURALOC Only:** Bevel the spigot ends of the replacement (repair) section as described earlier. This need not be done if you use repair clamps.
5. Make insert marks at both ends of the repair section that correspond to one-half the length of the repair coupling or clamp.
6. Insert the repaired section in the gap between pipe to be repaired, align and slide the repair coupling, center it over the joints (to the insert mark on the repaired section), or attach repair clamps, centering them over the joint.
7. Ensure that the entire area is re-established to correct bedding requirements. Some jurisdictions may call for anchoring the repair coupling with restraint clamps or thrust blocks. Do not attempt to leave a bell end or use a bell end in the repair since deflection of the bell can cause stress and damage the pipe.

AQUALOC can be repaired by replacing the damaged pipe, inserting a repair coupling, installing a repair clamp, or other technique approved by the engineer. A localized repair is possible with watermain pipe where there is no structural or stress damage such as an ineffective or relocated service tap. In this case, a repair clamp can be used. Care must be taken to follow manufacturer's instructions. DURALOC sewer pipe can be repaired using manufactured push-on repair couplings. A single clamp application for localized repair is possible for DURALOC.