Installation Guide for PVC Pressure Pipe

This installation guide has been developed by North American Pipe Corporation for use as a field installation guide. General information regarding the correct installation of PVC pressure pipe and assembly of integral bell gasketed joints is included.

For more detailed technical information, refer to American Water Works Association C605, "Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water." This installation guide outlines design and construction practices.

The statements contained in this installation guide are those of North American Pipe Corporation and are not warranties, nor are they intended to be warranties.

RECEIVING

When a load of pipe arrives at a job site, it is your responsibility to check it thoroughly. If possible, inspect each piece for damage. Check quantities against the shipping list. Note missing or damaged items on bill of lading. Set aside any damaged items and notify the shipper.

UNLOADING

It is also your responsibility to unload the shipment. DO IT WITH REASONABLE CARE. Careless unloading can result in damaged product or personal injury.

Use a fork-lift or front-end loader with fork attachment, if available. Ensure the fork attachment is long enough to support the bundles. When unloading by hand, remove one piece at a time, and block the shipment to keep pipe from rolling off the truck.

STORAGE

If you can unload the shipment in unit packages, the pipe will be easier to store. Stack it on reasonably level ground. If you unload one piece at a time, place the pipe bevel to bell. Never stack over eight feet in height. Don't stack the pipe next to heat sources such as boilers, steam lines, electrical equipment or engine exhausts. Gaskets should also be protected from heat, oil and grease.

HANDLING

DO NOT DROP THE PIPE. String pipe close to the trench with the bell ends pointing in the direction of work progress to save extra effort. Be particularly careful in very cold weather. The following table provides approximate weights only and is provided for use as a guide in selection of handling equipment.

Weight of 20-foot pipe lengths (pounds)

Nom. Size in (mm)	DR 51	DR 41	DR 32.5	DR 26	DR 25	DR 21	DR 18	DR 14
4 (100)	--	--	--	31	37	38	51	64
6 (150)	--	--	--	67	77	82	105	132
8 (200)	--	--	--	115	132	140	180	227
10 (250)	--	--	--	179	199	219	271	342
12 (300)	--	--	--	252	281	307	383	484
14 (350)	190	239	299	304	385	--	525	--
16 (400)	--	310	388	400	499	--	684	--
18 (450)	315	391	489	515	630	--	862	--
20 (500)	390	484	608	636	783	--	1078	--
24 (600)	560	694	871	916	1121	--	1540	--
30 (750)	860	1074	1346	--	1732	--	--	--

TRENCHING

Clean trenches save time and money. Don't let the excavated material block sidewalks, drive or utility outlets. Follow all safety rules and regulations. Protect workers with sheeting and trench boxes in hazardous areas and slope walls in dry soils. When sheeting or trench box is moved, make sure the pipe is not moved and the side support material is not disturbed.

WIDTH OF TRENCH

The width of the top of the trench will be determined by local conditions. At the pipe zone, the trench width should be kept to a practical minimum.

The minimum clear width of the trench measured at the springline of the pipe is generally specified at least one foot greater than the outside diameter of the pipe to enable backfill material to be installed in the haunching area. Where embedment compaction is required, the trench shall be wide enough to accommodate the compaction equipment. If minimum trench width is exceeded, and embedment compaction is required, pipe zone haunching should be compacted to a point at least one pipe diameter from the pipe on both sides of the pipe.

DEPTH OF TRENCH

For water distribution and transmission lines, pipe should be buried so that the top of the pipe is at least 6 inches (150 mm) below the deepest recorded penetration of frost. Where surface loads will be encountered and where frost is not a problem, the minimum height of cover over the crown of the pipe is 12 inches (300 mm).

THE BOTTOM OF THE TRENCH

The objective of bedding is to provide a continuous support for the pipe at the required line and grade. Frozen material should not be used to support or bed the pipe. At least 4 inches (100 mm) of bedding material should be placed under the pipe if rocky conditions exist. The bedding may or may not be compacted, but in any event, the projecting bells of the pipe should be properly relieved in the trench bottom so that the entire pipe is evenly supported by the bedding. Where the trench bottom is unstable (organic material, or “quick” sand or similar material), the trench bottom should be over-excavated and brought back to grade with approved material.

LOWERING THE PIPE INTO THE TRENCH

Place the pipe and fittings into the trench using ropes and skids, slings on the backhoe bucket, or by hand. Do not throw the pipe or fittings into the trench or allow any part of the pipe to take an unrestrained fall onto the trench bottom. At this point, the pipe and other accessories are in a good position for final inspection. Ensure there are no damaged materials before assembly begins.

FIELD CUTTING

PVC pipe can be easily cut with a hacksaw or power-driven abrasive disc. Be sure you make a square cut. Bevel the end with a beveling tool, wood rasp or power sander to the same angle as provided on the factory-finished pipe. Remark the insertion line on the spigot using a factory marked spigot as a guide.

ASSEMBLY

The gasket, the groove area behind the gaskets and the pipe spigot ends should be wiped clean. Check each gasket to insure that it is inserted uniformly into the race. DO NOT REMOVE GASKETS FROM THE RACE FOR CLEANING. The gaskets are not removable and will be damaged by attempts to remove them.

LUBRICATION

Lubricant should be applied to the bevel of the spigot end and approximately mid-way back to the insertion line. Apply lubricant to the inside surface of the gasket. Only use supplied or approved lubricants.

PROBLEMS

If you have trouble assembling the joint, disassemble and examine the gasket. Replace if damaged. If gaskets are damaged, cut off the bell, bevel the new edge and use a coupling to assemble. Be sure the gasket is properly seated and both pipe lengths are in straight alignment. Repeat assembly steps. Correct assembly is achieved when the insertion line on the spigot is lined up with the edge of the bell. The insertion line must remain visible at the edge of the bell.

IF NECESSARY

The bar and block method is recommended as a worker is able to feel the amount of force being used and whether the joint goes together smoothly. Larger pipe will require mechanical assistance to apply sufficient force to assemble the joint.

With mechanical devices, care must be taken to insure that the spigot is NOT OVERINSERTED and that previously assembled pipe joints are not disturbed. This is accomplished by inserting only to the insertion line on the spigot end. In all cases, good alignment of the pipe is essential for proper assembly. If the pipe is misaligned, overinserted or assembled with excessive force, the following are possible consequences:

- rolled gaskets
- split bells
- failure to pass acceptance testing (e.g. hydrostatic pressure test)
- damage to previously assembled joints

INSTALLING PIPE THROUGH CASINGS

When the pipeline intercepts a heavily traveled, protected or landscaped area, it may be necessary to install the pipe through a protective casing. There are five major precautions to observe in the design of the casings and while pushing the pipe through the casing. These are:

1. Select the appropriate casing size.
2. Install spacers and skids on the PVC pipe.
3. Minimize the friction force during the push.
4. Avoid over-insertion.
5. Install a water-permeable seal at the casing ends.

CASING SIZE

The casing size should be large enough to readily accommodate the maximum outside diameter at the pipe bells and the projections of the supporting skids. The casing should not be so large as to permit excessive “whipping” or “snaking” of the PVC pipe when it is pressurized after installation in the casing.

SKIDS

The pipe should not rest on the bells after installation in the casing. Runners, or skids, should be attached to the barrel of the pipe with steel straps for a sufficient distance along the barrel to prevent any portion of the pipe contacting the casing. Pipe sizes 12 inch (300 mm) and under should have four skids arranged at 90° intervals around the pipe. Pipe over 12 inch (300 mm) may need six skids at 60° around the pipe at intervals adequate to ensure that no part of the barrel or bell is in contact with the casing. To help prevent over-belling as the pipeline is pushed though the casing, place one set of runners with their ends even with the assembly line on the spigot end of the pipe. The wood used to make the skids should not be creosote treated, because this material will damage the pipe.

MECHANICAL CASING SPACERS

Mechanical pipe spacers are available to provide proper separation between the carrier pipe and the casing. These spacers are manufactured from polyethylene, stainless steel or carbon steel and come complete with runners to provide clearance for the bell – spigot assemblies. The casing spacer manufacturer should be contacted for information on the location and number of casing spacers required.

EMBEDMENT

The use of proper embedment materials is very important to trouble-free operation of the pipe system. Avoid using angular rock larger than ¾ inch (20 mm) or rounded rock larger than 1½ inches (40 mm) for embedment.

BEDDING

Bedding may be used to bring the trench bottom up to grade before the pipe is installed. Its purpose is to provide continuous support. Where required, a maximum depth of 4 to 6 inches (100 to 150 mm) is normal.

HAUNCHING

Placement of the haunching material is the most important factor affecting pipe performance and deflection. Proper placement of material in the haunch reduces voids and increases pipe support. Granular materials may be properly placed using techniques such as shovel slicing. Place material under the haunches and at least halfway up the pipe to provide side support. Make sure the material is properly compacted. CAREFUL: DON’T MOVE THE PIPE. DON’T DISTURB SIDE SUPPORT WHEN MOVING SHEETING OR TRENCH BOX.

The material placed to the sides of the pipe from the bedding to about the springline (center line) is intended to help the pipe support the vertical loads. The pipe stiffness and anticipated loadings will dictate whether or not any compaction of the haunch material is necessary.

INITIAL BACKFILL

The material placed over the crown of the pipe to a height of 6 to 12 inches (150 to 300 mm) is the initial backfill. Where it is not otherwise specified, the initial backfill may consist of the native material in the trench provided it is free from large stones, not frozen, and free of debris or other organic materials. The purpose of the initial backfill is to protect the pipe from the final backfill.

Machine compaction of initial backfill directly over the pipe is not desirable unless adequate cover has been provided to protect the pipe. Adequate cover will depend on the type of compaction equipment. For adequate cover to prevent pipe damage or deflection, consult the project engineer.

FINAL BACKFILL

In the final backfill, avoid using rocks over 4 inches (100 mm), clumps of frozen soil, rubble and other such material. In most cases, the material that was originally excavated can be used for final backfill.

COMPACTING THE BACKFILL

Compact the haunching, initial backfill and final backfill in accordance with the job drawings. Observe the following precautions:

1. When a “self-compacting” material is used, such as crushed stone, ensure the material does not arch or bridge beneath the haunch of the pipe. Remove such voids by shovel slicing.
2. When compacting the material underneath and at either side of the pipe, do not allow the tool or the machine to strike the pipe.

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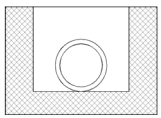
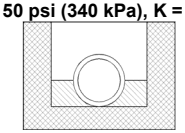
3. When compaction in excess of 85% standard proctor density is required in the haunching area, ensure that the compacting effort does not dislodge the pipe from the correct grade. If the compacting effort dislodges the pipe, re-lay the pipe to the correct grade.
4. It is not necessary to compact the initial backfill directly over the top of the pipe for the sake of the pipe's structural strength. However, it may be necessary for the sake of roadway integrity.

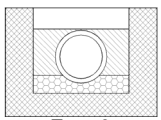
TYPICAL EMBEDMENT TYPES



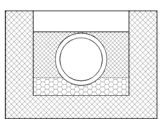
Type 1
Flat-bottom trench. Loose embedment.
E' = 50 psi (340 kPa), K = 0.110



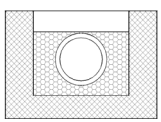
Type 2
Flat-bottom trench. Embedment lightly consolidated to centerline of pipe.
E' = 200 psi (1,380 kPa), K = 0.110



Type 3
Pipe bedded on 4 in. (100 mm) minimum of loose soil. Embedment lightly consolidated to top of pipe.
E' = 400 psi (2,760 kPa), K = 0.102



Type 4
Pipe bedded on sand, gravel, or crushed stone to depth of 1/8 pipe diameter, 4 in. (100 mm) minimum. Embedment compacted to top of pipe. (Approximately 80 percent Standard Proctor, AASHTO T-99 or ASTM D698.)
E' = 1,000 psi (6,900 kPa), K = 0.096



Type 5
Pipe embedded in compacted granular material to centerline of pipe. Compacted granular or select material to top of pipe. (Approximately 90 percent Standard Proctor, AASHTO T-99 or ASTM D698.)
E' = 2,000 psi (13,800 kPa), K = 0.083

OVERNIGHT PRECAUTIONS

At the end of each workday, be sure that all installed pipe ends are covered to keep dirt, debris and animals from entering the pipe. Backfill is needed to avoid flotation.

ACCEPTANCE TESTING

General: Sufficient backfill (approximately 1½ times the pipe size) shall be placed over the pipe prior to filling with water and testing to prevent lifting of the pipe. When local conditions require that the trenches be backfilled immediately after the pipe has been laid, the testing may be carried out after backfilling has been completed, but before placement of permanent surface. In all cases, sufficient backfill shall be placed to confine the pipe system during testing.

The engineer shall assure that the pressure and leakage test requirements do not exceed the design pressure of the pipe, fittings or the specified thrust restraint capabilities at the specified time of test.

Procedure: The following procedure is based on the assumption that the pressure and leakage tests will be performed at the same time. Separate tests may be made if desired; however, if separate tests are made, the pressure test shall be made first.

Each section of the pipeline shall be slowly filled with water and all air expelled by means of taps at high points. The specified test pressure shall be applied by means of a pump connected to the pipe in a manner satisfactory to the engineer. The test pressure shall be maintained by additional pumping if necessary for the specified time during which the system and all exposed pipe, fittings, valves and hydrants shall be carefully examined for leakage. All defective elements shall be repaired or removed and replaced and the test repeated until all visible leakage has been stopped and the allowable leakage requirements have been met.

Test Method: The contractor may perform simultaneous pressure and leakage tests, or he may perform separate pressure and leakage tests on the installed system at test durations and pressures specified below.

Procedure	Pressure	Duration of Test
Simultaneous Pressure and Leakage Tests	150% of Working Pressure at Point of Test, but not less than 125% of Normal Working Pressure at Highest Elevation	Two Hours
Separate Pressure Test	150% of Working Pressure at Point of Test, but not less than 125% of Normal Working Pressure at Highest Elevation	One Hour
Separate Leakage Test	150% of Normal Average Working Pressure of Segment Tested	Two Hours

Allowable Make-Up Water: After pressurizing the line for testing in accordance with the above table, a measurement of allowable make-up water must be made. Make-up water is defined as the volume of water necessary to be added to bring the line pressure back to its initial test value. The maximum allowable pressure drop during the testing is 5 psi (35 kPa). It is possible that no make-up water will be required, that is, if the pressure remains unchanged during the test period. The make-up water volume must then be compared to an allowable water loss as determined by the following formula:

$$L = ND\sqrt{P} / 7400$$

L is the allowable water loss in gallons per hour; N is the number of joints in the length of pipeline tested; **D** is the nominal diameter of the pipe in inches; and **P** is the average test pressure during the hydrostatic proof test in pounds per square inch gauge. Water loss values determined by the above formula can be found below.

Allowable Water Loss for Pressure Pipe Systems
(U.S. Gallons per hour)
Per 1000 Feet or 50 Joints

Nominal Pipe Size (In)	Average Pressure in Line (p.s.i) 50	100	150	200	250
4	0.19	0.27	0.33	0.38	0.43
6	0.29	0.41	0.50	0.57	0.64
8	0.38	0.54	0.66	0.76	0.85
10	0.48	0.68	0.83	0.96	1.07
12	0.57	0.81	0.99	1.15	1.28
14	0.67	0.95	1.16	1.34	1.50
16	0.76	1.08	1.32	1.53	1.71
18	0.86	1.22	1.49	1.72	1.92
20	0.96	1.35	1.66	1.91	2.14
24	1.15	1.62	1.99	2.29	2.56
30	1.43	2.03	2.48	2.87	3.21

Should the make-up water volume exceed the allowable water loss based on the formula, it is probably that the system has a leak that must be located and repaired. The test must be repeated after any repairs are made.

Having a make-up water volume below the allowable leakage indicates a successful proof test. Very low volumes of make-up water normally do not indicate a leak, but rather just a small increase in interior pipe volume due to radical expansion, air entrapment, or slight movement of the thrust restraint devices.

SPECIAL CONSIDERATIONS

Allowable Bending: Some changes in direction may be accomplished without the use of elbows, sweeps or other fittings. Controlled bending within acceptable limits can be accommodated by PVC pipe. A general rule of thumb for the minimum bending radius (R_b) calculation is $R_b = 300$ O.D. In most cases, if bending is required, it can and should be accomplished manually. It is not recommended to attempt bending pipes greater than 12" (300 mm) in diameter due to the forces required.

Joint Deflection: Changes in direction may also be accomplished through joint deflection. Either joint deflection or longitudinal bending may be used for changes in direction, BUT NOT BOTH, on the same length of pipe. Maximum joint deflection for all sizes is 1°.

Thermal Effects: PVC will display a variation in physical properties with changes in temperature. Extremely cold temperatures result in increases in pipe stiffness and tensile strength and decreases in impact strength. The decrease in impact strength requires care in handling during installation in cold temperatures.

The actual rate of expansion/contraction for PVC is 3/8 inch per 100 feet of pipe per 10 degrees F temperature change. Stresses caused by thermal changes are rarely ever generated in PVC pipe due to gasketed joints absorbing any thermal movement.

Disinfection: For information on the procedures for disinfecting water mains, refer to AWWA C651, "Disinfecting Water Mains".

Joint Restraint Devices: Mechanical thrust restraint devices are available which clamp to the wall of the pipe and tie back to a mating collar on the fitting or pipe bell. It is recommended that such devices conform to the requirements of ASTM F1674, which specifies restraint devices for use with PVC pipe. Contact the joint restraint manufacturer for installation recommendations.

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