Thermal Pipe Systems, Inc.

KOOL-KORE® PIPING SYSTEM

FOR CHILLED WATER SERVICE

SPECIFICATIONS & DRAWINGS

5205 W. WOODMILL DRIVE, SUITE 33
WILMINGTON, DELAWARE 19808
PHONE: 302.999.1588
WWW.THERMALPIPESYSTEMS.COM

KOOL-KORE PIPING SYSTEMS SPECIFICATIONS

KOOL-KORE shall be used where specified for chilled water service, using a rubber ring joining method.

PVC CARRIER PIPE: Carrier pipe shall be Polyvinyl Chloride (PVC) 160 psi pipe - SDR 26 in accordance with ASTM D2241. Pipe shall be extruded from clean, virgin approved class 12454A PVC compound conforming to ASTM D1784.

CASING PIPE: The casing shall be **[Polyvinyl Chloride (PVC)]** pipe shall be of virgin PVC resin meeting the minimum classification requirements of ASTM D1784 or extruded, black, **[High Density Polyethylene (HDPE)]** conforming to ASTM D1248 and D3350. The thickness for PVC casing shall be as shown on page three. Consult manufacturer for HDPE dimensional data. The casing ends shall butt when pipe is pushed together. This automatically sets the insertion depth of the carrier pipe.

RUBBER SEALING RINGS: Sealing rings for the PVC carrier pipe shall be a molded solid compression type rubber compound suitable for the service and pressure of the system.

RUBBER END SEALS: End seals for insulated KOOL-KORE shall be rubber with a compression type seal.

POLYURETHANE FOAM INSULATION: The insulation shall be Polyurethane Foam and shall meet the following specifications:

Type:	Two component urethane
Compressive Strength:	40 psi parallel min at 5% comp
Shrinkage:	None at 70°F
Free Rise Density:	2.0 to 3.0 lbs./cubic foot
Aged "K" (70°F - 72 hrs)	0.16 BTU-in./hour-°F-ft.2
Closed Cell Content:	90%

Insulation concentricity: Carrier Pipe shall be concentric to casing pipe. The allowable maximum deviation from centerline of carrier pipe shall be plus or minus 1/4 inch at the casing center point and plus or minus 1/16 inch at the end seals.

WALL PENETRATION SLEEVES: Provide where piping passes through masonry or concrete walls, floors, and roofs. Sleeves in outside walls below and above grade, in floor, or in roof slabs, shall be schedule 40 or standard weight coated black steel pipe or shall be as specified by the Design Engineer. Space between pipe OD and sleeve ID shall never be less than ½". Sleeves shall be held securely in proper position and location during construction. Sleeves shall be of sufficient length to pass through entire thickness of walls or slabs. Sleeves in floor slabs shall extend 2 inches above the finished floor. Refer to typical detail of wall penetration as shown. In existing concrete manholes or building wall penetrations may be made using the "core drilling" method providing proper care is taken to drill the holes to the size needed and square to the line of the pipe.

WALL PENETRATION SEALS: All wall penetrations shall be sealed to prevent water from entering the building or manhole. The sealing material shall be as specified by the engineer.

KOOL-KORE APPLICATION ENGINEERING

PIPE SYSTEM DESIGN: Standard design techniques and practices for KOOL-KORE shall be used. Thermal Pipe Systems, Inc. Engineering Department may on request provide certain detailed design aspects of the piping for each project based on the project documents and drawings provided by the Design Engineer. It is understood that the project specifications and layout drawings will specify the type of service, temperature and pressure classifications, soil conditions, and general path and elevations of the system, location and design of manholes, known obstacles, the size of the carrier pipe, and valves and the maximum permissible heat gains. The design provided by Thermal Pipe Systems, Inc. and their engineers for the piping will be in accordance with good engineering practices.

Fluid flow design will be based on Hazen-Williams formula with "C" Factor of 150, or a variation of the Euler formula for water flow.

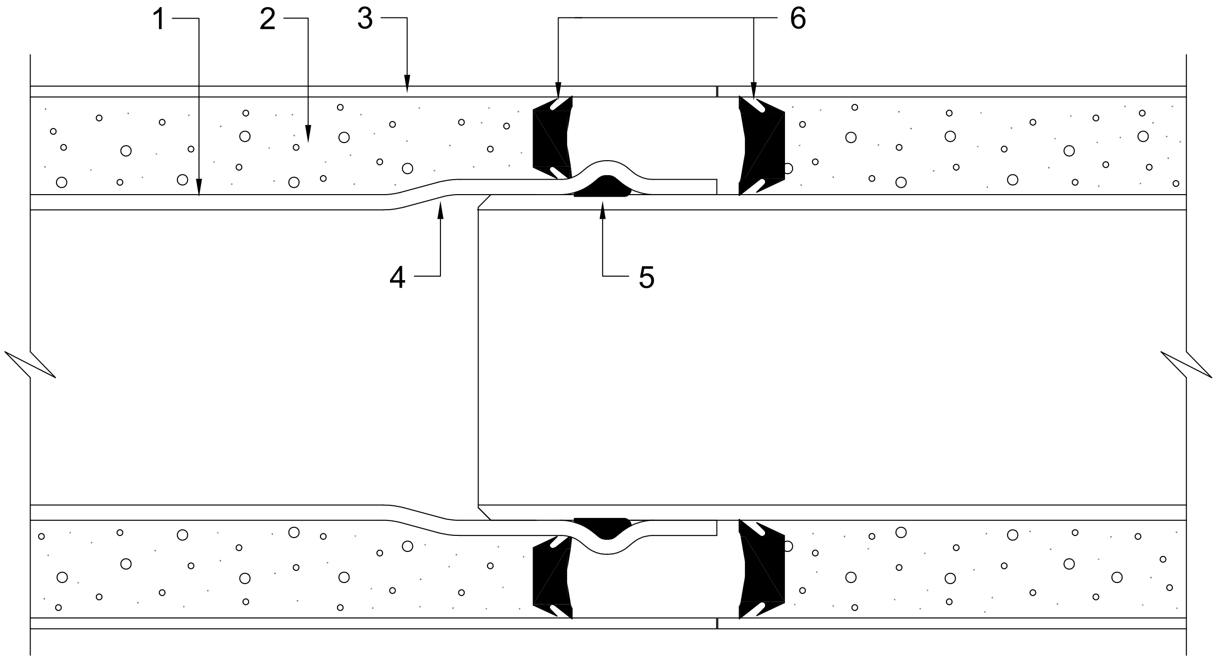
INSULATION: Thickness of insulation for KOOL-KORE pipe shall be as shown on the drawing on page three.

TEMPERATURE AND PRESSURE: The KOOL-KORE piping system and all its components are designed to operate at temperatures up to 70°F at 160 psig or at reduced pressures for elevated temperatures, as follows:

TEMPERATURE (°F)	PRESSURE (psig)
80	144
90	121
100	102
110	80
120	64
130	49

DIMENSIONS AND WEIGHTS of insulated KOOL-KORE piping system are as shown on page three. The KOOL-KORE piping will be furnished in 20-foot lengths.

PRE-INSULATED KOOL-KORE® PIPE

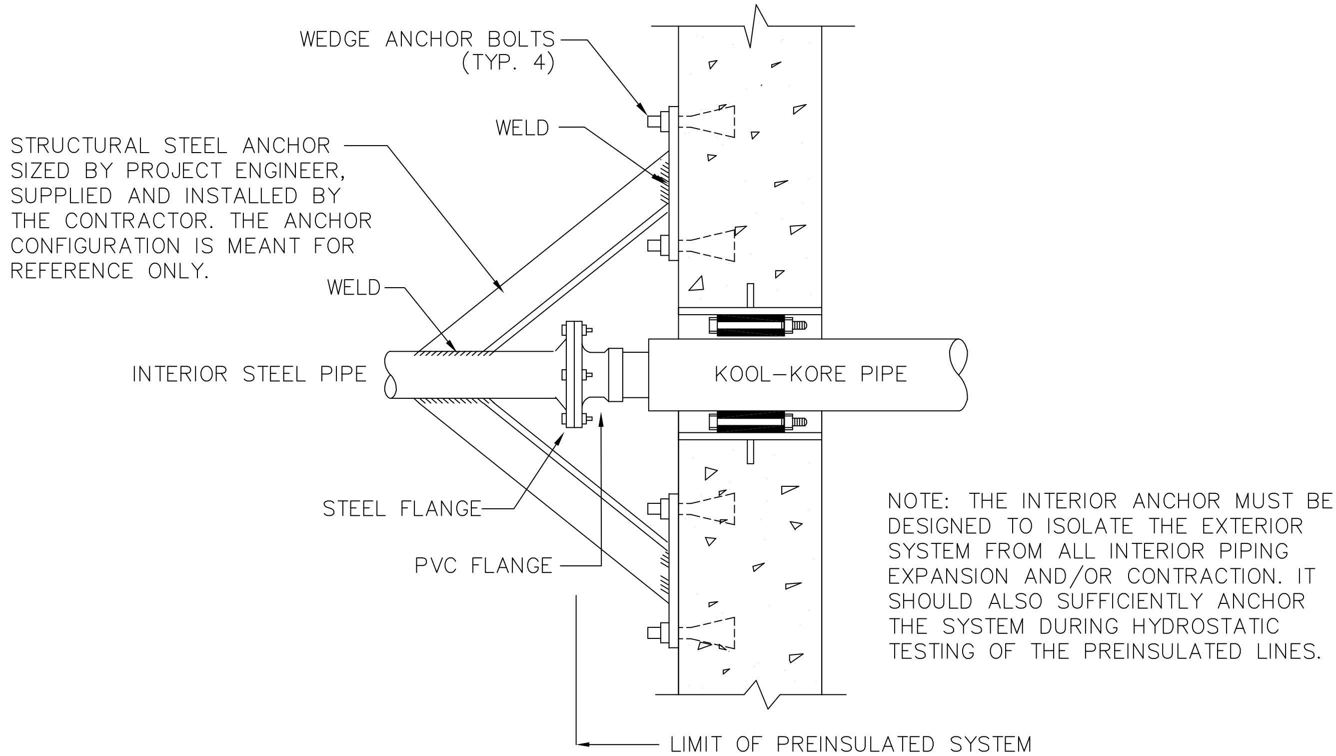


1. CARRIER: Polyvinyl Chloride (PVC)
2. INSULATION: Polyurethane Foam
3. CASING: PVC or HDPE
4. BELL: Grooved PVC
5. SEALING RING: Rubber
6. END SEAL: Rubber

NOM. PIPE SIZE	CARRIER O.D.	CASING O.D.	THICKNESS		WEIGHT (LBS./20 FT.)
			PVC CASING	FOAM	
1 1/2	1.90	4.50	.14	1.16	34
2	2.38	4.50	.14	0.92	36
2 1/2	2.88	6.14	.12	1.51	50
3	3.50	6.14	.12	1.20	55
4	4.50	8.16	.16	1.67	96
6	6.63	10.20	.20	1.59	166
8	8.63	12.24	.24	1.57	253
10	10.75	14.28	.28	1.49	313
12	12.75	16.00	.25	1.38	438
14	14.00	18.70	.37	1.98	629
16	16.00	22.05	.43	2.59	857

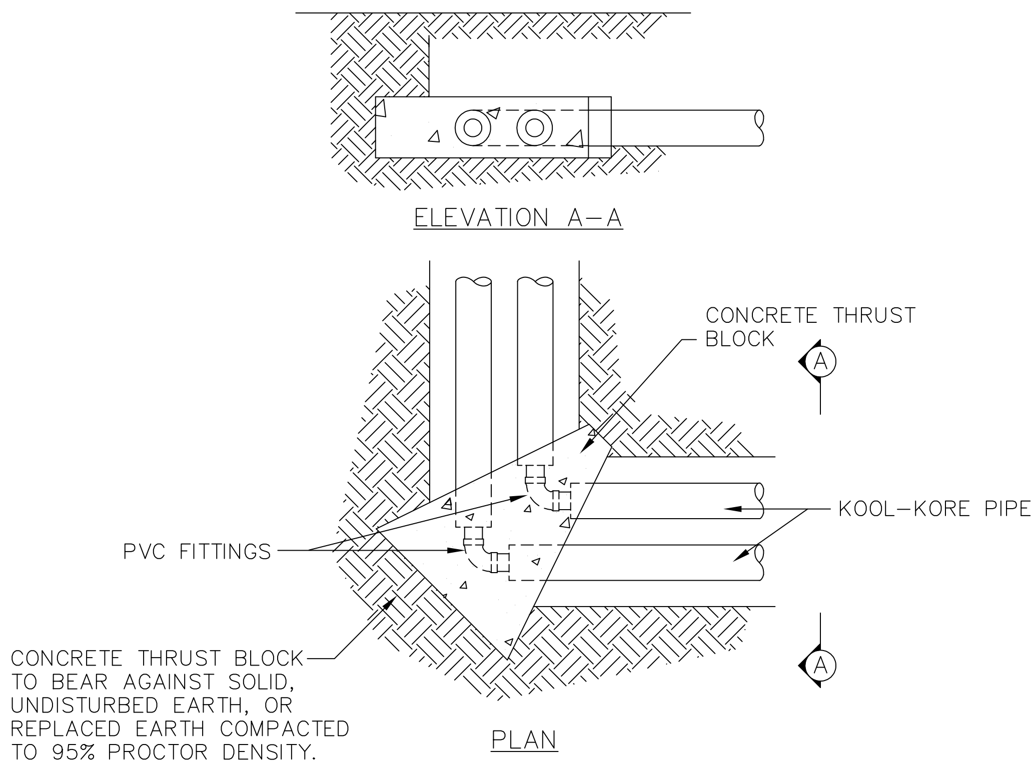
NOTE: All dimensions are in inches unless noted. Consult manufacturer for HDPE dimensional data.

PRE-INSULATED KOOL-KORE® PIPE



TYPICAL ANCHOR AT WALL PENETRATIONS

NO SCALE



TYPICAL CONCRETE THRUST BLOCK AT ELBOWS

NO SCALE

KOOL-KORE INSTALLATION SPECIFICATION

GENERAL: Installation of the KOOL-KORE piping system shall be done in accordance with the following specifications and instructions. A Thermal Pipe Systems, Inc. field representative may conduct an installation clinic to pre-qualify contract personnel in the proper procedures for the installation.

Piping shall be accurately cut to dimensions established at the construction site and shall be worked into place without springing or forcing, properly clearing all openings and equipment. Excessive cutting or other weakening of structural members to facilitate piping installation shall not be permitted. Pipe ends shall have burrs removed by reaming and shall be installed to permit free expansion and contraction without damage to joints. Good workmanlike procedures shall be followed.

All piping unless otherwise indicated, shall be pitched with a grade of not less than 1 inch in 40 feet toward the drain points when applicable.

Open ends of pipe lines and equipment shall be properly capped or plugged during installation to keep dirt or other foreign matter out of the system.

RECEIVING AND HANDLING SHIPMENTS

INSPECTION: Each Shipment shall be inspected upon its arrival at the job site. The products are carefully loaded at the plant using methods acceptable to the carrier and it is his responsibility to deliver the pipe in good condition. It is the responsibility of the installing contractor to ascertain whether there has been any loss or damage. The carrier is the contractor's agent. Any pipe or equipment that arrives damaged or is lost in shipment shall be reported by the contractor.

Make overall inspection of the load. If load is intact, ordinary inspection while unloading should be enough to make sure that the pipe has arrived in good condition. It is the responsibility of the receiver to make certain that there has been no loss or damage. Note specifically that any end packaging should not show signs of damage. If the load has shifted, or end packing damaged, then each piece must be carefully inspected for damage. Specifically, the ends should be inspected for scars, nicks, etc. Other obvious damage is also cause for rejection. Check total quantities of each item against the tally sheet (pipe, fittings, etc.). Any damaged or missing items are to be noted on delivery receipt and the receipt returned to the carrier. Notify the carrier immediately and make claim in accordance with the carrier’s instructions. Thermal Pipe Systems, Inc. will assist, if necessary, in handling this claim. Do not dispose of damaged material - the carrier will notify you of the procedure to follow.

UNLOADING INSTRUCTIONS: The means by which the pipes are unloaded in the field is the decision and responsibility of the installing contractor. The use of forklift type equipment frequently simplifies and speeds up the unloading of larger sizes and usually provides extra protection against damage in handling. To prevent the possibility of the core pipe from shifting within the casing pipe, do not stand a length on one end or raise it vertically. Under no condition should a pipe be dragged along the ground. Do not lift fittings or pipe by inserting a bar, pipe, etc., inside of the core. Damage to the pipe may result. If any pipe is damaged in unloading and handling, mark the damaged area and set it aside. A Thermal Pipe Systems, Inc. representative will determine whether damaged casing can be repaired in the field and will determine the exact method for repair and instruct the contractor in making the repair.

COLD WEATHER HANDLING FOR PVC CASED PIPE: As the temperature approaches freezing, the flexibility and impact resistance of KOOL-KORE pipe is reduced. PVC casing becomes hard and brittle in cold weather and will crack more readily if dropped or hit. Therefore, extra care should be used in handling during cold weather. Pipe at the bottom of a stack may become out-of-round due to the weight of material above it. At normal application temperatures, this corrects itself soon after the load is removed. Under freezing conditions, this recovery to full initial roundness may take several hours.

STORAGE: Store pipe on dunnage in a flat area. Support the barrel of the casing evenly. Bell and spigot ends should overhang dunnage. Individual lengths of pipe should be stacked in piles no higher than five (5) feet. It should be noted that when PVC pipe is stored outside and exposed to sunlight for prolonged periods, a slight discoloration of pipe could occur. This coloration is a surface layer of hardened plastic and does not inhibit the long-term properties and performance of the pipe. A method of protecting the pipe during long exposures (several months) to sunlight is to cover it with canvas or other opaque material. Do not use clear plastic and be sure to provide for air circulation under the sheets.

LOADING TRANSFER TRUCKS: Use trucks with long bodies so that pipe lengths do not overhang. Make certain truck bed is smooth, without cross-strips, bolt heads, or other protrusions that could damage the pipe. Short body trucks may be used if fitted with racks that properly support the pipe in a horizontal position. The rack should have supports spaced every 3 feet or less along the pipe lengths. Pad the contact areas to avoid damage to the pipe.

EXCAVATION: Excavation should consider the need for the thrust blocks at all fittings that are directly buried in the ground. The trench bottom must give uniform support along the entire length of any pipelines. Where several pipelines are in a common trench, the trench must be wide enough to maintain the specified distances between adjacent lines; generally a minimum of 6" is sufficient. The excavation should be in a straight line.

TRENCHING: Trenching shall follow the elevations provided by the Design Engineer on the contract drawings. The trench depth should always allow for a minimum cover height of 24" over the top of the casing pipe. Keep excavations free of water during construction. If the contractor determines it is necessary to remove unsuitable material to a depth greater than specified, refill over excavated area to the proper depth with specified bedding material compacted in 6 inch lifts to 95 percent of maximum density in accordance with ASTM D1557, Method D. Excavate and replace soil disturbed and weakened by the contractor's operations or soils permitted to soften from exposure to weather, with bedding material and compact with a plate-type vibratory compactor.

TRENCH WIDTHS: The width of the trench at the top of the pipe should be held to the minimum required for efficient and proper installation. The reason for this is to keep the earth load on the pipe as small as possible, since, in general, the wider the trench at the top of the pipe, the greater the load on the pipe. But note that an increase in trench width above the top of the pipe, by sloping the sides or digging a wider offset trench, does not affect the earth load on the pipe. On the other hand, a trench that is too narrow will make assembly difficult and may reduce the rate and quality of installation. In addition, lack of ample room will limit the capability to properly backfill and tamp around the pipe. Although each job or portion of a job must be considered on an individual basis, as a rule, the following minimum trench widths at the top of the pipe are recommended: Minimum: One foot greater than the outside diameter of the casing. Where two or more pipes are in the same trench, use the distance between outside casing of the outside pipes plus one foot. Maximum: Use above method for minimum plus two feet.

DISTRIBUTING PIPE ALONG TRENCH: Pipe lengths may be strung along the line of the trench to minimize additional handling during installation.

PLACING PIPE IN THE TRENCH: The KOOL-KORE pipe may be hand or mechanically passed into the trench. The latest state and federal safety regulations should be understood and observed. If slings are necessary use only canvas straps, do not use cable or chain slings. A backhoe or boom truck is an excellent way of lowering the pipe into the trench.

BEDDING: Bedding material should be sand or other materials free of sharp objects, heavy clods, boulders or frozen lumps as specified by the Design Engineer. The approved bedding should be used 6" under, around and over the pipe. Utilize good practices that apply to buried pressure piping.

PIPE ASSEMBLY:

Be sure the sealing ring is correctly and completely seated in the groove of each pipe bell.

1. Make certain that the ring and ring groove in the bell is clean, with no dirt or foreign material that could interfere with proper seating of the ring.

2. Make sure the spigot end is clean. Wipe with a clean dry cloth around the entire circumference of the exposed carrier spigot.

3. Lubricate the spigot end of the pipe, using only Thermopipe Lubricant supplied. Be sure to cover the entire circumference. The coating should be the equivalent of a brush coat of enamel paint. It can be applied by hand, cloth, pad, sponge, or glove. Do not lubricate the rubber ring or the ring groove in the bell because such lubrication could cause ring displacement.

4. Insert the bevel end into the bell so that it is in contact with the ring. Hold the pipe lengths being joined close to the ground to keep the lengths in proper alignment. Brace the bell while the bevel end is pushed in under the ring. Push the spigot end all the way home. The casing of the bell must butt against the casing of the spigot end. If undue resistance to insertion or pushing home is encountered, disassemble the joint and check the position of the ring. If it is twisted or pushed out of its seat, clean the ring, bell and beveled end, and repeat the assembly steps.

NOTE: if a spigot or bell end has become deformed due to a load on the pipe while in the stock pile during hot weather, it will be necessary to exercise more care in assembling the joint to prevent fishmouthing of the rubber ring.

USE OF DOUBLE BELL COUPLINGS FOR REPAIRS AND ADAPTION TO STEEL

The double bell coupling is used for joining spigot ends, for making repairs and for adapting to steel pipe in sizes 1-1/2" through 12". Other methods of adaptation, such as Ductile Iron and PVC flanges are available, and may be specified by the design engineer.

NOTE: In all cases be sure that the steel end is beveled, smooth, and free of burrs.

To insure proper assembly of the double bell coupling with beveled ends of pipe, follow the instructions for rubber ring joint assembly steps as given above. Then, if one beveled end is in a fixed position, such as the end length of a pipeline, mount the coupling on the fixed length first. Then, while holding the coupling firmly in this position, insert the beveled end of the free length into the coupling.

TESTING: After all concrete thrust blocks have adequately cured, a hydrostatic test is applied to determine the soundness of the line. A test pressure of 50 psi over working pressure for one hour is generally used unless other requirements are specified. Joints should be visually inspected and proved tight.

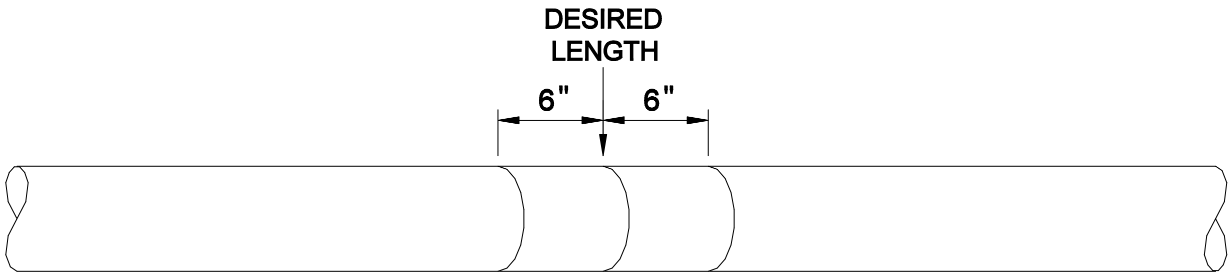
It should be noted that, entrapped air, temperature changes and slight movement of the pipe can cause variations in test pressures. These factors should be taken into consideration when testing and care taken to minimize their influence on the test results.

BACKFILLING: Backfilling of trenches shall progress as rapidly as construction, testing, and acceptance of work permits. Uniformly compact and grade bottom of trenches. After installation of pipe and bedding material, backfill as follows: Place initial backfill in layers to a depth of 12 inches of the initial bedding. Compact the material to a density equivalent to the surrounding undisturbed soil or to 90 percent of maximum density (ASTM D1557, Method D), whichever is greater. Backfill remainder of trench in one-foot lifts and compact to 90 percent maximum density (ASTM D1557, Method D). For trenches excavated in roads, streets, or located under structures, place backfill in 6-inch layers to top of trench and compact each layer to at least 95 percent maximum density (ASTM D1557, Method D).

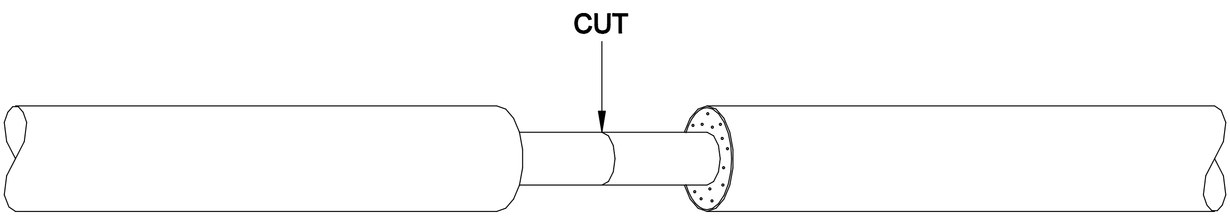
FLANGED JOINTS: Flanged joints shall be faced true, provided with gaskets, and made perfectly square and tight. It should be noted that flanged joints are not recommended underground.

FIELD CUTTING PIPE TO A SPECIFIC LENGTH

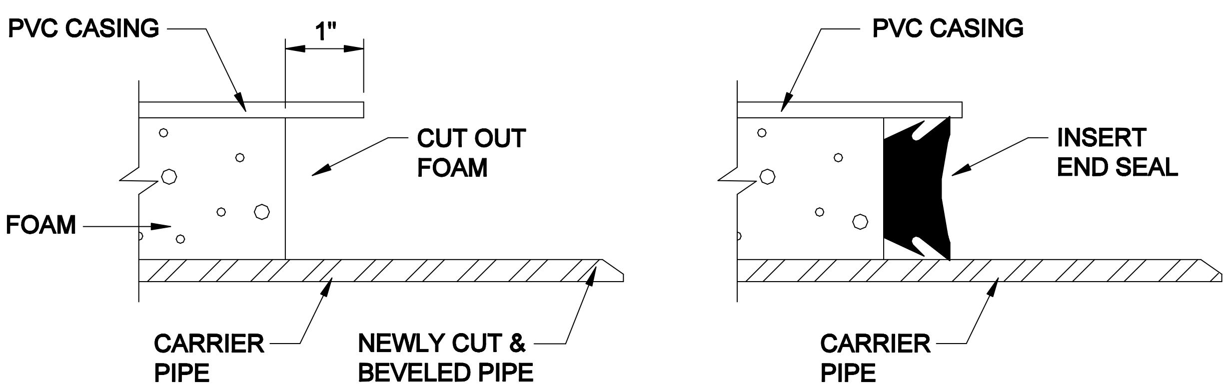
Determine the exact length of carrier pipe needed. Mark the casing at this point. Measure back 6 inches on both sides and mark the casing at these points using a wrap-around.



Use a carpenters handsaw or PVC saw to cut the PVC or HDPE casing. Remove the casing and cut off the insulation. Be careful not to damage PVC carrier pipe during this operation. See illustration below.



Mark, cut, and bevel the PVC pipe at the desired length. Make sure cut is square. Using a utility knife, remove the insulation between the casing and the carrier pipe one inch in from the face of the casing as shown below. Insert the rubber end seal between the casing and the carrier pipe using the handle of a hammer or screwdriver to push the seal all the way. Silicone caulking may be used in lieu of the rubber end seal.



THRUST BLOCKS: Thrust blocks must be installed wherever the pipeline changes direction or size as at tees, elbows and reducers or at any point that develops thrust such as at a valve or similar equipment. The above situations may occur either where the fittings etc., are directly buried in the soil, or are in a manhole.

Thrust blocks must be designed for maximum anticipated operating or test pressure. If it is anticipated that pressures higher than normal operating pressures will be used at some later date, thrust blocks to accommodate such pressures should be installed initially. Size and type of thrust blocks depend on pressure, pipe size, and the type of soil. The Design Engineer shall supply this information. Where a thrust block serves more than one line, the block must be designed to resist the sum of the thrusts of all the lines involved. Thrust blocks should be poured on and against undisturbed soil or soil tamped to 95% proctor density.

Thrust blocks shall be installed using a concrete having a compressive strength of not less than 3,000 psi minimum ultimate 28 days compressive strength, air entrained, with water reducing admixture. Where the soil bearing value is less than 1,000 pounds per square foot, Thermal Pipe Systems, Inc. will make the necessary calculations and recommendations as to how the fitting should be thrusted. Where special thrust provisions are needed, Thermal Pipe Systems, Inc. will recommend the necessary design.

The table below gives the thrust load at any fitting in lbs. at 100 psi* pressure.

Size (in.)	90° Elbow	45° Elbow	Tee
1 1/2	415	225	295
2	645	350	455
2 1/2	935	510	660
3	1,395	755	985
4	2,295	1,245	1,620
6	4,950	2,680	3,500
8	8,375	4,540	5,930
10	12,833	6,963	9,076
12	18,000	9,700	12,765
14	21,780	11,790	15,400
16	28,440	15,490	20,110
18	36,000	19,600	25,450
20	44,430	24,195	31,420
24	63,970	34,840	45,240

*For pressure other than 100 psi increase loads proportionately (example: for 150 psi multiply by 1.5; for 200 psi multiply by 2.0: etc.)

NOTE: Dead End and Anchor loads are equal to TEE shown on previous page.

The approximate safe bearing loads of various soils given in the following table are for horizontal thrusts when the depth of cover over the top of the pipe exceeds two feet. These loads are estimates only. Actual soil and safe bearing loads should be determined by the design engineer.

SOIL	SAFE BEARING LOAD lbs./sq. ft.
Muck, Peat etc.*	0
Soft Clay	1,000
Sand	2,000
Sand & Gravel	3,000
Sand & Gravel Cemented with Clay	4,000
Hard Shale	10,000

* All thrusts are resisted by piles or tie rods to solid foundations, or by removal of muck or peat and replacement with ballast of sufficient stability.

START UP PROCEDURE: Start up procedure shall conform to generally accepted practices and be done in a workman-like manner. The line shall be filled slowly from any available low-pressure source. The water can be introduced from lines in service directly through valved connections, or by temporary connections to taps made in the new line. If possible, all such connections should be made at the lowest point in the line to avoid air entrapment. All valves and other control points in the line that are open as the line filling begins should be closed gradually to avoid the possibility of water hammer.