



**Recommendations for
Installation of
AWWA C900
4” thru 60”
PVC Pipe Products**

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Sales Office

DIAMOND PLASTICS CORPORATION

P.O. Box 1608

Grand Island, NE 68802-1608

MANUFACTURING PLANTS:

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Lubbock, Texas

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Casa Grande, Arizona

TABLE OF CONTENTS

Introduction..... 2

Receiving 2

Unloading and Handling 3

Storage 4

Trenching..... 5

De-Watering 5

Field Cutting 6

Lowering Pipe Into The Trench 6

Cleaning and Inspection 7

Lubrication..... 7

Joint Assembly..... 8

Curvilinear Alignment..... 9

Thrust Restraint 9

Diamond Lok-21 10

Service Connection..... 11

Installing Pipe Through Casings 12

Installation of Fittings and Valves 14

Tracer Wire 14

Trench Construction 15

Foundation 15

Bedding 15

Haunching 15

Initial Backfill 16

Final Backfill..... 16

Compacting the Backfill..... 16

Overnight Precautions..... 16

Acceptance Testing..... 17

Special Considerations/Checklist..... 19

Warranty..... 20

INTRODUCTION:

This document has been developed by the Diamond Plastics Corporation for use as a field installation guide. General information regarding the correct installation of gasketed-joint PVC pressure pipe is included. Diamond Plastics Corporation supplies PVC pipe manufactured to AWWA C-900 dimensions with an integral coupling which utilizes an elastomeric gasket for an assembled seal. In this guide we will attempt to outline the basic handling, storage, assembly, and installation procedures for these products.

For more detailed information refer to the current edition of AWWA C605 "Standard for Underground Installation of PVC and PVC Pressure Pipe and Fittings," and AWWA Manual M23 "PVC Pipe – Design and Installation." The Handbook of PVC Pipe: Design and Construction provides additional guidance on PVC pipe design and installation. For information on this publication, please contact Uni-Bell.

-Installation Guide Disclaimer-

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RECEIVING:

When a load of pipe arrives at the job site, it is your responsibility to check it thoroughly. If possible, inspect each piece for damage. Check quantities against the shipping list. Note that the policy of the Diamond Plastics Corporation is that once the pipe leaves the manufacturer's plant, it becomes the property of the shipping company. Any damaged or missing items should be documented on the bill of lading prior to signing. The Carrier will advise you of the procedure to follow for freight damage. Make claims in accordance with the Carrier's instructions. Set aside any damaged items and notify the shipper.

UNLOADING AND HANDLING:

If it is also your responsibility to unload the shipment, unload with reasonable care. Careless unloading can result in damaged product or personal injury.

Use a forklift or a front-end loader with fork attachment, if available. Make sure that the forks are 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.



Below is a list of precautions /guidance:

- DO NOT drop pipe off the truck.
- DO NOT insert a forklift fork into a pipe end to transport.
- Do not attempt to handle pipe bundles by pulling or lifting on strapping or packaging material.
- Equipment should be equipped to avoid excessive swinging.
- Do not use chains as a sling
- Avoid all impact blows, gouging, or abrasions caused by metal surfaces, rocks, material handling equipment, or any other source.

Cold Weather Handling: Extra care should be used in handling during cold weather.

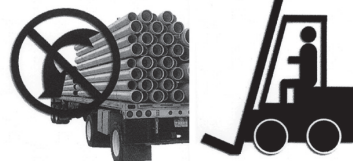
WARNING: Carelessly unloading pipe can be hazardous. Use appropriate equipment and stay clear when removing tie-downs, banding, and dunnage material.



FALLING PIPE CAN CAUSE SERIOUS INJURY OR DEATH

DO NOT ROLL PIPE TO UNLOAD

DO UNLOAD WITH FORKS THAT EXTEND TO SUPPORT ALL OF THE PIPE IN THE BUNDLE.



The table below is provided for use as a guide in selection of handling equipment:

APPROXIMATE JOINT WEIGHTS (lbs)

PVC Pressure Pipe C10D

Pipe Size (in.)	DR 51	DR 41	DR 32.5	DR 25	DR 21	DR 18	DR 14
4	x	x	x	42	x	57	73
6	x	x	x	87	x	121	154
8	x	x	x	154	x	209	253
10	x	x	x	220	x	308	385
12	x	x	x	319	x	429	550
14	x	264	330	429	506	583	737
16	x	341	429	550	649	759	957
18	352	429	539	693	814	946	1210
20	429	520	660	847	1001	1210	1446
24	605	746	946	1210	1430	1650	2074
30	936	1158	1431	1872	2200	2538	3200
36	1333	1649	2080	2654	3145	3639	4575
42	1823	2275	2852	3645	4092	4947	x
48	2396	2966	3658	4744	5593	x	x
54	2927	3628	4547	5854	x	x	x
60	3358	4157	5209	6706	x	x	x

* based on 22 foot laying length

STORAGE:

If you can unload the shipment in unit packages, the pipe will be easier to store. Stack the packages on reasonably level ground. If you unload one piece at a time, place the pipe bevel to bell. Never stack more than eight feet in height. Do not stack the pipe next to heat sources or engine exhausts. Gaskets should also be protected from heat, oil, and grease.



TRENCHING:

Do not let the excavated material block sidewalks, drives, or utility outlets. Follow all safety rules and regulations. Protect workers by using sheeting and trench boxes in hazardous areas and by sloping the trench walls in dry soils. When sheeting or a trench box is moved, make sure that the pipe is not moved and that the side-support material is not disturbed.

For information on trench terminology and recommended practices, see the “Trench Construction” section.

Trench width: Working space is the primary consideration in determining the trench width to be used. Trench width at the ground surface may vary with the trench depth, nature of soils encountered, existence of any pavement, and the proximity of adjacent structures. If compaction of the pipe haunch zone embedment is required in the project contract documents, the minimum trench width as measured at the centerline of the pipe (pipe springline) shall be not less than the greater of the outside diameter of the pipe plus 16 inches (400mm) or the pipe outside diameter times 1.25, plus 12”(300mm). Where embedment compaction is required, the trench must always be wide enough to accommodate the compaction equipment. Refer to the Trench Construction section for the location of the haunch area.



DE-WATERING:

Keep the trench as dry as possible until the pipe has been installed and enough backfill placed to prevent the pipe from floating. PVC pipe will float if not filled with water or weighted down. The height of loose backfill material required to prevent flotation of empty pipe is conservatively equal to $1\frac{1}{2}$ times the pipe diameter.



FIELD CUTTING:

PVC pipe can be easily cut with a power handsaw 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 and length as provided on the factory-finished pipe. Redraw the insertion line on the spigot using a factory-marked spigot as a guide. Large diameter pipe's combination of size, weight and wall thickness means that cutting techniques that have been used for smaller pipe may no longer be safe or efficient. The following considerations become even more important:

- **Pipe Movement:** It is necessary to roll a pipe to cut it all the way around its circumference. However, uncontrolled pipe movement should be prevented for safety reasons and may break a partially cut pipe.
- **Pipe Support:** Support of the pipe and drop off piece must be maintained. Large diameter pipes can weigh in excess of 350 pounds per foot which will cause the pipe to break when nearing the end of the cut if the drop off is not kept in line with the pipe and supported.
- **Saw Kerf:** Proper support of the pipe being cut is necessary to prevent the saw kerf from closing (binding the saw blade) or opening (potentially cracking the pipe).



LOWERING PIPE INTO THE TRENCH:

Place the pipe and fittings into the trench using ropes and skids, slings on the backhoe bucket, or by hand. Follow proper safety procedures when workers are present in the trench. 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.



CLEANING AND INSPECTION:

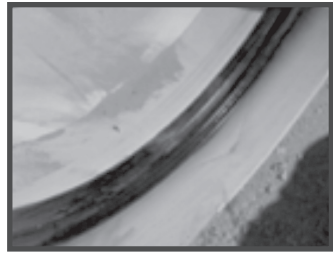
Reiber Gaskets are installed in the pipe bells Diamond Plastics produces at the manufacturing facility at the time of production and should not be removed/replaced.

Prior to joint assembly the gaskets, the inside of the pipe bell, and the outside of the pipe spigot ends from the bevel to the second assembly mark should be clean. This can be accomplished with a small brush, forced air, or a clean rag.

DO NOT ATTEMPT TO REMOVE THE GASKETS FROM THE RACE FOR CLEANING. Reiber gaskets are not removable and will be damaged by attempts to remove them.



Remove debris.



Clean annular.

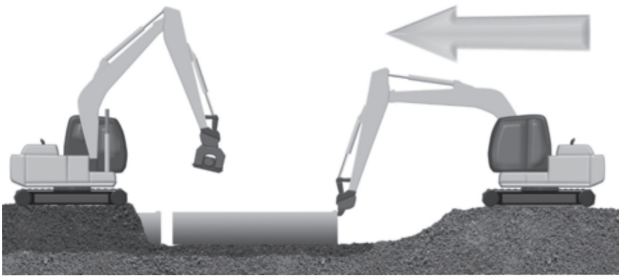
LUBRICATION:

Clean any dirt or foreign matter from the gasket and spigot. An even, uniform application of gasket lubricant must be applied to the bevel of the spigot as well as the contact surface of the gasket. Gasket lubricant may be applied with a swab, brush, or roller. Gasket lube is furnished with each truckload of pipe directly shipped from Diamond Plastics to jobsites. Additional lubricant may be purchased from your distributor.



JOINT ASSEMBLY:

Assembly is made by sliding the lubricated spigot end into the gasketed bell end. The gasket seals the joint against leaks, into or out of the pipeline. Insert the spigot end into the socket so that it is near contact with the gasket. The bell hole should be large enough to prevent any bedding material from sticking to the lube on the spigot. Keep the pipe lengths in proper alignment. Brace the bell while the spigot end is pushed through the gasket so that previously completed joints in the line will not be “stacked,” “over belled,” or inserted past the second reference mark. Push the spigot end in until the first insertion line is adjacent to the lip of the bell. If the spigot is inserted beyond the first insert reference mark, laying length will be lost. Loss of laying length can be significant on long footage projects. If the spigot is not inserted beyond the second insertion line the joint is not over-inserted. Joint flexibility is reduced when the spigot is inserted beyond the second insert reference mark. Some joints may require barring to seat the joint. If so, use a wood block to protect the end of the pipe. A come-a-long may be preferred to the bar and block, but a swinging stab is not recommended. Where the physical weight or trench conditions make the recommended methods unsafe, joints may be assembled using mechanical equipment provided that the pipe is properly lubed and aligned. The end must be protected from damage, and the joint must not be “over belled” or inserted beyond the second insert reference mark. If a backhoe is used for assembly, the backhoe should be “walked” forward to push the spigot into the bell. This gives the operator greater control over the speed of insertion than extending the arm of the backhoe. It is likely the joint will be over-inserted if the operator extends the hydraulic arm instead of “walking” the machine forward.



If the second insertion mark is not visible after assembly, the pipe was over-inserted. The spigot needs to be pulled back until the second assembly mark is visible. Likewise, if the first mark falls short of the lip of the bell, the spigot end needs to be pushed a little further until the lip of the bell is either at the first insertion line or falls between the two reference marks on the spigot. The images below show that an over-inserted joint has no flexibility and cannot expand. An “over-assembled” joint can be under substantial stress. In pressure pipe these stresses are additive to hydrostatic stresses and bells can fail directly due to over-insertion.



Properly Inserted Spigot



Over Inserted Spigot

If the pipe is misaligned during insertion, over-inserted, or assembled with excessive force, the following are possible consequences:

- rolled gasket
- split bell
- failure to pass acceptance testing (e.g., hydrostatic pressure test)
- over-insertion of previously assembled joints

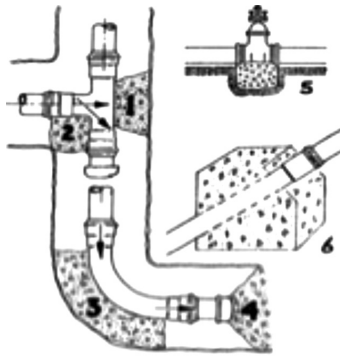
Curvilinear Alignment: (Without Bending the Pipe)

During construction, it may become necessary to make very slight changes of direction. When this situation is encountered, the clearance between the inside diameter of the socket and the outside diameter of the spigot may be utilized to accomplish curvilinear alignment without bending the pipe. Neither the pipe nor the joint should be axially deflected in any manner to cause stress at the joint. Diamond C900 will accommodate a 1° change in direction, which is equivalent to a four-inch offset per 20' joint and a 4.5 inch offset for 22' long joints. The minimum radius of curvature for 20' joints is 1,146 feet; for 22' joints the minimum radius is 1,260 feet. The minimum radius of curvature assumes the spigot is not inserted beyond the second insert reference mark. Inserting the spigot beyond the second insert reference mark eliminates the one degree allowable joint offset.

Thrust Restraint:

Diamond's gasketed C900 PVC pipe utilizes an integral bell socket with an elastomeric sealing gasket and is not self-restraining. Therefore, thrust restraining is required at certain points in the piping system such as at valves, change in horizontal or vertical direction, fittings, etc.

The following diagram illustrates typical locations where thrust restraint is required. While thrust blocking is depicted, thrust restraint devices meeting the requirements of ASTM F1674 may be utilized. Diamond Plastic's Diamond Lok-21 pipe (page 16) contains an integral self-restraining bell and spigot to provide a thrust restrained joint.



1. Tees
2. Plugged End of Tee
3. 90° Elbow
4. End Caps or Plugs
5. Valve
6. Steep Incline

Thrust at 90-degree elbow based on 100 psi internal pressure.

Pipe Size	Thrust (psi)	Pipe Size	Thrust (psi)
4" (100)	2,560	20" (500)	51,800
6" (150)	5,290	24" (600)	73,900
8" (200)	9,100	30" (750)	114,000
10" (250)	13,700	36" (900)	163,000
12" (300)	19,400	42" (1050)	220,000
14" (350)	26,000	48" (1200)	287,000
16" (400)	33,600	54" (1350)	339,000
18" (450)	42,200	60" (1500)	389,000

As the chart above demonstrates, enormous thrust loads may be generated. Properly designed thrust restraint is a must. The specifying engineer should provide this information.

Diamond Lok-21®:

Diamond Lok-21® is standard AWWA C900 pipe with a modification to the bell to accommodate a casing and gripper ring to provide a thrust restrained joint. The additional length of the bell changes the assembly marks. For this reason, when connecting Diamond Lok-21 to C900 similarly sized pipe, the proper assembly mark for the bell being used should be applied to the spigot being inserted. Diamond Lok-21® should be unloaded, handled and strung the same as for our standard AWWA C900 pipe. Those guidelines may be found in other parts of this document. A separate installation guide detailing the specific installation guidelines is provided with each load of Diamond Plastics Lok-21 pipe. Both guides should be read entirely before beginning the installation of the product.

Prior to joint assembly, any dust or foreign material must be removed from the relative joining areas of the socket and the spigot. The grip ring edges that provide restraint are sharp, and care should be taken when verifying proper gripper ring installation. When in proper position the gripper ring can be easily rotated (turned) by hand within the casing cavity—if the ring is not in proper position, it won't easily rotate within the casing cavity. Several things can cause the ring to lose its ability to rotate freely. Dirt, dust, moisture between the ring and casing or an improperly sized ring may be the reason. If the ring still does not rotate freely after checking these things contact your Diamond Plastics representative

For the joint to work properly straight alignment of the spigot and bell is required. It is extremely important that the bell and spigot be assembled with straight alignment to reduce the assembly force and allow the gasket to seal properly. A clean gripper ring and casing along with a clean gasket and spigot are required.

Lubricate the bevel of the spigot and the gasket of the socket. Ensure straight alignment and push the spigot into the socket until the end of the entry lip is at the first insertion line or falls between the two assembly marks. Be careful not to over-assemble because the gripper ring will not allow the spigot to be pulled out to proper position. The assembled joint cannot be pulled apart without potential damage to the joint.

Casing Installation

The Diamond Lok-21®'s restraint system provides uniform circumferential contact with a simple push together system that is suited for installations up to 24" nominal diameter, encasements, and other applications which require joint restraint. Diamond Lok-21 **must** be pulled into the casing. It can sustain the following levels of pull force:

<u>Size</u>	<u>Force (Pounds)</u>	<u>Size</u>	<u>Force (Pounds)</u>
4" (100)	15,000	14" (350)	52,000
6" (150)	20,000	16" (400)	60,000
8" (200)	30,000	18" (450)	70,000
10" (250)	40,000	20" (500)	80,000
12" (300)	45,000	24" (600)	100,000

If the pipe installation requires pushing the pipe into the casing, the procedures described in "Installing Pipe thru Casings" (page 12) must be followed to prevent over-assembly of the joints.

Directional Drilling Application

The Diamond Lok-21®'s restraint system provides uniform circumferential contact with a simple push together system that is suited for directional drilling operations up to 12" nominal diameter. The pull loads used in directional drilling should be measured and set not to exceed the allowable pull forces that are listed below.

<u>Size</u>	<u>Force (Pounds)</u>
4" (100)	15,000
6" (150)	20,000
8" (200)	30,000
10" (250)	40,000
12" (300)	45,000

In horizontal drilling applications the angular deflection and bending radius for the finished installation should comply with the guidelines contained in AWWA C605 (the minimum bending radius is the pipe diameter times 250) when installed at temperatures above freezing. Additional information for installation in temperatures below freezing or directional drilling installation of diameters larger than 12" can be obtained by contacting Diamond Plastics Engineering department.

In many directional drilling applications, the entrance and exit may require a more severe bending radius due to construction limits and pit dimensions. Project planning should consider the Diamond Lok-21 joint deflection and bending radius installation restrictions. **Caution is advised in that exceeding the maximum joint deflection and/or bending radius of the pipe can result in pipe or joint failure.**

Service Connections:

Service lines are connected to water mains by either:

1. Direct Tapping
2. Saddle Tapping
3. Tapping Sleeve & Valve
4. Use of fabricated or injection molded couplings with threaded outlets

Direct tapping (1" or smaller tap) is restricted to C900 pipe sizes 6" through 16" with pipe walls at least 3/8" thick.

Saddle tapping is restricted to a maximum corporation stop of 2 inches.

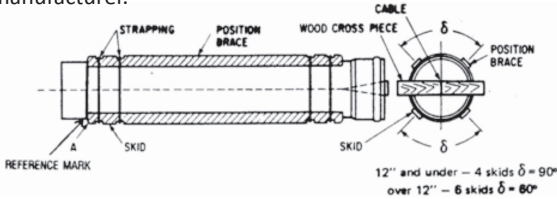
Tapping sleeves and valves are used when service connections larger than 2 inches are required.

A wide strap tapping saddle may be used for outlets less than two inches. For outlets larger than two inches, use a tapping sleeve and valve. Taps should follow the placement guidelines in the Uni-Bell Tapping Guide for PVC Pressure Pipe.

It is recommended that prior to tapping, those responsible for completion of the tap watch the video by the Uni-Bell PVC Pipe Association entitled "Direct Tapping PVC Pipe" and familiarize themselves with the Uni-Bell Tapping Guide for PVC Pressure Pipe. You may obtain these from your Diamond Pipe Sales Representative or from the Uni-Bell PVC PIPE Association (972-243-3902) www.UNI-BELL.ORG. Proper tapping procedures and tools are very important in maintaining safety.

INSTALLING PIPE THROUGH CASINGS:

Casings may be installed by boring where open excavation is not desirable, for example, under highways, runways, or railways. To provide long term support to the pipe and to prevent damage to belled sockets during installation, skids or casing spacers must be attached to the pipe before the pipe is installed in casings. Casing spacers or skids should be fastened securely to the pipe with steel strapping, cables, or clamps as recommended by the casing manufacturer.



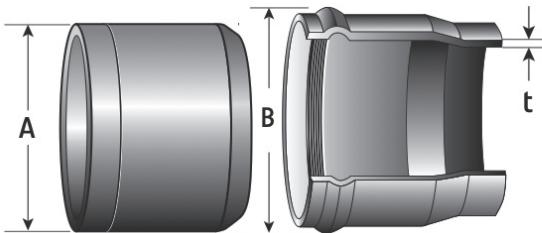
The installer must ensure the pipe is not “over-belled” or inserted beyond the second insert reference mark, the skids or casing spacers must be aligned with the reference marks on the spigot. Use of gasket lube between the skids and the casing can ease installation into the casing. The approximate socket outside diameter is the critical dimension for casing installation. The dimensions shown in the following tables are approximate as noted and conservative; actual pipe bell dimensions may vary.



RIEBER SEAL AWWA C900

PIPE DIMENSIONS

RIEBER JOINT ILLUSTRATION



* Approximate Socket OD dimensions

Nominal Size	Pipe O.D. (A)	Approximate Socket O.D. (B)	C900 Minimum Wall (t)		
			DR-14	DR-18	DR-25
4" (100)	4.800 (121.9)	6 ½"	.343 (8.71)	.267 (6.78)	.192 (4.88)
6" (150)	6.900 (175.3)	9 ¼"	.493 (12.52)	.383 (9.73)	.276 (7.01)
8" (200)	9.050 (229.9)	11 ¾"	.646 (16.41)	.503 (12.78)	.362 (9.19)
10" (250)	11.100 (281.9)	14 ¼"	.793 (20.14)	.617 (15.67)	.444 (11.28)
12" (300)	13.200 (335.3)	16 ¾"	.943 (23.95)	.733 (18.62)	.528 (13.41)

Nominal Size	Pipe O.D.	Approximate Socket O.D.	C900 Minimum Wall							
			DR-14	DR-18	DR-21	DR-25	DR-32.5	DR-41	DR-51	
14" (350)	15.300 (388.6)	19 1/4"	-	.850 (21.59)	.729 (18.51)	.612 (15.54)	.471 (11.96)	.373 (9.47)		
16" (400)	17.400 (442.0)	21 3/4"	1.243 (31.57)	.967 (24.56)	.829 (21.05)	.696 (17.68)	.535 (13.59)	.424 (10.77)		
18" (450)	19.500 (495.3)	24 1/4"	1.393 (35.38)	1.083 (27.51)	.929 (23.60)	.780 (19.81)	.600 (15.24)	.476 (12.09)		
20" (500)	21.600 (548.6)	26 3/4"	1.543 (39.19)	1.200 (30.48)	1.029 (26.14)	.864 (21.95)	.665 (16.89)	.527 (13.39)		
24" (600)	25.800 (655.3)	31 3/4"	1.843 (46.81)	1.433 (36.40)	1.229 (31.22)	1.032 (26.21)	.794 (20.17)	.629 (15.98)		.506 (12.85)
30" (750)	32.000 (812.8)	38 1/2"	2.286 (58.06)	1.778 (45.16)	1.524 (38.71)	1.280 (32.51)	.985 (25.02)	.780 (19.81)		.627 (15.93)
36" (900)	38.300 (972.8)	45"	-	2.128 (54.05)	1.824 (46.33)	1.532 (38.91)	1.178 (29.92)	.934 (23.72)		.751 (19.08)
42" (1050)	44.500 (1130.3)	53"	-	-	2.119 (53.82)	1.780 (45.21)	1.369 (34.77)	1.085 (27.56)		.872 (22.15)
48" (1200)	50.800 (1290.3)	59 1/2"	-	-	2.419 (61.44)	2.032 (51.61)	1.563 (39.70)	1.239 (31.47)		.996 (25.30)
54" (1350)	57.560 (1462)	66 3/4"	-	-	-	2.303 (58.50)	1.771 (44.98)	1.404 (35.66)		1.129 (28.68)
60" (1500)	61.610 (1565)	72"	-	-	-	2.465 (62.61)	1.896 (48.16)	1.503 (38.18)		1.208 (30.68)

INSTALLATION OF FITTINGS AND VALVES:

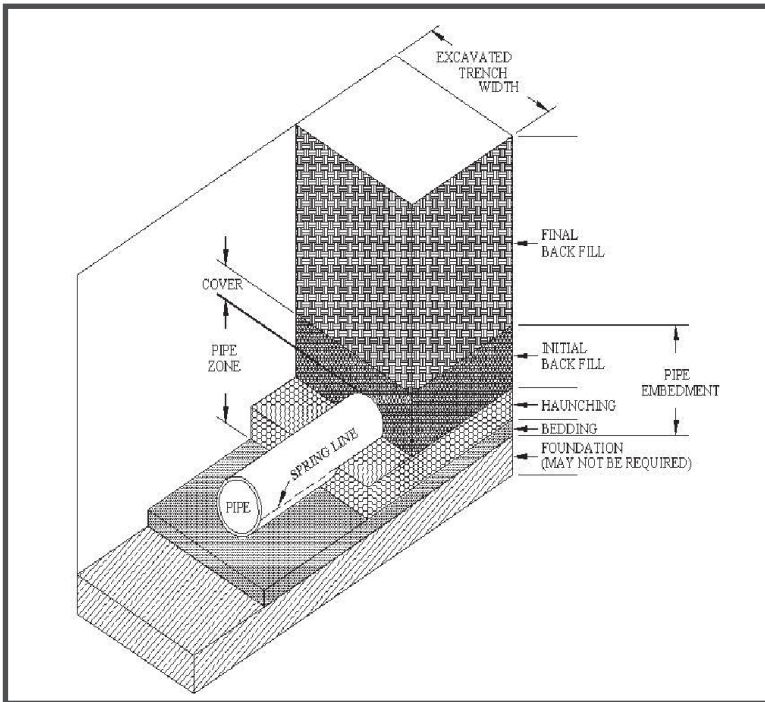
Metallic fittings and valves should be independently supported. The insertion depths of valve and fitting joints are usually less than those of PVC pipe joints. In all cases, consult the fitting or valve manufacturer's instructions for installation. As a general rule for iron fittings, cut the spigot end to remove the factory bevel. Make sure the pipe spigot end is squarely cut, deburred, and the sharp edge removed. Insert the pipe spigot into the iron fitting bell until the pipe end contacts the fitting. See AWWA Standard C605 "Standard for the Underground Installation of PVC and PVC Pressure Pipe and Fittings" for additional guidance for fitting and valve installation.

TRACER WIRE:

Properly installed tracer wire will aid in locating PVC pipe. Typically, an insulated wire or plastic-coated metal strip is laid above the pipe after installation. The tracer wire is generally accessible at a riser but is not electrically connected to the riser.

TRENCH CONSTRUCTION:

Terms used in pipe installation are illustrated in the trench cross-section below. The use of proper embedment materials is very important to minimize trench settlement. Embedment material should not contain debris, frozen lumps, or rock of diameter greater than 1½ inches.



FOUNDATION:

An adequate or stable foundation should be present (or provided) to uniformly support the full length of the pipe. Bell holes should be provided at each joint to permit proper assembly and support of the pipe. Unstable trench bottoms shall be stabilized by methods and with materials required by the specifying engineer to provide adequate and permanent support for the conditions encountered.

BEDDING:

The trench bottom should be over excavated to permit placement of bedding materials when encountering rock, hard pan, boulders, or other materials that could damage the pipe due to point loading on the bell. Over excavate and place a minimum of 4" of bedding for pipe nominal diameters 4" - 16", a minimum of 6" of over excavation and bedding for pipe nominal diameters 20" - 42", and a minimum of 8" of over excavation and bedding for pipe nominal diameters 48" - 60". The bedding should consist of an evenly graded, free flowing, granular material which is free of large stones or frozen material and with particle size of up to approximately 10% of the pipe size and no larger than 1 ½" in size. Bell holes should be utilized to reduce axial deflection, support the barrel of the pipe, be large enough to prevent any bedding material from sticking to the lube on the spigot.

HAUNCHING:

Proper placement of material in the haunch reduces voids and increases pipe support. Haunch materials should be placed in layers no more than six inches at a time up to the springline (halfway up the pipe), and be free of frozen material or debris. If granular materials are used, they should be free of large stones (1-1/2" or larger) and may be properly placed using techniques such as shovel slicing. Compact as required by the designer of the pipe system. **DO NOT DISTURB SIDE SUPPORT WHEN MOVING SHEETING OR TRENCH BOX.**

The pipe stiffness and anticipated loadings will dictate whether or not granular material and/or compaction of the haunch material are necessary.



INITIAL BACKFILL:

The material placed from the springline to a point 6 to 12 inches above the top of the pipe is the initial backfill. The purpose of the initial backfill is to protect the pipe from the final backfill. Where not otherwise specified, the initial backfill may consist of the native material in the trench provided it is not frozen and is free from large stones, debris, and other organic materials.

Machine compaction of initial backfill directly over the pipe is not desirable unless adequate cover has been provided to protect the pipe. The required depth of cover will depend on the type of compaction equipment – consult the project engineer for information.



FINAL BACKFILL:

Final backfill is often specified by the project engineer based on site design. Material selection, placement, and compaction should meet the project requirements. In many 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:

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

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 roadway integrity and for minimizing trench settlement.

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 as needed to avoid flotation.

ACCEPTANCE TESTING:

General: When local conditions require that trenches be backfilled immediately after pipe has been laid, testing may be carried out after backfilling has been completed. If testing portions of a pipeline as they are completed and joints are exposed during testing, center loading the pipe to resist movement is recommended. In all cases, sufficient backfill (minimum depth 1½ times the pipe size) should be placed to confine the pipe system during testing.

The engineer should assure that the test pressure does not exceed the design pressure of any of the components of the pipe system.

Procedure: Testing should be performed only after the pipeline has been properly filled, flushed, and purged of all air. Fill the pipeline slowly, limiting the flow to approximately one foot per second, making sure there is no imposed surge or water hammer. Entrapped air can lead to very unsafe explosive failures. Fire hydrants are not an adequate replacement for air/vacuum release valves. Appropriate pressure relief, air release, and vacuum release valves should be installed prior to testing.

Approximate Volume of Water Required to Fill Pipe

Pipe Size	U.S. gal/100ft	liters/30.48 meters
4"	70	265
6"	153	579
8"	259	980
10"	405	1533
12"	573	2169
14"	810	3066
16"	1050	3975
18"	1315	4978
20"	1615	6113
24"	2305	8725
30"	3545	13419
36"	5078	19222
42"	7197	27244
48"	9400	35583
54"	12447	47117
60"	14265	53999

The specified test pressure should be applied by means of an approved pumping assembly connected to the pipe in a manner satisfactory to the purchaser. To prevent pipe movement, the contractor should place sufficient backfill prior to filling and testing of the pipe. The test pressure should not exceed the test pressure specified by the engineer. If necessary, the test pressure should be maintained by additional pumping for the specified time during which the system and all exposed pipe, fittings, valves, and hydrants should be carefully examined for leakage. All visible leaks should be stopped. All defective elements should be repaired or removed and replaced. The test should be repeated until the test requirements have been met.

Test Duration: The duration of the hydrostatic test should be 2 hours, unless otherwise specified.

Test Pressure: A hydrostatic test pressure of 150% of the normal operating pressure is generally sufficient. In no case should the test pressure exceed the design pressure limit for any system component, including pipe, thrust restraint, valve, fitting, or other appurtenance.

NOTE: Air should not be used for pressure testing.

Test Allowance: The testing allowance should be defined as the quantity of water that must be supplied to the pipe section being tested to maintain a pressure within 5 psi of the specified hydrostatic test pressure.

$$Q = \frac{LD\sqrt{P}}{148,000}$$

Where: Q = testing allowance, gal/hr
 L = length of pipeline being tested, feet
 D = nominal diameter of pipe, inches
 P = average test pressure, psi

Make-up water allowances are provided in the table below:

HYDROSTATIC TEST MAKE-UP WATER ALLOWANCE
(U.S. Gallons per Hour Per 1000 Feet of PVC Pipe)

Pipe Size (in.)	Average Pressure in Line (psi)				
	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
36	1.72	2.43	2.98	3.44	3.85
42	2.01	2.84	3.48	4.01	4.49
48	2.29	3.24	3.97	4.59	5.18
54	2.58	3.65	4.47	5.16	5.77
60	2.87	4.05	4.97	5.73	6.41

When testing against closed valves, an additional allowance per closed valve may be required.

Should the make-up water volume exceed the testing allowance, it is probable that the system has a leak that must be located and repaired.

Having a make-up water volume below the testing allowance indicates a successful test. Since PVC gasketed pipe is a leak-free system, low volumes of make-up water do not indicate a leak. Instead make-up water is necessary to accommodate entrapped air, slight movement of the pipe at thrust restraints, or a small increase in interior pipe volume due to radial expansion.

SPECIAL CONSIDERATIONS:

Changes in Direction:

1. Pipe bending – Some changes in direction may be accomplished without the use of bends, 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 (Rb) calculation is $Rb = 250 OD$. This calculation is based on pipe wall temperatures of 74F, contact Diamond Plastics Engineering department for information on the allowable minimum bending radius of PVC pipe at temperatures below freezing. In most cases, bending should be accomplished manually. It is not recommended to attempt bending pipes greater than 8" in diameter due to the forces required.
2. Joint deflection – Changes in direction may also be accomplished through joint deflection. When this situation is encountered, the clearance between the inside diameter of the socket and the outside diameter of the spigot may be utilized to accomplish curvilinear alignment without bending the pipe. Neither the pipe nor the joint should be axially deflected in any manner to cause stress at the joint. Diamond C900 will accommodate a 1° change in direction, which is equivalent to a 4" offset per 20' joint and a 4.5" offset per 22' joint. The minimum radius of curvature for 20' joints is 1,146 feet; for 22' joints the minimum radius is 1,260 feet. This minimum radius of curvature assumes the spigot is not inserted beyond the second insert reference mark. Inserting the spigot beyond the second insert reference mark reduces allowable joint offset.
3. Combined pipe bending and joint deflection – Either joint deflection or longitudinal bending may be used for changes in direction, BUT NOT BOTH on the same length of pipe.

Cold-Weather Installation: 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.

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

CHECKLIST:

- Take all precautions necessary to protect workers and materials.
- Plan ahead for fittings.
- Use trench boxes or shoring as required.
- Do not disturb installed pipe or haunching material when moving trench boxes or shoring materials.
- Properly assemble pipe joints by inserting the spigot end until the lip of the bell is between the insertion marks.
- Keep the trench bottom as dry as possible.
- For detailed installation recommendations, see AWWA C605 "Standard for Underground Installation of PVC and PVCO Pressure Pipe and Fittings."
- Consult Diamond Plastics for specifics regarding gaskets and lubricants.
- Check with the project engineer regarding specifications and procedures.

LIMITED WARRANTY AND LIABILITY

Diamond Plastics Corporation, 1212 Johnstown Road, P. O. Box 1608, Grand Island, NE 68802, does hereby warrant, subject to the limitations hereinafter stated, its PVC Pipe to be free from defects in material and workmanship under normal use and service for a period of twelve (12) months from the date of invoice. This limited warranty extends only to the original purchaser for use, and will be void if the product is used under conditions other than those for which it was designed or if it is not used in compliance with all instructions contained in any operating manual or specification sheets provided for such product.

Alteration or modification of the PVC Pipe in any manner, (other than as may be specifically authorized by Diamond Plastics Corporation or permitted in accordance with the installation guide provided by Diamond Plastics Corporation for such product), will void this limited warranty.

The sole obligation of Diamond Plastics Corporation, under this limited warranty, and the exclusive remedy of the purchaser under this limited warranty is the repair or replacement, without charge, F.O.B. shipping point, of such products or parts of products only, specifically excluding any labor or installation thereof, which Diamond Plastics Corporation, after inspection, determines to be defective.

Purchaser must notify Diamond Plastics Corporation, in writing at its address shown above within ten (10) days from the date of discovery of any claimed defect specifically stating the details of such defect, and, if requested by Diamond Plastics Corporation, return the defective product, freight prepaid, to Diamond Plastics Corporation, F.O.B. shipping point as shown on Diamond Plastics Corporation's order acknowledgment.

Diamond Plastics Corporation shall not be liable for any other damages, whether direct or consequential. Specifically, but without limitation, Diamond Plastics Corporation shall not be liable for any crop damage or any other incidental or consequential damages resulting from any breach of warranty, express or implied, or from any defects in its products.

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STATUTE OF LIMITATION: Any action for breach of this LIMITED WARRANTY AND LIMITATION OF LIABILITY must be commenced within one (1) year after the cause of action has accrued.

THERE ARE NO EXPRESS OR IMPLIED WARRANTIES BY Diamond Plastics CORPORATION, OTHER THAN THOSE SPECIFICALLY SET OUT ABOVE. THERE ARE NO IMPLIED WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE IN CONNECTION WITH ANY SALE EXCEPT AS SET FORTH ABOVE.

WARNING: Carelessly unloading pipe can be hazardous. Use appropriate equipment and stay clear when removing tie-downs, banding, and dunnage material.



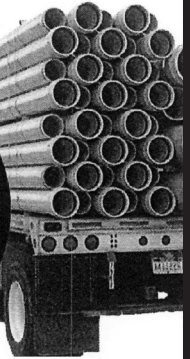
WARNING



DO NOT UNLOAD BED ON UNEVEL GROUND.

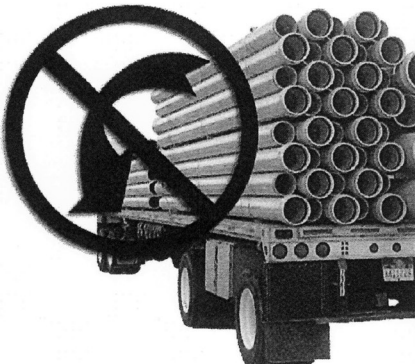


DO NOT STAND OR WALK BESIDE THE TRUCK WHILE UNLOADING.



FALLING PIPE CAN CAUSE SERIOUS INJURY OR DEATH

DO NOT ROLL PIPE TO UNLOAD.



DO UNLOAD WITH FORKS THAT EXTEND TO SUPPORT ALL OF THE PIPE IN THE BUNDLE.

