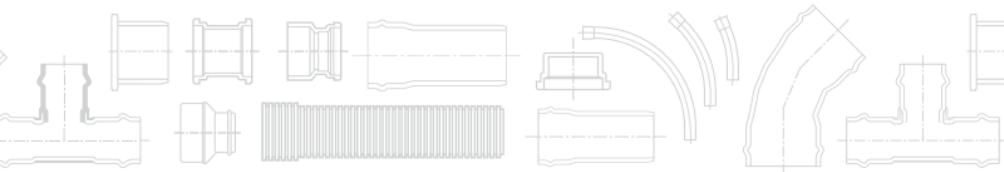


Pressure Pipe and Fittings Installation Guide

Suitable for Pressure Applications
Installation Guide





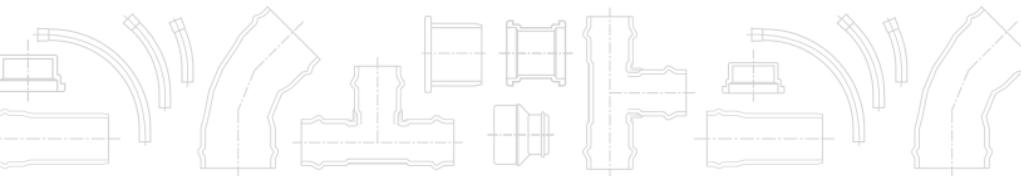
ROYAL

Pipe & Fittings Solutions

Royal Municipal Solutions Pressure Pipe & Fittings Installation Guide

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Introduction

This guide is intended for use by installers, supervisors, and inspectors responsible for the installation of Royal Municipal Solutions PVC Pressure Pipe and Fittings. It is not a design manual. Rather, it is intended as a guide for the proper receiving, handling and installation of PVC pressure pipe and fittings. If used properly, the information in this booklet can help maximize product performance.

This booklet is not intended to assume the authority of the Design Engineer. System requirements and actual field conditions will vary significantly. The sole responsibility for all design and installation decisions lies with the Design Engineer.

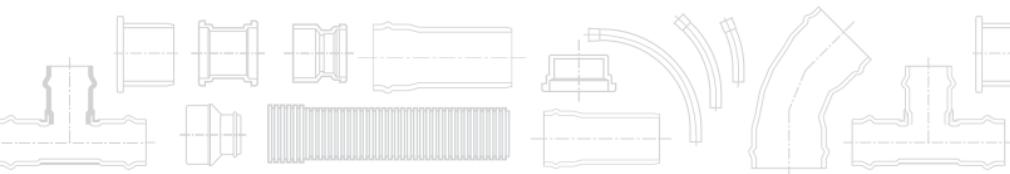
All Local Health and Safety Regulations must be followed.

This booklet is also available electronically on the Royal Building Products website www.royalbuildingproducts.com.



Certified to B137.3



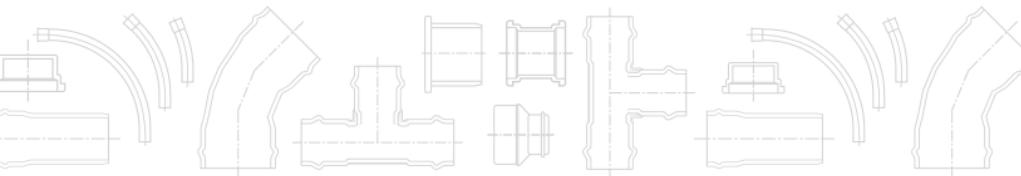


Receiving

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

The following procedures are recommended for acceptance of delivery:

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

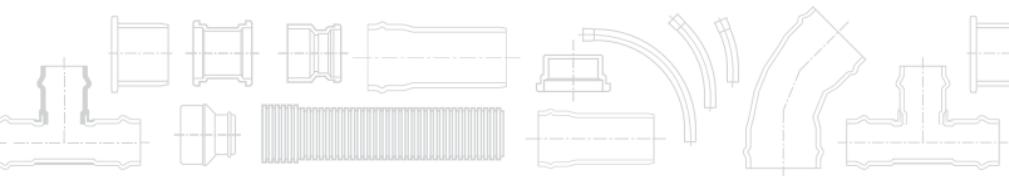


Unloading

The means by which pipe and fittings are unloaded in the field is the decision and the responsibility of the receiver.

The following recommendations should be followed:

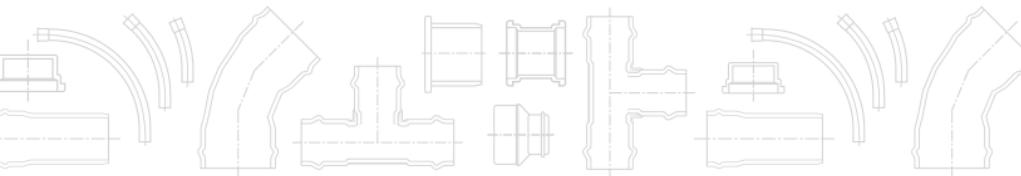
1. Remove restraints from the bundles. These may be straps, ropes, or chains with padding.
2. Remove any boards on the top or sides of the load that are not part of the pipe/fittings packaging.
3. When unloading fittings use industry-accepted means. Use extreme caution when unloading fittings with any type of machinery, as fittings may be fiberglass wrapped for added strength. Damage to wrapping could reduce strength of fabricated fitting. Do not drop or throw fittings into trench. Royal is not responsible for damage to mishandled fittings.
4. Using a forklift (or a front-end loader equipped with forks), remove the top bundles of pipe, one at a time from the truck.
5. If a forklift is not available, use a spreader bar with fabric straps capable of carrying the load. Space straps approximately 2.4 metres (8ft) apart. Loop straps under the load.
6. During the removal and handling, ensure that the bundles do not impact anything (especially in cold weather).
7. Place pipe bundles on level ground.
8. Do not handle bundles with individual chains or single cables, even if padded.
9. Do not attach lifting cables to bundles or bands.
10. Do not stack bundles more than 2.4 metres (8ft) high.
11. Protect bundles with packing materials the same way they were protected while on the truck.
12. To unload lower bundles, repeat the unloading process described above.
13. Do not unload pipe bundles by hand.
14. If unloading equipment is not available, pipe may be unloaded by removing individual pieces. Care should be taken to ensure that pipe is not dropped or damaged.



Storage

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

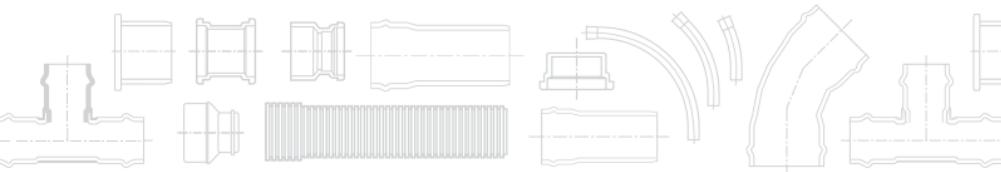
1. Store the pipe at the site in bundles.
2. Avoid compression, deformation or damage to bell ends of the pipe.
3. When bundles are stacked, ensure that the weight of upper bundles does not cause deformation to pipe in lower bundles (Maximum 2 bundles high).
4. Support pipe bundles at 2.4 metre (8ft) intervals (1.2 metres (4ft) from each end) on wood blocking to prevent damage to the bottom surfaces during storage.
5. Store lubricant in tightly sealed containers under cover.
6. Do not store pipe/fittings where gaskets may be exposed to ozone, UV radiation, or contamination (ie. grease, oil etc).
7. Protect the interior and sealing surfaces of pipe and fittings from dirt and foreign material. Leave caps on ends until just prior to installation.
8. When the bundles are stacked, ensure that the stack remains stable.
9. When pipe/fittings are being stored for a prolonged period, the bundles should be covered with an opaque cover, to protect against exposure to direct sunlight (Ozone, UV Radiation). The covering should allow adequate air circulation above and around the pipe to prevent excessive heat accumulation.



Handling

The following procedures are recommended for handling pipe and fittings:

1. When using mechanical equipment, exercise care to prevent damage to the pipe/fittings.
2. Lower pipe/fittings carefully from trucks and into trenches. Do not drop pipe/fittings. Dropped pipe/fittings can be damaged and should not be used.
3. In sub-zero (freezing) temperatures, use caution to prevent impact damage. Handling methods considered acceptable for warm weather are unacceptable during very cold weather.
4. When distributing the pipe along a trench (stringing), place pipe on the opposite side of the trench from the excavated earth. Place pipe with bell ends in the direction of the work progress.



Pipe Installation Instructions

Alignment and Grade

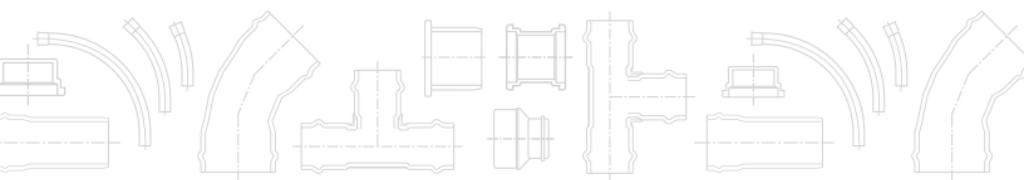
All pipe should be laid to, and maintained at required lines and grades established by the pipe system Design Engineer. Fittings, valves, air vents and hydrants should be installed at the required locations with valve and hydrant stems plumb.

Trench Width

Trench width at the ground surface may vary with and depend upon the depth, type of soils, and the position of the surface structures. The minimum clear width of the trench, measured at the spring line of the pipe should be 300mm (1ft) greater than the outside diameter of the pipe. The maximum clear width of the trench at the top of the pipe should not exceed a width equal to the pipe diameter plus 600mm (2ft). If the above defined trench widths must be exceeded, or if the pipe is installed in a compacted embankment, the pipe embedment should be compacted to a point of at least 2.5 pipe diameters from the pipe on both sides of the pipe or to the trench wall, whichever is less.

Preparation of Trench Bottom

- The trench bottom should be constructed to provide firm, stable and uniform support for the full length of the pipe.
- Bell holes should be provided at each joint to permit proper joint assembly and pipe support. Any part of the trench bottom excavated below grade should be backfilled to grade and should be compacted as required to provide firm pipe support.
- When an unstable sub-grade condition which will provide inadequate pipe support is encountered, additional trench depth should be excavated and refilled with a suitable foundation material as recommended by the project's Geotechnical Engineer. Ledge rock, boulders and large stones should be removed to provide 100mm (4") of soil cushion on all sides of the pipe and accessories.



Pipe Installation Instructions Continued

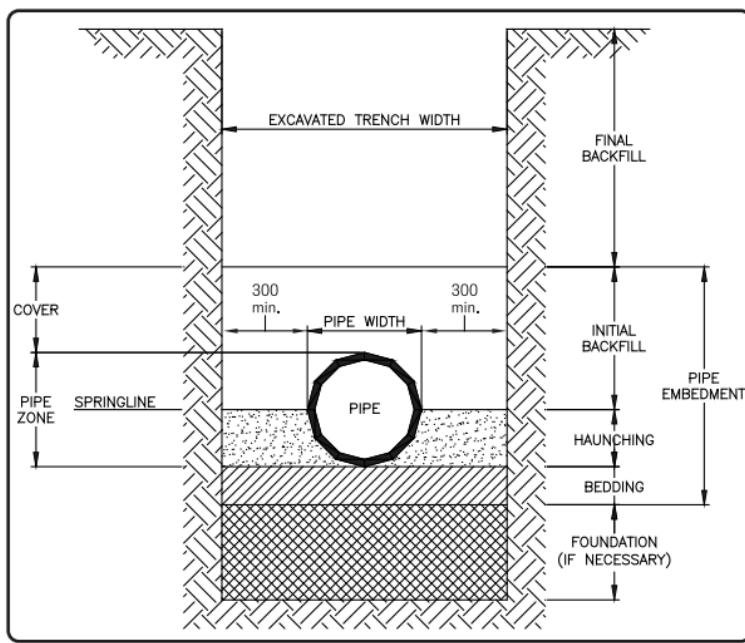


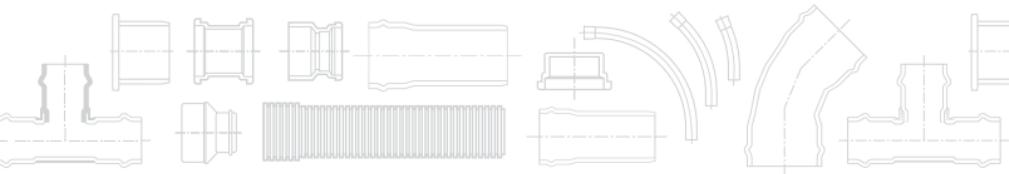
Figure 1. Typical Bedding Detail.

Laying of Pipe

To prevent damage, proper implements, tools and equipment should be used for placement of the pipe in the trench.

Under no circumstances should the pipe or accessories be dropped into the trench. All foreign matter or dirt should be removed from the pipe interior. Pipe joints should be assembled with care. When pipe laying is not in progress, open ends of the installed pipe should be closed to prevent entrance of trench water, dirt and foreign matter into the line.

It is good practice (if possible) to lay the pipe with the print line rotated to the top. This will help with the identification of the pipe if it ever has to be re-excavated.



Pipe Installation Instructions Continued

Pipe Embedment

PVC pipe should be installed with proper bedding that provides uniform longitudinal support under the pipe. Backfill material should be worked under the sides of the pipe to provide satisfactory haunching. Initial backfill material should be placed to a minimum depth of 300mm (1ft) over the top of the pipe. All pipe embedment material should be selected and placed carefully. Stones, frozen lumps and debris are not considered suitable for use in the embedment area of the pipe. Proper compaction procedures should be exercised to provide soil densities as specified by the Design Engineer.

Final Backfill

After placement and compaction of pipe embedment materials, the balance of backfill material may be machine placed. The final backfill should contain no large stones or large rocks, frozen material or debris. Proper compaction procedures should be exercised to provide required soil densities.

Assembly of Gasket Joints

The patented "Double-Seal" gaskets are "Locked-In" to the bell at the factory.

1. Remove caps and clean the gasket, bell interior, and spigot area with a clean rag, brush or paper towel to ensure all debris is removed from bell and spigot ends of the pipe. Check the gasket position. Inspect the gasket, pipe spigot bevel and sealing surfaces for damage or deformation. Be sure that the gasket is installed properly. Do not remove gasket as it is locked in during manufacturing. Once the gasket is removed, it cannot be reinstalled.

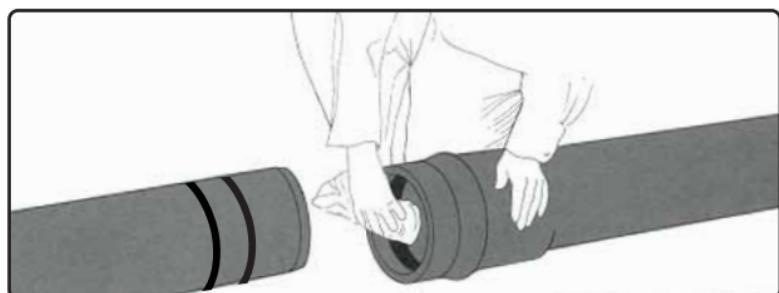
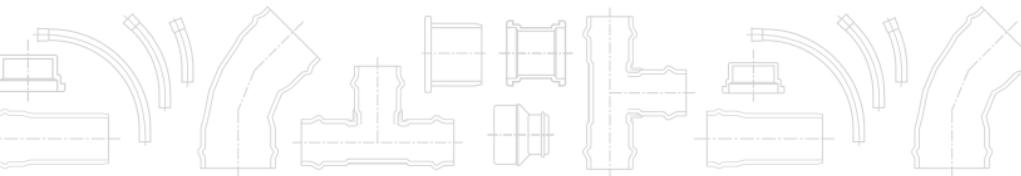


Figure 2. Cleaning gasket and bell.



Pipe Installation Instructions Continued

Assembly of Gasket Joints Continued

2. Use only Royal Building Products recommended lubricant supplied with the pipe. Apply lubricant to the gasket and spigot from the chamfer to 75mm (3") from the face of the spigot. Use of non-approved lubricants may promote bacterial growth and cause damage to the gaskets or pipe, as well as void the manufacturer's warranty.

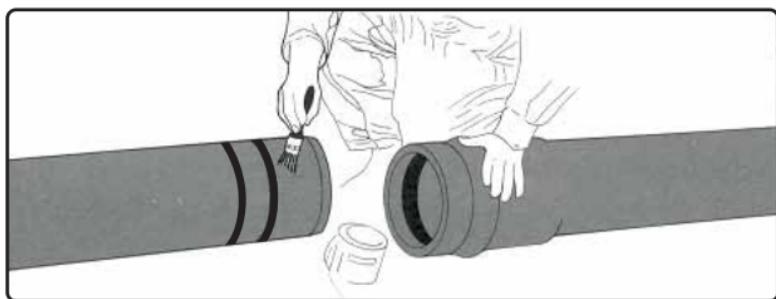


Figure 3. Apply lubricant.

3. After lubrication, the pipe is ready to be joined. Good alignment of the pipe is essential for ease of assembly. Align the spigot and the bell, and insert the spigot into the bell until it contacts the gasket uniformly. Do not suspend the pipe and "stab" it onto the bell. Ensure that the spigot does not touch bedding during installation. The spigot end of the pipe will be marked by Royal Municipal Solutions to indicate the minimum and the maximum depth of insertion. The first insertion line should be pushed all the way in and the second insertion should be exposed in front of the face of the bell. "Bury one - Show one".

Over-Insertion can cause leaks and/or breakage of the pipe bell. When unable to assemble using the bar and block method, then another mechanical method such as a come-along or an eagle claw should be used. "Do not use the backhoe bucket to assemble the pipe".

Do not assemble the joint beyond the second reference line.

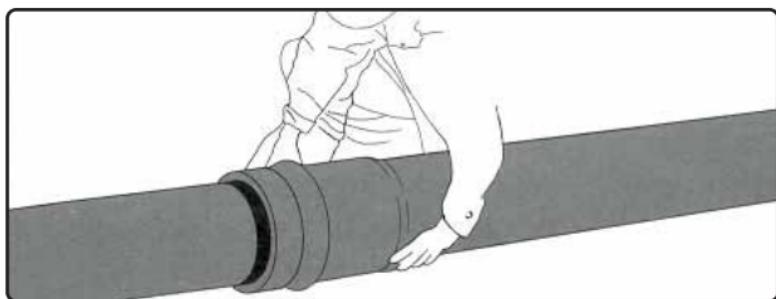
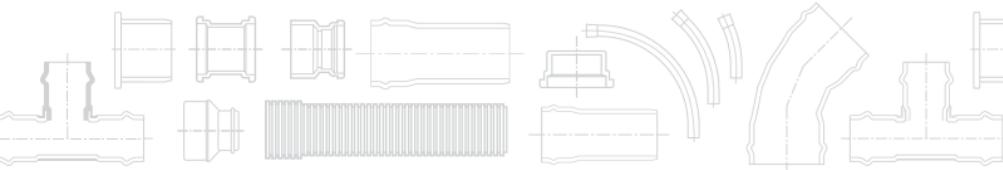


Figure 4. Assemble spigot into bell.

NOTE: Nitrile gaskets are available upon special request. Extra delivery time should be required for the supply of Nitrile gaskets.



Pipe Installation Instructions Continued

Field-Cut Pipe to Pipe

To join field-cut pipe, it is necessary to first prepare the pipe end. A square cut is essential for proper assembly. The pipe can be easily cut with a hacksaw, handsaw or a power saw with a steel blade or abrasive disc. It is recommended that the pipe be marked around its entire circumference prior to cutting to ensure a square cut. The insertion line should then be marked on the cut piece of pipe.

The location of the insertion line is determined by using the pipe bell as a guide. Measure the insertion depth of the bell. This is the distance from the end of the bell to the start of the bell taper. Subtract 19mm ($\frac{3}{4}$ ") from the insertion depth distance. The result is the distance from the end of the spigot to the insertion line (insertion depth).

IMPORTANT: This is the maximum insertion depth. Leave the second insertion line showing when the pipe is assembled. See Figure 5 below.

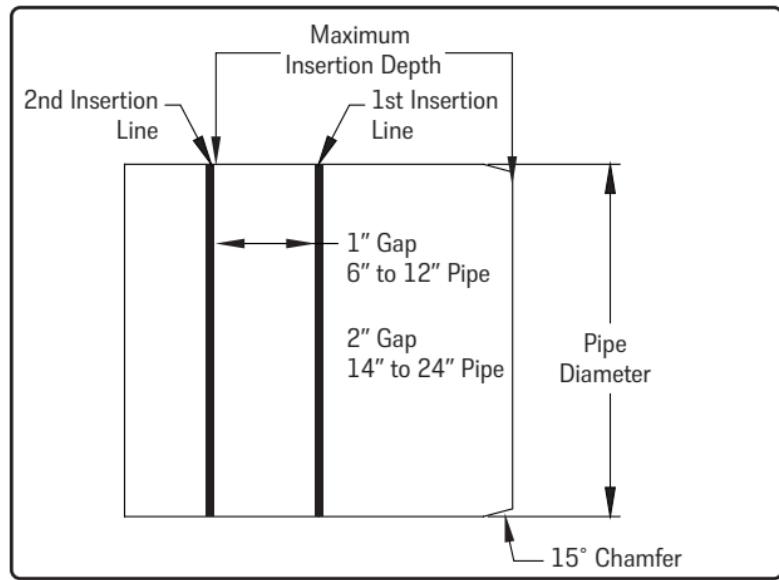
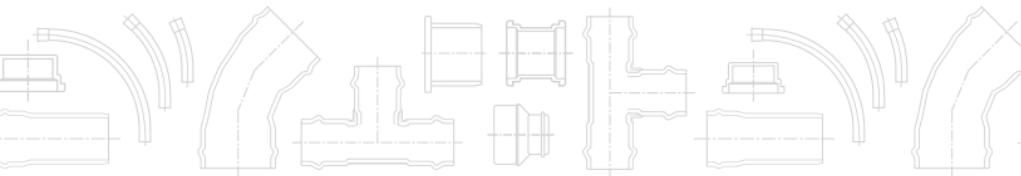


Figure 5. Chamfer Detail

Add a Chamfer to the spigot end of the field cut pipe. Use a factory-finished chamfer end as a guide for proper chamfer angle and depth. The end may be chamfered using a pipe chamfering tool or a wood rasp which will cut the correct taper. A portable sander or abrasive disc may also be used to chamfer the pipe end. Round off any sharp edges on the leading edge of the chamfer with a pocket knife or file. It is important to try and keep the chamfer depth even around the circumference of the pipe.



Pipe Installation Instructions Continued

Designed Changes in Alignment

Ideally all changes in alignment should be designed and accomplished with the proper use of fittings. Either push on PVC Fittings (injection moulded or fabricated) or Ductile Iron fittings (MJ or Push On) can be used.

The use of a fitting provides for straight insertion of the spigot into the joint, allowing the directional change (horizontal or vertical) to be made quickly and easily during construction. Since different fitting types have different insertion requirements always check bell depth of fitting and if necessary re-mark spigot, to ensure the correct insertion depth is achieved. Royal recommends that all detailed design incorporate the use of fittings. Other methods of changing the alignment are available to be used in the field in order to accommodate very minor changes in alignment as they come up during the construction process.

PVC Fittings

100mm - 200mm (4" - 8") fittings are injection molded to CSA B137.2 and AWWA C907 - For these sizes the standard angles are $11\frac{1}{4}^\circ$, $22\frac{1}{2}^\circ$, 45° and 90° degrees.

250 mm (10") and larger, are fabricated to CSA B137.3. These fittings are available in standard configurations and bend angles. In addition, custom bend angles and configurations can be special ordered. Keep in mind that delivery for custom orders may take a few days longer than standard bends.

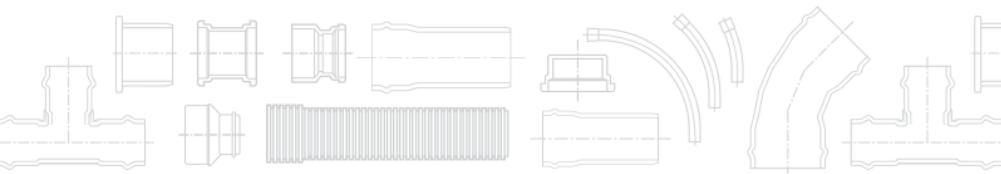
Royal Municipal Solutions also produce 5° Radius bends - For minor changes in alignment. The radius shape of the 5° bend affords virtually no axial forces; therefore, they can be installed without need for joint restraint.

MJ or Push on DI fittings

Ductile Iron fittings Mechanical Joint (MJ) or Push On in either compact (AWWA C153) or long body (AWWA C110) can be used with PVC pipe. See the fitting manufacturer's recommendations for alignment changes and deflections available with this type of fitting.

Field Changes in Alignment

A – Angular Deflection in the Joint – This should be used only in the field, when minor directional changes are required during construction. This method should be done with extreme caution and care. This technique should not be used during engineering design.



Angular Deflection Procedure

- 1- Under - insert spigot into bell; stop inserting when the first insertion line is even with the face of the bell. If you have a field cut spigot this is 25mm (1") closer to edge of the spigot than insertion line that you have just marked on the pipe.
- 2- Check to ensure that spigot is in straight alignment with the bell.
- 3- Manually, move the other end, bell end to achieve required offset.
- 4- Place and consolidate haunching and initial backfill along the barrel, leaving the previous joint exposed.
- 5- After under-inserting the next spigot, go to the previous joint and check to ensure that cascading of this joint has not occurred. (Cascading occurs when the spigot of the previous joint inserts further into the bell, than was originally intended.)

As this technique requires extra time and diligence by inspection and construction, it is recommended for only very minor field adjustments of maximum 2° on 100mm (4") to 300mm (12") and 1° on 350mm (14") to 600mm (24").

For reference purposes 1° of joint deflection is equal to a 100mm (4") offset for a 6.1m (20ft) piece of pipe.

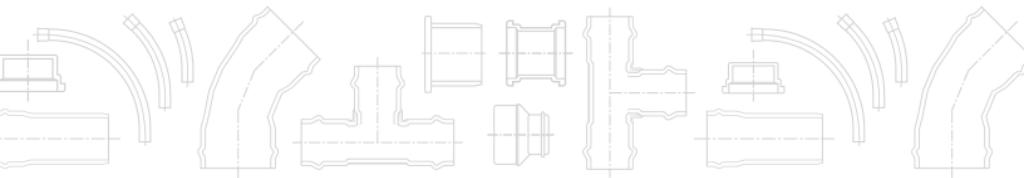
B- Longitudinal Bending of Pipe Barrel – This should be only be used when minor directional changes are encountered during construction. Note, this should not be performed if there is any chance that services connections are to be tapped into this length of pipe at a later date.

- 1- Correctly insert the spigot into bell leaving the second insertion line showing,
- 2- Place and consolidate haunching and initial backfill along one third of the pipe including the joint you have just assembled.
- 3- Manually, move the other end/ bell end to achieve the offset desired. See Table 1 below.
- 4- Place and consolidate the remaining haunching and initial backfill
- 5- Remove pry bar from against the bell.

Table 1.

Pipe Diameter mm (in)	Max. Angle of Deflection
150 (6)	4.0°
200 (8)	3.0°
250 (10)	2.5°
300 (12)	2.1°

Never Combine methods A and B. Royal does not recommend longitudinal bending of pipe in sizes above 300 mm (12").



Angular Deflection Procedure Continued

Due to the potential for catastrophic failure if a tap is made into a longitudinally bent piece of pipe this method should only be considered as a last resort.

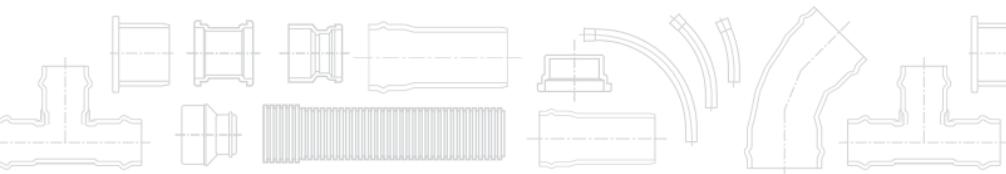
Due to this potential safety concern Royal does not recommend the use of this method to make alignment changes.

Fitting Installation Instructions

PVC Pipe and PVC Fitting Assembly

1. Cut the pipe square, to the required length, and chamfer the pipe end to match the factory chamfer. Remove any burrs or other sharp pieces that may harm the gasket when the pipe is inserted into the bell.
2. Mark the fitting insertion line on the pipe. Fitting bells are different from pipe bells so a new insertion line that corresponds to the fitting bell must be marked on the pipe. Measure the depth of the fitting bell. This is the distance from the edge of the bell to the start of the bell taper. For all sizes of fittings subtract 19mm ($\frac{3}{4}$ ") from the bell depth distance just measured. The result is the maximum insertion depth. Measure this distance from the end of the spigot and mark a line 360° around the pipe.
3. Clean the bell, gasket and spigot and ensure they are free from any debris.
4. Lubricate both the gasket and spigot. Apply a 1mm thickness of lubricant to the bell lip and gasket area and to the spigot a distance of 75mm (3") from the end of the spigot. Only use lubricant supplied by the manufacturer.
5. Position the spigot in the bell. Check that the bell and spigot are free from debris. Place the spigot at the bell lip such that the chamfer of the spigot is resting against the lip of the gasket.
6. Push the spigot into the bell, until the first insertion line is past the lip of the bell. The second insertion line should still be visible. If the second insertion line is not visible pull back on the pipe until the second insertion line becomes visible. **DO NOT OVER INSERT THE PIPE IN THE FITTING!**

Note: If there is a large resistance force to the insertion of the spigot into the bell, the gasket may have become dislodged. In this case, disassemble the joint ensure the gasket is in the correct position and then re-assemble the joint as per the instructions above.



Fitting Installation Instructions Continued

PVC Pipe and Ductile Iron Fittings assembly

Ductile Iron Fittings have shallower bells than PVC Fittings. For M-J Ductile Iron Fittings, the edge of the PVC should be square cut. For Push-On Ductile Iron Fittings, a small chamfer ($\frac{3}{8}$ ") is required. For more detailed information about assembly to Ductile Iron Fittings, please contact the fittings manufacturer.

Deflecting the Joint at Fittings

PVC Fittings

PVC Pressure fitting joints, by nature of their gasket design and insertion depth, cannot accommodate large deflection angles. The maximum angle of deflection is 1° for all sizes of PVC pressure fittings. This is equivalent to 100mm (4") of deflection over a 6.1 metre (20') length of pipe.

DI Fittings

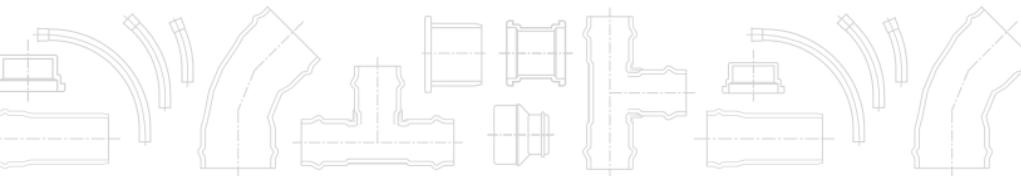
M-J Ductile Iron Fittings can generally accommodate more deflection at the joint than PVC Fittings. Consult the Ductile Iron Fittings manufacturer's installation guide for details.

When deflecting the pipe/fitting joint, use the following procedure:

1. Assemble the pipe/fitting joint such that there is a 13mm ($\frac{1}{2}$ ") gap between the insertion line and the edge of the bell. This gap will allow more movement at the end of the pipe.
2. Shift the bell end of the 6.1 metre length of pipe 100mm (4") in the direction of deflection. A pry bar should be used to shift the bell end—never use a backhoe or other mechanical equipment.

Pipe to Pipe and Pipe to Fitting Assembly Notes

- Never push directly against the pipe by any mechanical means (pry bar, hook, etc.). Always place a block of wood between the face of the pipe bell and the bar. This will protect the pipe from damage and help to ensure even distribution of the force pushing the pipe.
- Any means of assembly must allow for straight alignment of the bell and pipe during assembly. Pushing or pulling on one side of the pipe, causing misalignment of the pipe and bell, is not acceptable.
- Smaller diameters of pipe and fittings can generally be assembled by hand. Larger diameters of pipe may be assembled using a come-along or jacks and pulleys. A backhoe should never be used to assemble pipe to pipe or pipe to fittings.



Thrust Restraint

Thrust Blocking

Concrete reaction or thrust blocking should be provided at each hydrant, valve, bend, tee and at reducers or fittings where changes occur in pipe diameter or direction. Concrete thrust blocks shall be cast in place, poured against undisturbed soil. Pre-cast blocks are not permitted.

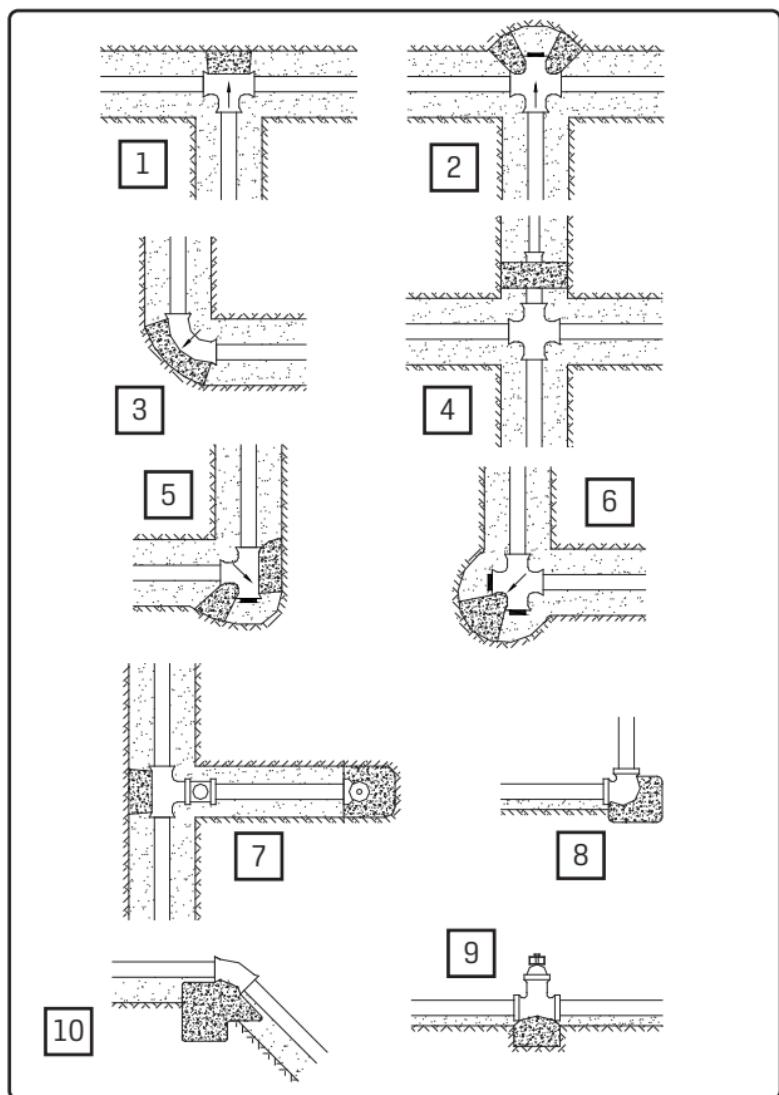
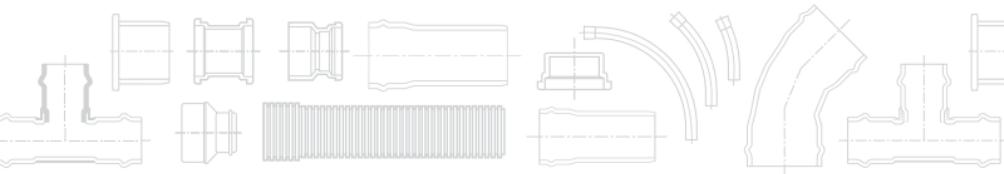


Figure 6. Thrust Block Detail.

1. Through line connection (tee)
2. Through line connection (cross used as tee)
3. Direction change (elbow)
4. Change line size (reducer)
5. Direction change (tee used as elbow)
6. Direction change (cross used as elbow)
7. Hydrant Tee
8. Hydrant Boot
9. Valve Anchor
10. Vertical direction change (bend anchor)



Thrust Restraint Continued

Mechanical Joint Restraint

Royal Building Products, Municipal Solutions will accept the use of any restraint device that carries third party certification to ASTM F1674 (American Society for Testing and Materials), FM (Factory Mutual) and UL (Underwriters Laboratories). It is the responsibility of the restrainer manufacturer to supply the necessary support data to prove that their product complies with these requirements and is compatible with the pipe/fittings.

It is important to note that Royal Building Products does not assume any liability arising from the use of any restrainers on pipe or fittings manufactured by Royal Building Products.

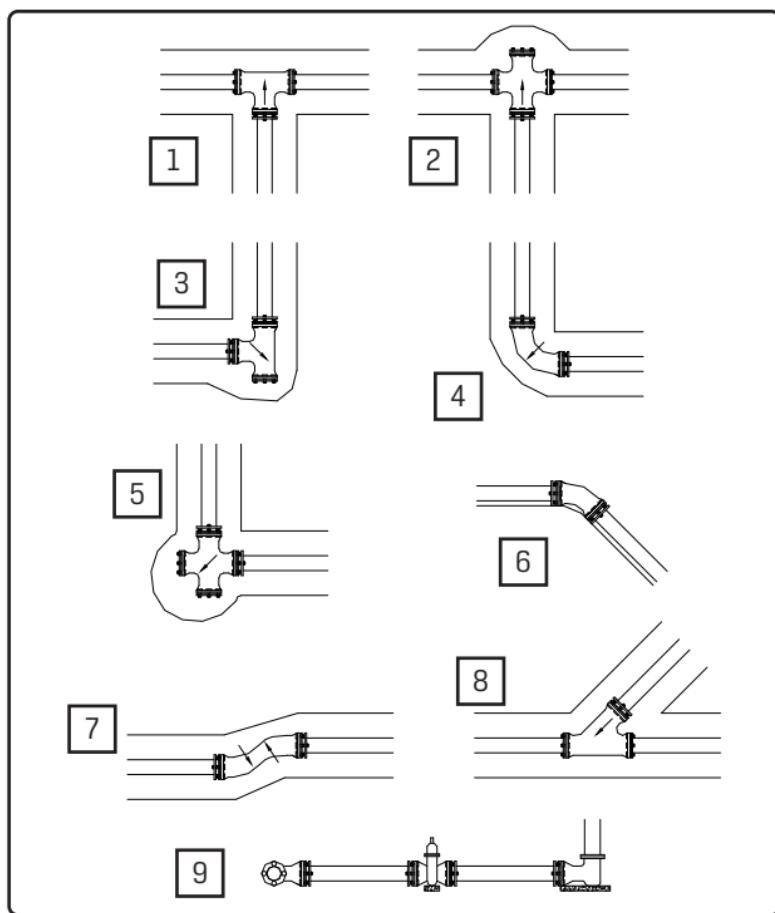
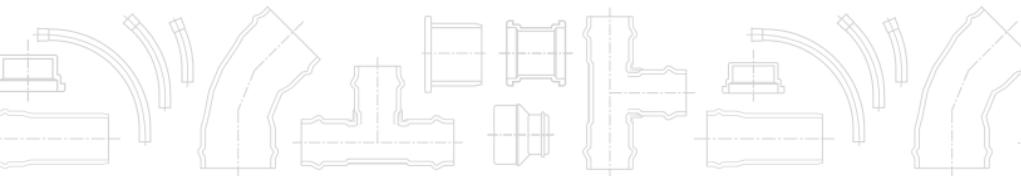


Figure 7. Chamfer Detail.

1. Through line connection
2. Through line connection (cross used as tee)
3. Direction change (tee used as elbow)
4. Direction change (elbow)
5. Direction change (cross used as elbow)
6. Vertical direction change (elbow)
7. Direction change
8. Through line connection (wye)
9. Hydrant runout



BullDog™ Installation Instructions

Royal Municipal Solutions BullDog™ Joint Restraint System

Royal manufactures a product that incorporates joint restraint with standard C900 pressure pipe. BullDog™ uses a restraint mechanism in the pipe bell to restrain the joint internally.

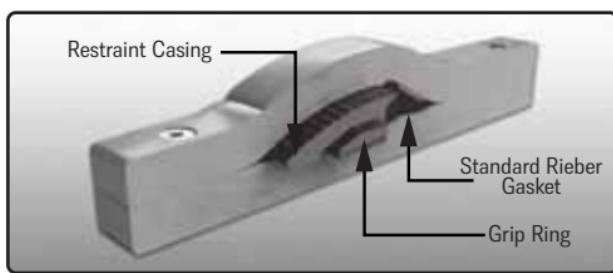
Cleaning the Bell and Spigot

As with standard joint assembly, the BullDog™ bell and spigot must be properly cleaned prior to assembly. In addition, the BullDog™ hardware must also be completely cleaned. Any debris in this area may prevent proper assembly of the joint and keep the restraint mechanism from engaging.

Inspection of BullDog™ Hardware

The sketch below shows the restraint mechanism and its location in the BullDog™ bell.

Figure 8.



The mechanism includes the metal casing, which is molded into the bell and holds the grip ring, and the grip ring itself. The grip ring should sit at the back of the casing and should be able to be spun easily within the casing. It should be oriented such that the tapered end of the grip ring matches the tapered end of the casing. If the grip ring is installed backwards, it will not spin easily within the casing and the joint cannot be assembled. See Figure 9.

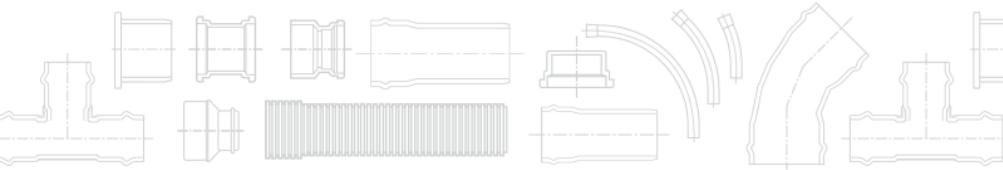
Figure 9.



Pipe Assembly

While Bull Dog pipe does have a rieber gasket the assembly of this type of joint is different from Royal C900/C905 bell and spigot pipe.

1. Clean the bell thoroughly, make sure the grip ring, gasket and pipe spigot are free of any foreign material before assembling the pipe.



BullDog™ Installation Instructions Continued

2. Lubrication is also very important. Only lubricate the Gasket in the bell. Do not lubricate the Bulldog grip ring or the spigot of the pipe. Lube can be applied sparingly to the chamfer or bevel of the pipe.

3. Joint Alignment is critically important for Bulldog. The pipe must be in straight alignment. Mis-aligned pipe requires a much higher force to complete the assembly. Properly aligned, the bulldog joint can be assembled manually using a prybar, come-along or Eagle Claw tool.

4. Once aligned a force pushes the chamfer through the bell lip and the bevel enters the grip ring. By slowly applying force the bevel will centre the grip ring inside the casing and the grip ring will expand slightly.

5. The grip ring is pushed to the back of the casing and butts up against the back of the casing. The spigot then moves on to the lip of the rieber gasket until it comes into contact with the gasket.

6. The spigot continues past the gasket until the first insertion line is past the lip of the bell. The second insertion line should still be visible in front of the bell lip.

For Open cut bulldog installations an initial pressurization will set the joints and may cause some minor expansion of the system that will require make up water prior to performing the actual pressure test. It is a good idea to pressurize the system up to the test pressure for a period of one (1) hour then remove the pressure and add any makeup water before beginning the actual final pressure test.

Assembly of the joint can under certain circumstances cause the over-insertion of previously assembled joints. Backfilling the pipe prior to joint assembly can prevent over-insertion of previous joints. Also, embedment material can be used to centre load the pipe and prevent movement. See figure 10.

For Directional drilling applications the Bulldog Joints must be set prior to being pulled into the bore. The joint is set by applying a back pressure of 2 to 3 times the assembly force used to put the pipe together. When using Bulldog in a directional drilling application please first consult with the Royal Technical Team for additional guidance.

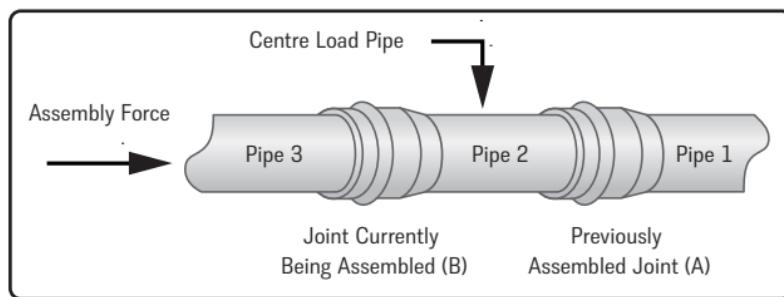
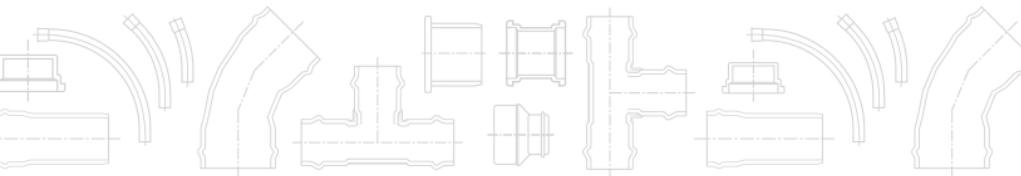


Figure 10.



Cobra Lock® Installation Instructions

Cobra Lock® HDD Pipe Solutions

Royal Municipal Solutions Cobra Lock® System is a self-restrained C900 pressure pipe system that can be used for Horizontal Directional Drilling installations or for open-cut installations. This system includes plain end CIOD pressure pipe, couplings and nylon splines used to lock the pipe and couplings together.

Cobra Lock® pipe is standard C900 pressure pipe with grooves cut into the pipe wall at both ends. The pipe is locked together by lining up the pipe grooves with the coupling grooves and inserting a nylon spline.



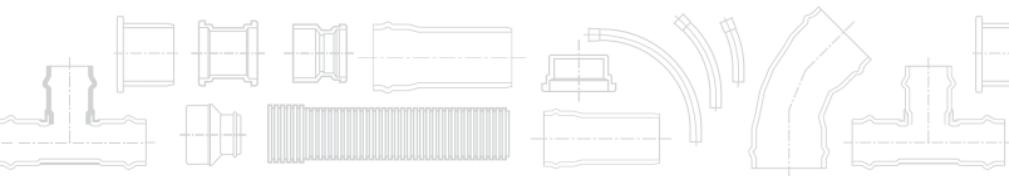
Figure 11.

Assembly

Cobra Lock® couplings are delivered with the O-rings already installed in the gasket grooves. Care must be taken that dirt does not get into the gasket grooves or on the O-rings. If the O-rings/gasket grooves are not kept clean, the O-ring must be removed, the O-ring and gasket groove cleaned, and the O-ring re-installed prior to installation. Each coupling should be checked to verify that O-rings are present in both sides of the coupling.

Prior to joint assembly, the pipe spigot ends must be lubricated, including lubrication of the pipe bevel. Proper lubrication of the pipe spigot is required to ensure that the pipe will slide past the orings during installation.

With the spline insertion holes on the coupling facing up, push the coupling onto the pipe spigot until it stops (when the pipe reaches the pipe stop in the coupling). Insert the spline into the spline insertion hole, ensuring that the spline is completely inserted. If difficulty is encountered when inserting the spline, adjust the coupling slightly to better line up the spline grooves.



Cobra Lock® Installation Instructions

Horizontal Directional Drilling

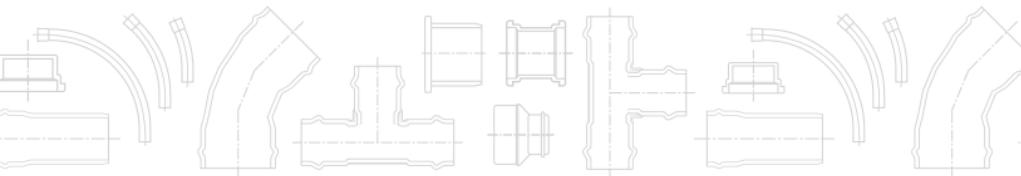
When installing Cobra Lock® using HDD, it is imperative that an experienced drilling contractor be used. If field cutting of pipe is necessary, field cut tool kits are available from Royal Pipe and Fittings Solutions for rent, Contact us for details.

When pulling Cobra Lock® using HDD, do not exceed the recommended maximum pulling force or bending limits shown below.

Recommended Maximum Pulling Force and Bending Limits

Trade Size in	Tightest Bending Radius, m (ft)	Maximum Pulling Force, kN (lb)	
		Straight Alignment	Tightest Bend
4" DR18	30.5 (100)	36.4 (8,200)	29.8 (6,700)
6" DR18	45.7 (150)	56.9 (12,800)	40.0 (9,000)
8" DR18	61.0 (200)	112.0 (25,200)	80.0 (18,000)
10" DR18	76.2 (250)	156.6 (35,200)	113.9 (25,600)
12" DR18	91.4 (300)	182.8 (41,100)	117.4 (26,400)

Table 3.



Inspection And Testing

Good practice dictates pressure testing portions of lines as they are completed in advance of the entire system. Before testing, the pipeline must be backfilled and braced sufficiently to prevent movement under pressure.

The following three points should be considered when testing:

1. The pipe to be tested must be sufficiently backfilled to prevent movement while under test pressure.
2. Thrust restraint at fittings should be permanent and constructed to withstand test pressure. If concrete thrust blocks are used, sufficient time must be allowed before testing to permit the concrete to cure.
3. Test ends should be capped and braced to withstand the thrusts that are developed under test pressure.

Pressure and Leakage Test

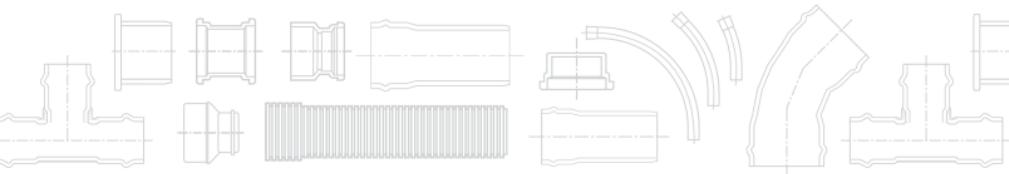
A combined pressure and leakage test is recommended. The test pressure and duration shall be as specified by the Design Engineer. The test pressure should never exceed the pressure rating of the pipe being tested.

Relieving Air From Pipe Line

The pipeline should be filled as slowly as possible (not more than 1 ft/sec) to avoid any unnecessary surges and entrapment of air. Venting air from the line is of utmost importance.

Pressure pipe is seldom laid to flat grade, so there are high and low sections along the line. If the high section elevation is above the low part of the line, a larger amount of air will be trapped. Corporation stops or automatic air relief valves should be installed at these points. Air can be blown from hydrants in pipe sizes up to 200mm (8"). In larger diameter pipes, air will not enter the hydrant branch, therefore it will be necessary to install air release valves at high points.

The line should be filled slowly with water to static pressure, and all air vents opened to allow air to escape. The line should be filled at a rate that allows air to leave the line at the same rate. It is recommended practice to let the line remain under static pressure for at least 15 minutes. All air vents should then be opened again to allow any remaining air to be released from the line, after which the line may be brought up to full test pressure. The leakage shall not exceed that specified by the Design Engineer. Test pressure should never exceed the pressure rating on the pipe being tested.



Service Connections And Tapping

Service lines can be connected to Royal PVC Pressure Pipe by the following methods:

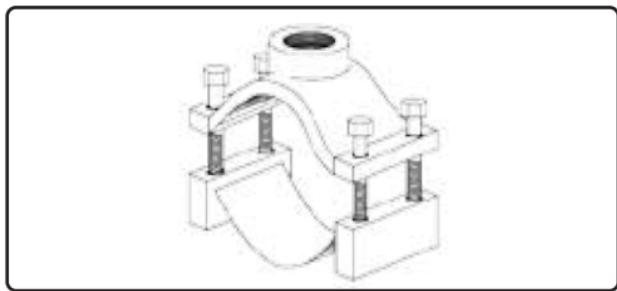
Direct Tapping

- Up to 25mm (1") corporation stops can be used.
- Only 150mm - 300mm (6" - 12") diameter AWWA C900 Pressure Class 235 (DR18) and Pressure Class 305 (DR14) pipe. Do not direct tap Pressure Class 165 (DR25) pipe.
- "Wet" (under-pressure) or "dry" (no-pressure) taps are permitted.

Approved Service Saddles for PVC Pressure Pipe (See Figure 12.)

- Can be used with any size or class of pipe.
- Maximum outlet permitted is 50mm (2").
- Saddles must be sized to provide even support around the full circumference of the pipe.
- The saddle must provide a minimum bearing width of 50mm (2") along the axis of the pipe.
- The design of the saddle should not have lugs that will indent the pipe when the saddle is tightened.
- Can be used with wet or dry taps.

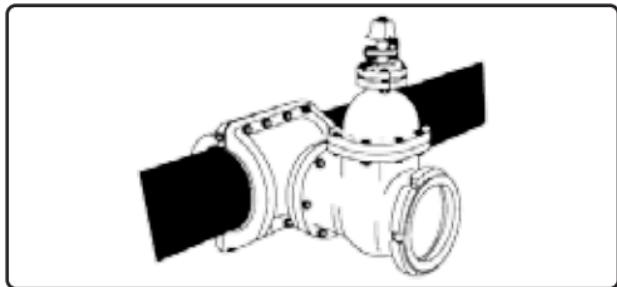
Figure 12.

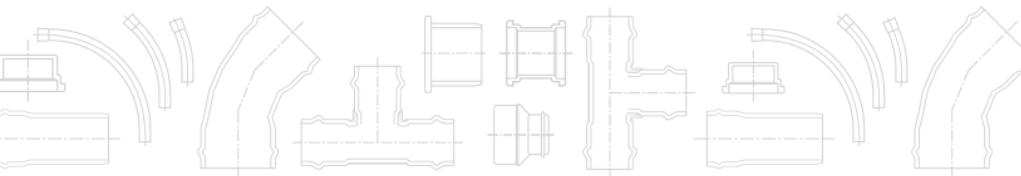


Tapping Sleeves and Valves (See Figure 13.)

- Used for services requiring larger than 50mm (2") taps.
- Must be supported independently of the pipe.
- Thrust restraints are required.
- Can be used with wet or dry taps.

Figure 13.





General Tapping Recommendations

1. AWWA C800 (Mueller) threads are required.
2. Shell cutters with a minimum of 2 slots are necessary to retain and remove the coupon. The throat depth should be sufficient to handle heavier DR14 pipe. Use the coupon removal tool supplied with the slotted cutting bit to remove the coupon. Running a screwdriver through the slots in the cutter to remove the coupon can prematurely dull the cutting bit and cause additional sharpening to be required.

Do not use twist drill bits for tapping PVC. It is required that a sharp tapping tool and tapping lubricant be used in the tapping process.

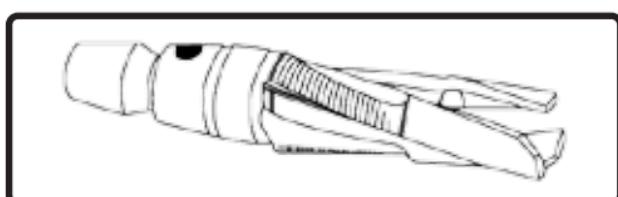


Figure 14.

3. The tapping machine shall have an independent boring bar feed mechanism. Manufacturers instructions for operating the tapping machine should be followed.

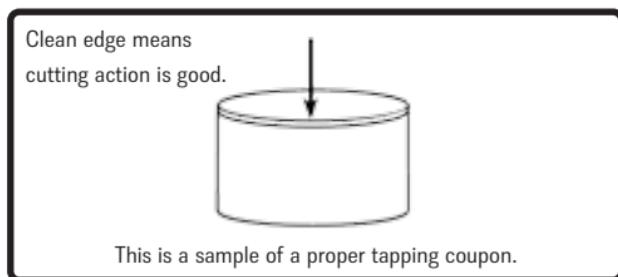


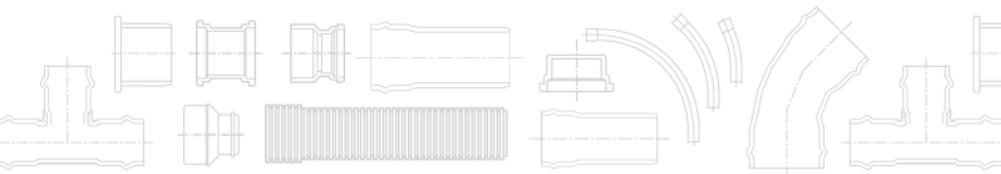
Figure 15.

4. The tapered thread of the corporation stop shall be spirally wound with 2-3 layers of Teflon® tape. This procedure is also required when installing corporation stops in tap couplings.

5. A torque wrench should be used to tighten the corporation stop using $36.7\text{N}\cdot\text{m}$ ($27\text{ft}\cdot\text{lb}$), 2-3 threads should be showing after removal of the tapping machine. If leakage is apparent after final torque tightening of $47.6\text{N}\cdot\text{m}$ ($35\text{ft}\cdot\text{lb}$), the corporation stop will have to be reinstalled. The line pressure should be relieved; the corporation stop removed; new Teflon® tape wrapped on the threads and the corporation stop reinstalled to a torque of $36.7\text{N}\cdot\text{m}$ ($27\text{ft}\cdot\text{lb}$).

6. Horizontal goose-necks of the service line are suggested to allow the expansion and contraction of the service line.

7. Pipe temperature should be between $0^\circ\text{C} - 40^\circ\text{C}$ ($32^\circ\text{F} - 104^\circ\text{F}$) when direct tapping under pressure. Be extremely cautious when tapping in very cold weather.



General Tapping Recommendations Continued

8. When making more than one tap on a length of pipe, the tap locations should be staggered (circumferentially) and at least 450mm (18") apart, longitudinally.
9. Do not tap closer than 600mm (2ft) from both the back of the bell and the spigot insertion line.
10. Never direct tap in an area of the pipe that has been bent.

Basic Safety Precautions

When drilling or tapping any pressurized water pipe, basic safety precautions are advised to assure personal safety of the workers in the event of a sudden and unexpected pipe failure.

All local Health and Safety Regulations must be followed.

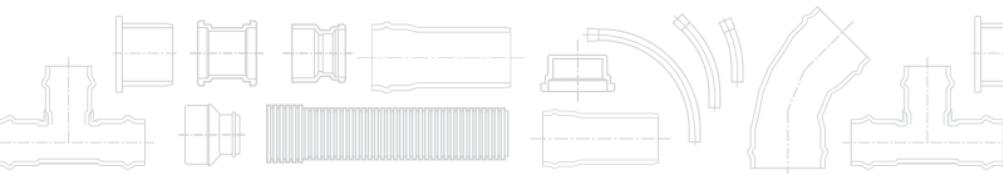
Although such failures are extremely infrequent, the following safety practices are recommended.

- A second worker or supervisor should always be present in the immediate vicinity when making "wet" taps. In addition, workers should be positioned at isolation valves.
- Protective clothing: including hard hat, safety shoes, goggles or face mask, should be worn. Means of quick egress from the trench must be available.
- A heavy protective blanket, 1.2 metres x 1.8 metres (4ft x 6ft) should be used to cover the exposed pipe in the area of the tap. The blanket should have a hole in the center permitting access and operation of the drilling and tapping machine.

Dimensions of Royal Municipal Solutions C900/C905 Pressure Pipe

Nominal Size mm (in)	Average Outside Diameter mm (in)	Average Bell Outside Diameter mm (in) (DR18)	Average Wall Thickness mm (in)		
			DR14	DR18	DR25
100 (4)	122 (4.799)	154 (6.05)	9 (0.362)	7 (0.281)	5 (0.203)
150 (6)	175 (6.899)	217 (8.55)	13 (0.522)	10 (0.406)	7 (0.291)
200 (8)	230 (9.052)	281 (11.05)	17 (0.685)	13 (0.531)	10 (0.383)
250 (10)	282 (11.100)	342 (13.45)	21 (0.839)	16 (0.653)	12 (0.470)
300 (12)	335 (13.200)	405 (15.97)	25 (0.999)	20 (0.777)	14 (0.559)
350 (14)	389 (15.299)	466 (18.38)	-	23 (0.901)	17 (0.649)
400 (16)	442 (17.401)	531 (20.92)	-	26 (1.025)	19 (0.738)
450 (18)	495 (19.500)	597 (23.51)	-	29 (1.147)	21 (0.826)
500 (20)	549 (21.598)	658 (25.90)	-	32 (1.271)	23 (0.917)
600 (24)	655 (25.799)	784 (30.86)	-	39 (1.513)	28 (1.094)

Table 4.

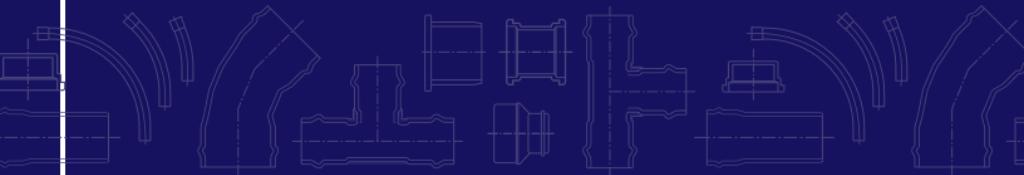


Conversion Chart

feet	to metres	0.3048
metres	to feet	3.2808
miles	to kilometres	1.6093
kilometres	to miles	0.6214
inches	to millimetres	25.400
millimetres	to inches	0.0394
U.S gallon	to cubic metre	0.003785
cubic metre	to U.S gallon	264.1728
cubic yard	to cubic metre	0.7645
cubic metre	to cubic yard	1.3079
pound (force)	to newton	4.4482
newton	to pound (force)	0.2248
pound (mass)	to kilogram	0.4536
kilogram	to pound (mass)	2.2046
psi	to kilopascal	6.8947
kilopascal	to psi	0.1450
US gpm	to cu. ft./sec	0.0022
cu. ft./sec	to US gpm	448.8306
US gpm	to litres/sec	0.0631
litres/sec	to US gpm	15.8503
ft•lb (force)	to N•m	1.3558
N•m	to ft•lb (force)	0.7375
lb/ft	to kg/m	1.4882
kg/m	to lb/ft	0.6721

Notes for Bulldog™ (Integral Joint Restraint System)

Notes for Cobra Lock® (HDD Pipe Solutions by Royal)



Our various pipe and fittings solutions have been manufactured to meet the needs of our customers and their applications. Contact one of the below Sales Centres for more information:

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