GUIDE FOR
PVC PRESSURE FITTINGS

PVCPIPE association

PVC PRESSURE FITTINGS

TABLE OF CONTENTS

PVC PRESSURE FITTINGS

INTRODUCTION

This document has been developed by the Uni-Bell PVC Pipe Association for design and installation of gasketed PVC fittings where gasketed PVC pressure pipe is used in potable water, force main, pressure irrigation, and reclaimed water applications. The guide provides information on gasketed PVC fittings that are available for various dimension ratios and outside diameters of PVC pipe through 60-inch. This document does not include information on solvent welded or fusible PVC fittings.

STANDARDS AND SPECIFICATIONS

Product standards used in this guide include:

- ASTM D2774, Standard Practice for Underground Installation of Thermoplastic Pressure Piping
- ASTM D3139, Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
- ASTM F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- ASTM F1674, Test Method for Joint Restraint Products for Use with PVC Pipe
- AWWA C605, Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
- AWWA C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4-inch through 60-inch (100 mm through 1500 mm)

  Note: In 2016, AWWA's latest edition of C900 consolidated all diameters 4-inch through 60-inch into a single standard; therefore, all fabricated fittings and machined couplings can now be specified by referencing the C900 standard.
- AWWA C907, Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4-inch through 12-inch (100 mm through 300 mm), for Water, Wastewater, and Reclaimed Water Service
- CSA B137.2, PVC Injection-Moulded Gasketed Fittings for Pressure Applications
- CSA B137.3, Rigid Polyvinyl Chloride (PVC) Pipe for Pressure Applications
- FM1612, Polyvinyl Chloride (PVC) Pipe and Fittings For Underground Fire Protection Service
- NSF/ANSI 14, Plastics Piping System Components and Related Materials
- NSF/ANSI 61, Drinking Water System Components – Health Effects
- UL1285, Standard for Pipe and Couplings, Polyvinyl Chloride (PVC), and Oriented Polyvinyl Chloride (PVCO) for Underground Fire Service

PVC PRESSURE FITTINGS

PRODUCTS

The different types of fittings are as follows:

Tees have an outstanding leg that is 90° from the main.

Crosses have two outstanding legs that are opposite each other.

PVC PRESSURE FITTINGS

PRODUCTS (CONT.)

Bends can have standard angles (11.25°, 22.5°, 45° and 90°) or any custom-built angle from 1° to 90°.

Sweeps are used to change alignment/direction while reducing hydraulic losses. Sweeps are typically available from 1° to 5°.

PVC PRESSURE FITTINGS

PRODUCTS (CONT.)

Couplings/Sleeves are used to join two pipes that have the same diameter. These have multiple applications including:

- Tie-in connections to existing lines
- Connecting short lengths of pipe
- Repairing damaged pipelines
- Changing pipeline direction (high-deflection coupling)

Reducers/Tapers/Adapters are used to transition between two different pipe diameters.

PVC PRESSURE FITTINGS

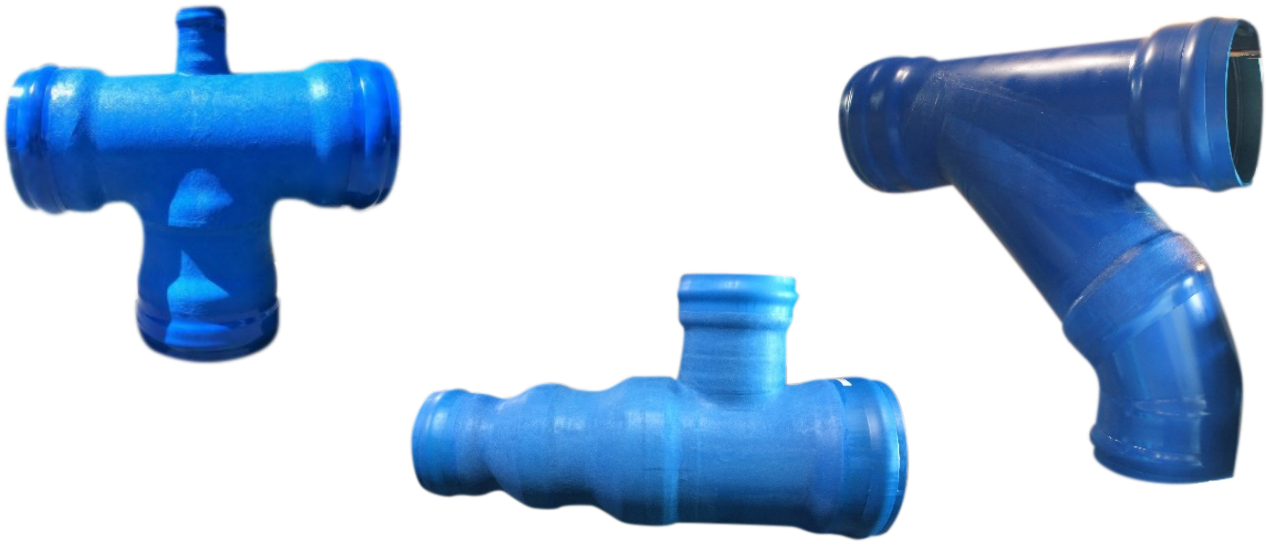
PRODUCTS (CONT.)

Tapped Couplings are one-piece fittings with pre-molded threads for service taps. Tapped couplings are available to accommodate various mainline sizes with numerous tap configurations.

Plugs/Caps are designed for stopping flow on a segment of pipe. Plugs are used at dead ends.

PVC PRESSURE FITTINGS

PRODUCTS (CONT.)



Custom Products can be manufactured and are available in push-on or restrained joint.

MANUFACTURING METHODS

There are three manufacturing methods used for AWWA PVC fittings. All three types use gasketed push-on joints and the internal pressure capacity is equal to or greater than that of the pipe pressure rating.

FABRICATED FITTINGS

Fabricated fittings are constructed from sections of PVC pipe meeting the requirements of the AWWA C900 standard. Their constituent parts are the same as the pipeline with which they will be used. The body of the fitting is extruded PVC pipe that has already passed the standard's testing requirements. Fabricated fittings include single thermoformed bends and couplers. As well, multiple segments of PVC pipe can be cut into wedge shapes, or prepared to accept leg insertions, and joined under factory-controlled conditions to form an essentially homogeneous structure. Reinforcement may be applied and permanently bonded to the outside surfaces of the fittings.

Available products include:

- Tees
- Crosses
- Bends (standard or custom angles)
- Couplings
- Reducers
- Adapters
- Tapers

PVC PRESSURE FITTINGS

Fabricated PVC fittings are available for any size PVC pipe from 4-inch through 60-inch. Fabricated fittings are available in multiple pressure classes and have the same or greater pressure class as the PVC pipe to which they are joined. Please use AWWA C900 for fabricated fittings recommended specifications.

INJECTION-MOLDED FITTINGS

Injection-molded fittings are manufactured by injecting PVC compound into a mold cavity per AWWA C907. The standard requires that each fitting be made from PVC compound with a minimum Hydrostatic Design Basis of 4,000 psi and a short-term strength of 6,400 psi. Qualification tests must produce a long-term pressure strength of 470 psi. Injection-molded PVC fittings have a wall thickness a minimum of 25% thicker than DR18 pipe.

Available products include:

- Bends (standard or custom angles)
- Couplings
- Tees
- Reducers
- Adapters
- Plugs
- Tapped couplings

Injection-molded fittings are available from 4-inch to 12-inch diameters in pressure Class 235 psi.

MACHINED COUPLINGS

Machined couplings are constructed from sections of PVC pipe meeting the requirements of the AWWA C900 standard. They are produced from a combination of molding and fabricating methods and available for any size PVC pipe from 4-inch through 60-inch. Please reference AWWA C900 for fabricated fittings recommended specifications.

COMPATIBILITY WITH DISSIMILAR MATERIALS

Pipes and fittings made from PVC and Ductile Iron (DI) use the same outside diameter regimen, meaning that the outside diameters specified in both product standards are identical. (Note: CIOD = Cast Iron Outside Diameter, which is the same as cast iron pipe size.) PVC fabricated fittings and injection-molded fittings are available in CIOD and Iron Pipe Size (IPS).

PVC PRESSURE FITTINGS

Transitioning from a PVC pipe or fitting into a DI pipe or fitting is easily accomplished when inserting PVC spigots into iron bells. In this situation, a coupling is not necessary. If making this transition requires a DI spigot into a PVC bell, transition couplings are necessary. Check with a manufacturer if connecting to other diameter regimens. *NOTE: Never insert a DI spigot into a PVC bell.* This is because DI pipe outside diameters are held to tight tolerances in the inside of the bell and the outside of the spigot, while the outside of the remainder of the barrel of the pipe is held to looser tolerances. As a result, the OD of field-cut DI pipes may vary. Transition couplings provide watertight joints between PVC and DI pipes. Typical products include solid-sleeve couplings or mechanical-compression couplings.

DESIGNING TO PREVENT PIPE MOVEMENT

Longitudinal thrust forces may develop in a pressurized piping system. Typical options for balancing hydrostatic thrust forces include:

- Internally restrained joints
- External mechanical restraint devices
- Concrete thrust blocks

When internal or external restraint is used, the pipeline becomes its own thrust block. By restraining certain joints at bends and along the pipeline, the resultant thrust force is transferred to the surrounding soil by the pipeline itself. In a properly designed pipeline using restrained joints, thrust forces are resisted by the bearing strength of the soil and the frictional resistance between the pipe and soil.

Thrust forces are developed at:

- Changes in horizontal and vertical direction at fittings (tees, bends, wyes, and crosses)
- Changes in pipe size (reducers)
- Dead ends (plugs, closed valves, and hydrants)

Size and type of internal or external restraint devices or thrust blocking depend on:

- Maximum system pressure (including field-testing pressures)
- Pipe size
- Type of fitting or appurtenance
- Line profile (horizontal or vertical bends)
- Bearing strength of undisturbed soil
- Depth of cover

PVC PRESSURE FITTINGS

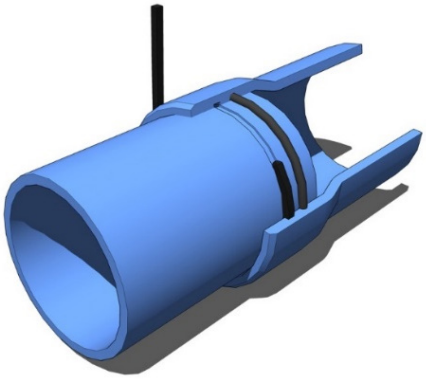
The selection of the appropriate method for providing thrust restraint must be based on the consideration of present and future conditions. Long-range considerations should include:

- The prediction of future activities around the bends that might jeopardize the water main, such as construction of other services, changes in groundwater levels, and changes in ground elevation.
- The ability to control and monitor activities around the bends, especially those on easements away from public surveillance.

Computer programs are available to calculate required restrained lengths and to guide the user to suggested configurations. Click here for a thrust restraint calculation website.

INTERNALLY RESTRAINED JOINTS

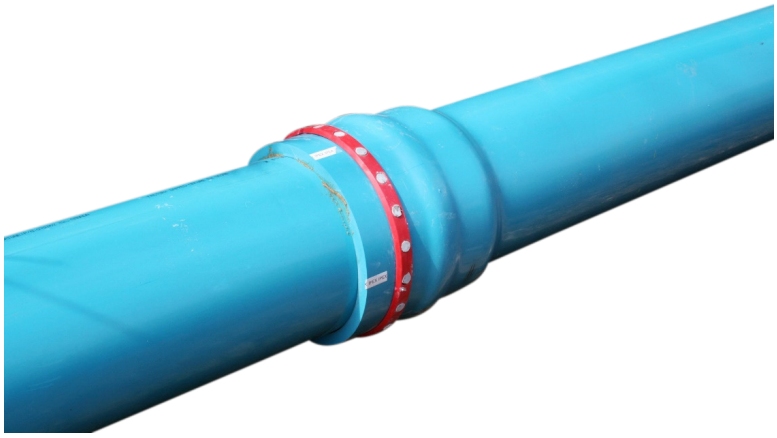
For each of the PVC pipe restraint products listed below, design methods are available from the manufacturer.



Spline-Lock Gasketed Joint - This joint uses a gasketed coupling or integral bell with nylon splines that extend into aligned grooves in the coupling bell and the pipe spigot.

Grip-Ring Gasketed Joint - Restraint internal to the bell is available for bell-and-spigot pipe and fabricated PVC fittings.

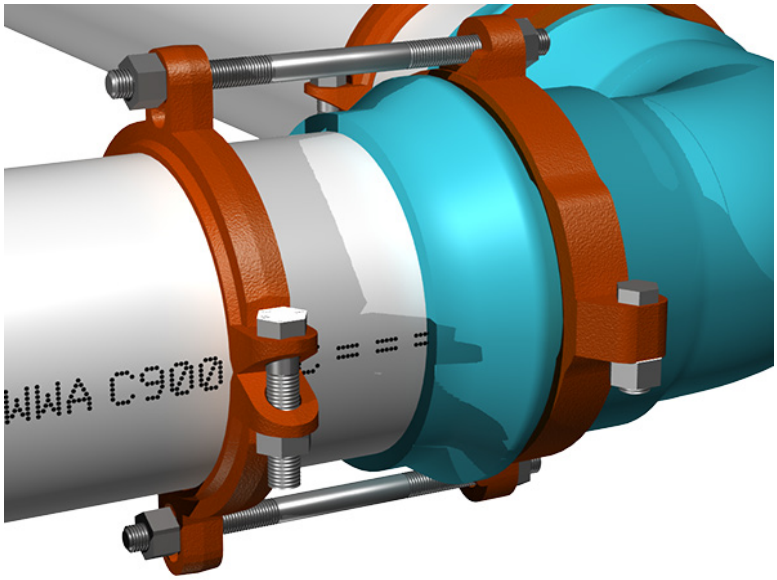
PVC PRESSURE FITTINGS



Pin-and-Groove Gasketed Joint - A groove on the outside of the pipe spigot aligns with holes spaced around the pipe bell. Pins are driven through the holes into the grooves to prevent movement.

EXTERNAL RESTRAINT DEVICES

In order to properly restrain a fitting, it is essential that the installation instructions of the restraint-device manufacturer be followed. Correct lubrication, bolt-torque, and tightening pattern are crucial to making a proper joint. For the external joint restraint products below, design methods are available from the manufacturer.



External Joint Restraint - These devices clamp to the wall of the pipe and tie back to a mating collar on the fitting or pipe bell.

PVC PRESSURE FITTINGS

CONCRETE THRUST BLOCKS

One method of resisting the unbalanced forces in a water main is concrete thrust blocks. The disadvantage of thrust blocks is that they rely on the undisturbed soil behind the thrust block. Their reliability may be compromised if future digging occurs near the thrust block. Thrust blocks should be shown on the water main system plans and a cautionary note about digging in the area should be on the drawing. In some cases, the actual size of the block will prohibit its use. This is particularly true in many urban areas. In poor soil conditions, large and heavy thrust blocks may cause settlement of the pipe. See Chapter 11 of the *Handbook of PVC Pipe Design and Construction* for more information.

INSTALLATION

Fittings should be installed per the general requirements of AWWA C605 and ASTM D2774.

HANDLING

Place the pipe and fittings into the trench using ropes and skids, slings on the backhoe bucket, or by hand. Do not throw pipe or fittings into the trench or allow any part of the pipe to make an unrestrained fall onto the trench bottom. Ensure that there are no damaged materials before assembly begins.

PIPE AND FITTING PREPARATION

The pipe end should be square and beveled. The bevel should be cut at approximately 15° and should be about ¾-inch long. Remove any burrs and ridges on the pipe. Measure the fitting bell depth and mark the pipe with an insertion line. Follow the fitting manufacturer's recommended insertion depth. Note that fitting insertion depths are often different from the factory insertion lines marked on the pipe and therefore it is important to measure and field-mark the insertion line to ensure a properly assembled joint.

Clean all debris from the bell areas of the fitting. Check that the gasket is fully seated in the groove with no raised areas.

Lubricate pipe and fitting per the fitting manufacturer's instructions.

JOINT ASSEMBLY

Align the pipe with the fitting and push together by hand or with pry bars (using wood blocks between the bars and the fittings). Insert until the insertion line is even with the edge of the fitting bell. Proper insertion is important because over-insertion is the primary cause of leaks in fittings. Do not install using a backhoe.

PVC PRESSURE FITTINGS

CHANGES IN DIRECTION

Do not deflect the pipe in the fitting bell more than the fitting manufacturer's recommendation. Be careful that over-insertion or over-deflection does not occur when installing adjoining lengths of pipe. Point loading caused by excessive deflection can create distortion and cause leaks and/or breakage. Follow the fitting manufacturer's recommendations for joint-deflection limits. Follow the pipe manufacturer's recommendations for pipe bending.

ACCEPTANCE TESTING

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 class/rating for any system component including pipe, thrust restraint, valve, fitting, or other appurtenance.

NOTE: For safety reasons, compressed air or gas should not be used for pressure rating.

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