

PERMA-PIPE®

Multi-Therm 500 Fiberglass Jacketed Steel Conduit Piping Systems

Installation Manual

ISSUE 1

JULY 15, 1998

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NOTICE

This installation manual and the recommendations it contains are reasonably believed to be accurate and reliable. However, due to variations in environment, application or installation, and because the conditions of use are beyond our control, the user of this manual assumes all risk connected with the use thereof. The installer of these piping products is ultimately responsible for his own work and, thus, the integrity of the system. PERMA-PIPE assumes no responsibility for the use of information presented herein and, hereby, expressly disclaims all liability in regard to such use.

Any technical suggestions or advice with respect to storage, handling, installation or use of Seller's materials by or on behalf of Seller is an accommodation to Purchaser for which Seller shall have no responsibility unless responsibility, therefore, has been expressly assumed in writing by the President or a Vice President of Seller.

PREFACE

The consulting engineer has been provided with information on what to expect from a PERMA-PIPE Multi-Therm 500 system once it is installed. However, the true operating success of the system is greatly dependent upon proper installation. PERMA-PIPE is committed to supporting the installation of a complete and high-quality piping system. This support includes clear and concise installation recommendations and expert field technical assistance.

The objective of this manual is to aid the installer on recommended installation procedures of a Multi-Therm 500 piping system. This booklet contains information on all aspects of the installation process, from initial receiving and storage through final backfill.

The manual has been divided into sections, one section for each phase of the installation process. Each section contains an explanation and illustrations on proper installation procedures.

By following these step-by-step instructions, the installing contractor should achieve a successful installation.

GENERAL PRECAUTIONS

These instructions are for general applicability. If they conflict with contract, specifications or drawings specific to the job, the job-specific documents take precedence. If in doubt, check with your project engineer or PERMA-PIPE field technical representative.

Carefully observe job work sequence to avoid errors and expensive mistakes. **DO NOT skip steps.**

If leak detection or other PermAlert electrical or electronic system is involved, use the appropriate PermAlert installation manual in conjunction with this piping system installation manual.

DO NOT complete backfilling the trench until all testing and inspection is completed and accepted by the appropriate authority.

1.0 INTRODUCTION

Multi-Therm 500 is a versatile fluid transportation system for the distribution of steam, condensate, hot water, process fluid, fuel and heavy oils. Application flexibility is achieved through PERMA-PIPE's integrated engineered system design utilizing state-of-the-art CAD technology.

The Multi-Therm 500 system has been designed with the installer in mind. Multi-Therm 500 arrives at the project site partially assembled. In-plant fabrication means less field work and fewer complications. This significantly reduces the installation cost while maintaining the integrity of the system. The features that make Multi-Therm 500 unique extend beyond the product itself. An expert project design staff tailors each system to meet the needs of the customer. Also, an experienced technical service staff is available to provide assistance that will assure a quick and smooth installation.

A series of factors contribute to a reliable, high-quality piping system, such as design, construction, delivery, installation and testing, with stringent quality control procedures applied at every step. The importance of proper installation practices for any piping system and adherence to this procedure, in particular, cannot be overstated. When installed according to the recommended practices presented in this manual and from PERMA-PIPE technical service, Multi-Therm 500 will provide excellent service, meeting or exceeding expectations.

2.0 SCOPE AND APPLICATION

The scope of this procedure is limited to Multi-Therm 500 piping systems.

This procedure applies to the customer-designated contractor who will perform the installation. A factory-trained, experienced field installation instructor will be present at critical periods during the installation, when required by the specifications, and/or where the furnishing of such service is included as a part of the customer's purchase order.

Trouble-free, efficient operation will result

from close cooperation between the installing contractor and the field installation instructor. PERMA-PIPE is committed to supporting the proper installation of a complete and high quality piping system. Nevertheless, ultimate responsibility for proper installation rests with the installing contractor.

3.0 EQUIPMENT AND MATERIAL

3.01 Equipment and Materials.

In order to install Multi-Therm 500, PERMA-PIPE has furnished the following:

1. Pipe assemblies, fittings and accessories
2. Field joint closure materials (see applicable chapters of Section 7.0)

Installing contractor must furnish the following:

1. Crane and excavation equipment
2. Welding equipment
3. Saws, grinders and wire brushes
4. Other materials as described in applicable chapters of Section 7.0.

3.02 Receiving, Handling and Storage.

3.02.1 Receiving.

The piping was inspected and loaded with due care at the factory. It is the carrier's responsibility to deliver the shipment in good condition. It is the responsibility of the receiver to ensure there has been no loss or damage. The following procedures are suggested to minimize problems:

- It is recommended that the PERMA-PIPE field representative be present during receipt of the shipment.
- Obtain the following from the carrier:
 1. Part Drawing Layout (PDL)
 2. X-Ray Film (if applicable)
 3. Packing slip
 4. Bill of Lading
 5. MSDS Sheets

NOTE: Material Safety Data Sheets (MSDS) for each of the components described in this manual should be reviewed for safety precautions and protective equipment requirements.

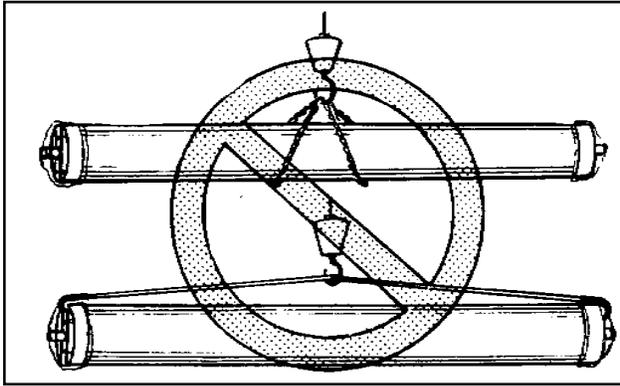
- Check all shipped materials against the packing slip for shortages.
- Visually inspect the materials of shipment as they are unloaded.
- List all damages and/or shortages on the packing slip and the bill of lading. **DO NOT dispose of any damaged material.** The carrier will notify you of the necessary procedure to be followed.
- Submit claims to the carrier. Failure to do so will result in loss of compensation for missing or damaged material.
- Notify your PERMA-PIPE field representative of these claims if assistance is required. PERMA-PIPE terms are F.O.B. our plant, full freight allowed to project site, unless specified differently by contract or purchase order.
- Shortages and damaged materials are normally not reshipped, unless requested to do so. If replacement material is needed, contact a PERMA-PIPE sales representative.

3.02.2 Material Handling.

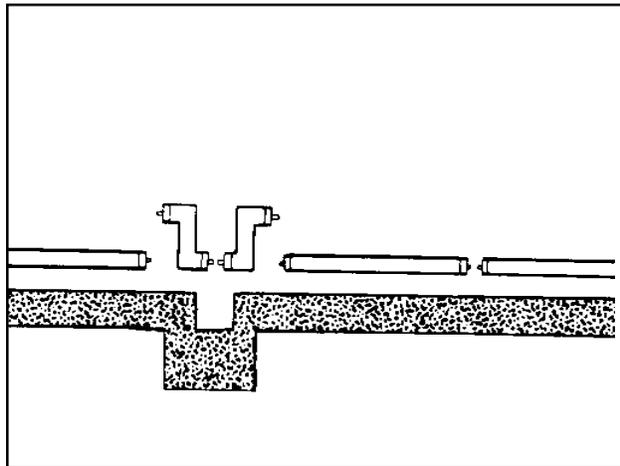
The means by which Multi-Therm 500 is unloaded and handled in the field is the decision and responsibility of the receiver. PERMA-PIPE's FRP jacket is designed to resist corrosion and is strong enough to withstand heavy soil loads and system pressures. The jacket is extremely durable. However, if damage does occur due to improper handling, the jacket must be repaired at the customer's expense. The following procedures are suggested to minimize problems:

- Support each assembly with nylon slings during all phases of handling. The nylon slings prevent severe scratching and/or chipping of the FRP jacket. Nylon slings are provided free of charge by PERMA-PIPE.

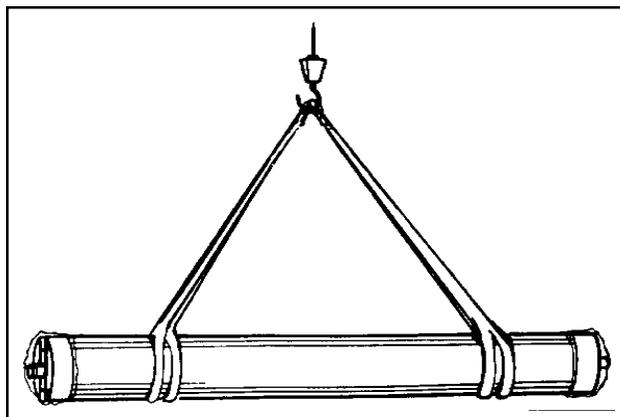
- **DO NOT use steel cables or chains for handling Multi-Therm 500 assemblies.**



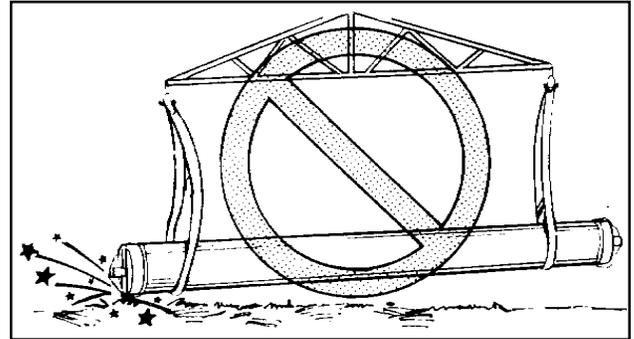
- Use two slings where possible. The use of two slings provides much more control of pipe movement. A 40-foot section of pipe suspended by a single line is extremely likely to swing out of control. This greatly increases the chances of personal injury and/or damage to the pipe from contact with the truck, nearby buildings and equipment.



- Use a spreader bar to maximize control of the pipe assemblies during handling.



- If a spreader bar is not available, choke the slings together as shown.
- Space the slings about 20 feet apart. Again, a spreader bar is recommended.
- **DO NOT drop the Multi-Therm 500 assemblies or strike them against hard surfaces at any time.**

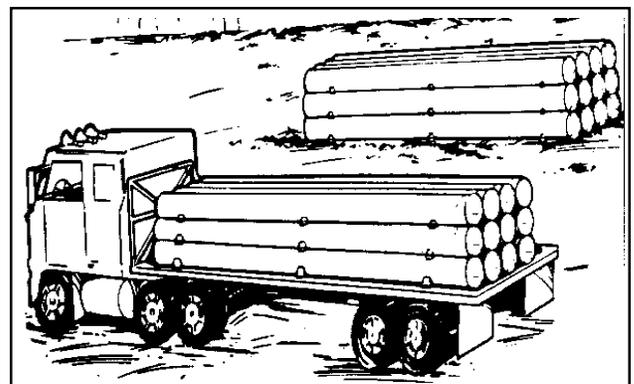


- If an accident occurs, inspect the jacket for damages. Repair if necessary (see Section 8.02).

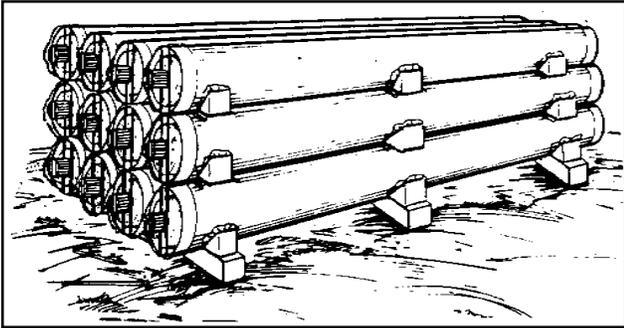
3.02.3 Pipe Storage.

Multi-Therm 500 assemblies can deteriorate and sustain damage if not stored properly. Proper storage of the product is the responsibility of the receiver. The following procedures are suggested to minimize problems:

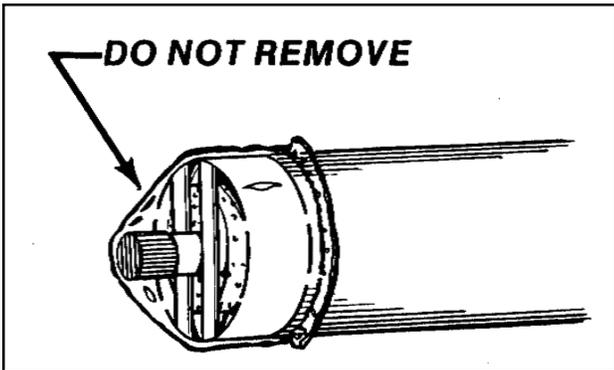
- If possible, store the pipe in a warehouse or heated shelter. If this is not possible, store the pipe on high ground to avoid ingress of water into pipe ends.
- Multi-Therm 500 can be stored during the winter months (or for prolonged periods of time) with minimal special handling.
- When stacking the Multi-Therm 500 for storage, stack it in the same fashion that it was received.



- Wooden shipping braces must be used as runners between the layers of pipe. PERMA-PIPE recommends stacking pipe no more than three tiers high.



- Use foam or other padding between layers.
- **DO NOT remove plastic covers or end caps from the Multi-Therm 500.** All pipe ends are shipped with plastic protective coverings (bagged ends) and must be checked periodically for rips or tears and are to be replaced as necessary.



- Always leave the shipping bars on the assembly ends until the carrier pipes are to be welded.
- PERMA-PIPE recommends using a light-colored or opaque tarpaulin to cover stored pipe. This cover will protect it against ultraviolet (UV) rays that will discolor the FRP jacket.
- Store all field joint materials indoors and in a dry area. Keep the materials in their shipping containers. The recommended storage temperature range is 60°-85°F (18°-29°C).

4.0 PREPARATION AND SET-UP

PERMA-PIPE cannot anticipate every circumstance that might involve hazard. The warnings in this procedure are, therefore, not all inclusive. The installing contractor must satisfy himself that each procedure, tool, work method or operating technique is safe.

PERMA-PIPE recommends that only qualified personnel perform all steps of the installation procedure.

Proper implements, tools and equipment should be used for placement of the pipe in the trench to prevent damage. In no case should pipe or accessories be dropped into the trench. Additional handling and joining procedures are covered elsewhere in this manual. Pipe laying generally should commence at the lowest elevation and terminate at manholes, service branches or clean outs. Use the Pipe Drawing Layout to place the assemblies in correct order.

5.0 EXCAVATION

NOTE: All federal, state and local regulations concerning jobsite safety should be observed.

5.01 Trenching.

All types of flexible pipe derive some of their strength from the passive soil resistance on the sides of the pipe. Therefore, the proper excavation of the trench is very important to ensure a structurally sound system. Usually, the centerline dimensions for the placement of the pipe in the trench can be found in the drawings.

Multi-Therm 500 is designed to handle normal soil and H-20 loading. If PERMA-PIPE's recommended procedures are followed, a minimum burial depth is required at taxiways, runways, railroads and other areas of high surface loading conditions. It is recommended that the customer contact both PERMA-PIPE and the local authority for more specific burial instructions.

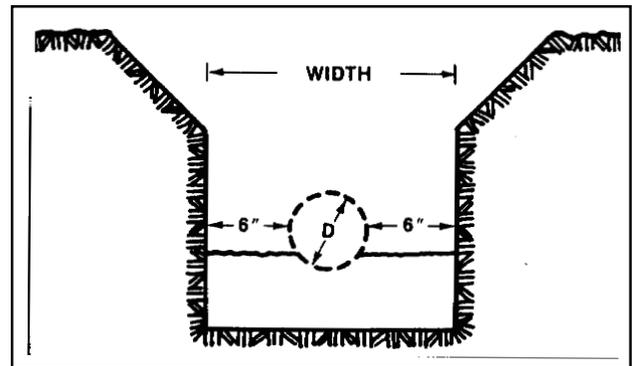
The trench floor should be completely cleared of stones and rocks and covered with a 4-inch compacted bedding. The bedding soil should correspond with the soil description.

During excavation, an unstable soil condition may be encountered, particularly in installations with deep burials. If this occurs, shore the trench walls before lowering the piping assembly into the trench.

Local, state and federal regulations for shoring should be followed where applicable. As the shoring is removed, it should be replaced with backfill soil.

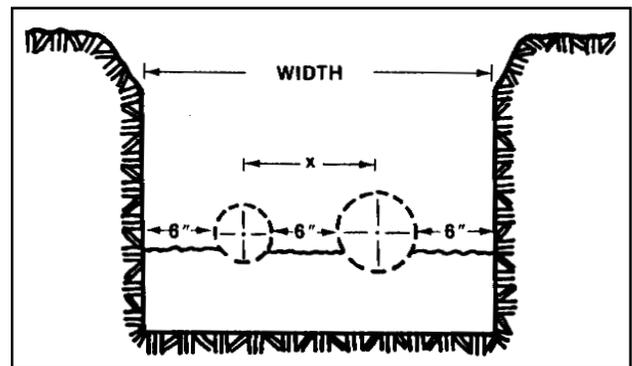
Organic soils or plastic clays and silts with high liquid limits may be encountered that are incapable of supporting the pipe. Remove the poor soil, and replace it with the proper bedding soil to a depth that will provide a firm stable foundation.

The minimum recommended trench width for single pipe is 12 inches plus the diameter of the conduit.

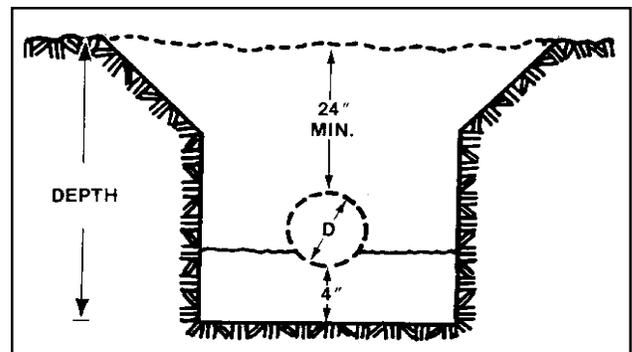


For multi-pipe installations, centerline dimensions can usually be found in the drawings.

If the centerline dimensions are not specified in the drawings, PERMA-PIPE recommends computing the width of a multi-pipe trench by adding 6 inches to the combined radii of each pair of pipes (value X in the figure below) and, then, adding another 12 inches and the combined radii of the two outermost pipes to allow for clearance.



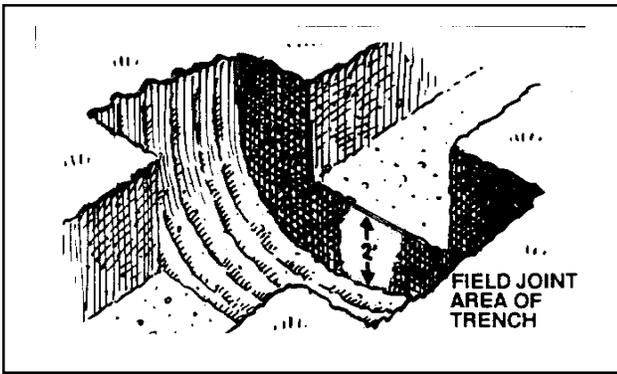
The total trench depth should allow for a 4-inch bedding, the conduit diameter and a minimum 24 inches cover depth above the conduit. See contract drawings for specific pipe burial depths. For depths less than 24 inches, contact PERMA-PIPE.



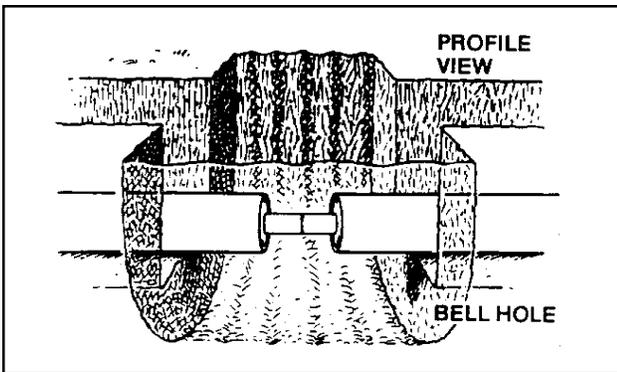
A minimum bedding of 4 inches must be raked uniformly along the entire length of the run. The bed of the run must be graded to a minimum slope of 1 inch per 40 feet. The bedding material should conform with the recommendations in the **Backfill** section of this manual (see Section 9.0).

5.02 Bell Holes.

Digging bell holes at field joint locations allows room for welding, field joint closure and testing. Field joint locations are marked on the part drawing layout (PDL). A common way to dig bell holes is to cut across the trench with a backhoe:



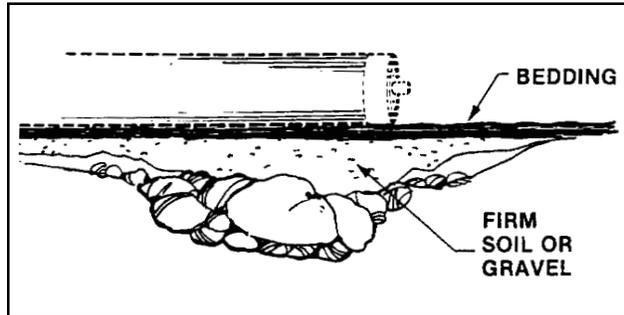
- Cut into the side of the trench and 1½ to 2 feet below the system grade.
- Dig the bell holes before lowering Multi-Therm 500 into the trench.



5.03 Special Trench Conditions.

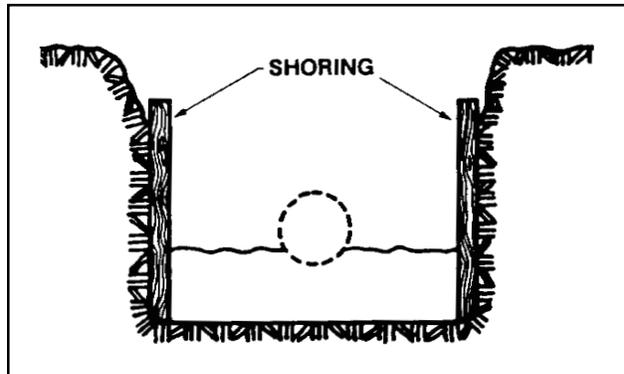
5.03.1 Rock Bottom Trench.

- A rocky or uneven trench foundation should be covered with a firm soil or gravel before bedding is constructed.



5.03.2 Unstable Soil.

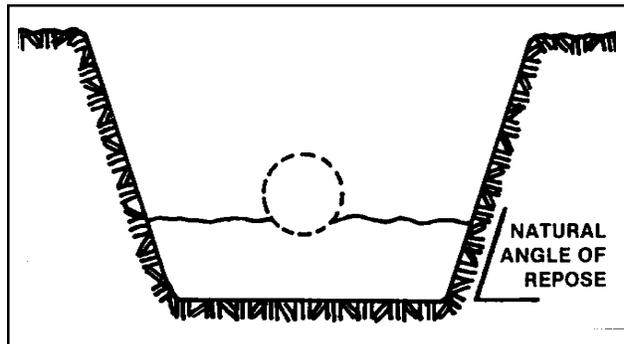
- When trenching in unstable soil, **DO NOT** lay any Multi-Therm 500 until the trench walls are stabilized with staybracing or shoring.



- Replace and compact the soil as the shoring is removed.

5.03.3 Granular Soil.

- In granular soil, the trench wall should be sloped at the natural angle of repose.



5.03.4 Over-excavation.

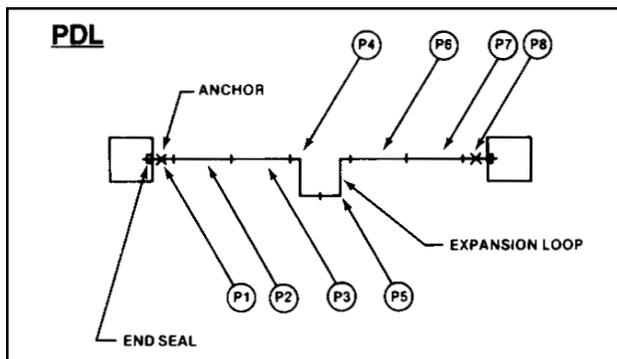
- Any accidental over-excavation should be filled with bedding material and compacted to 90-95% modified proctor.

6.0 PIPE SYSTEM ASSEMBLY

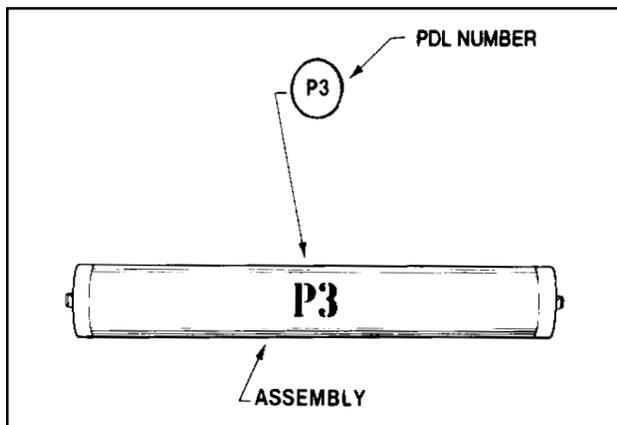
NOTE: When installing pipe in ambient temperatures below 60°F, contact your PERMA-PIPE field representative for special cold weather procedures.

6.01 Layout.

After trench excavation is complete and installation of the pipe is to start, the Multi-Therm 500 assemblies should be distributed along the trench top. Installation can be simplified by laying the assemblies in order along the trench according to the part-drawing layout (PDL).

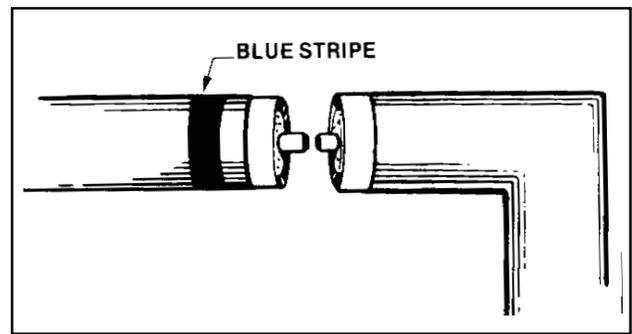


The part-drawing layout shows the location for each Multi-Therm 500 assembly. Each assembly is marked with a number matching the number on the PDL drawing.



Laying assemblies in order next to the trench will simplify installation.

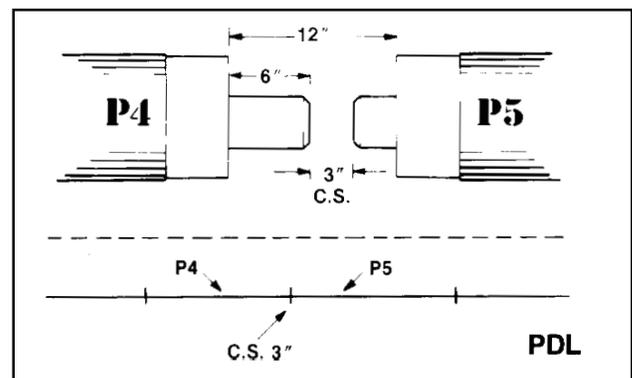
Certain assemblies are marked with a stripe to indicate the specific orientation of the pipe. Straight assemblies with a blue stripe on the end must be placed with that end toward the adjacent elbow.



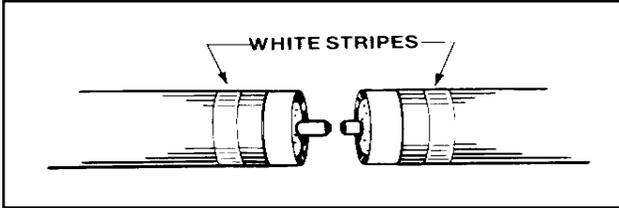
Elbows are sometimes modified to allow for the thermal expansion of the carrier pipe. Part of the elbow expansion movement will be transferred to the straight assembly to which it is connected. PERMA-PIPE utilizes oval supports at one end of the straight assembly to allow for this movement. The blue stripe indicates the location of these oval supports.

The oval supports must be oriented correctly in relation to the adjacent pipe. To ensure proper placement, PERMA-PIPE has marked the word "TOP" on each assembly. The "TOP" label should be facing exactly straight up in the 12 o'clock position. For systems with leak detection, the top marks will be located on the carrier pipe ends.

Assemblies with white stripes should be positioned with the striped ends together. The white stripes indicate a cold spring location. This information is also shown on the PDL as "C.S." **DO NOT complete these joints until this instruction says to do so.** When cold springing is required, the

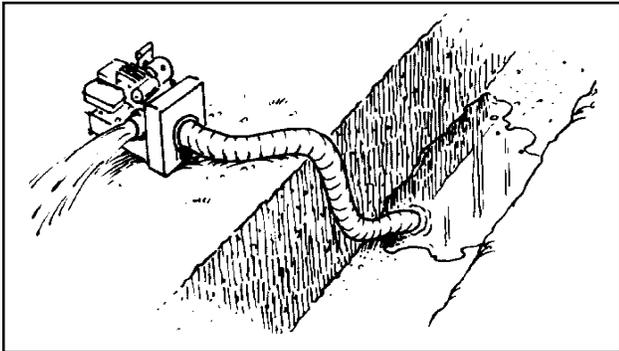


field joints to be sprung are pre-cut to specific lengths. The correct pipe ends must be welded together for the pipe to be sprung correctly. Thus, white stripes are painted on the pipe ends to be positioned together.

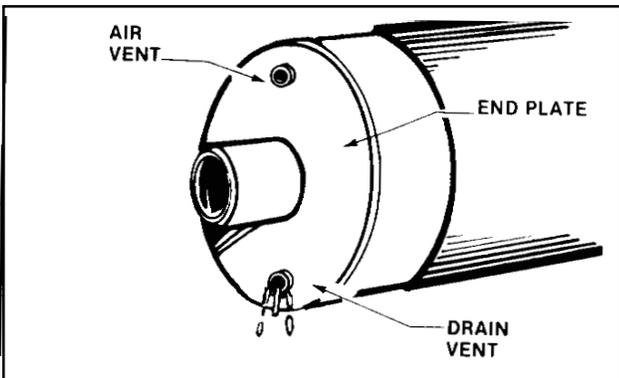


6.02 Lowering of the Conduit.

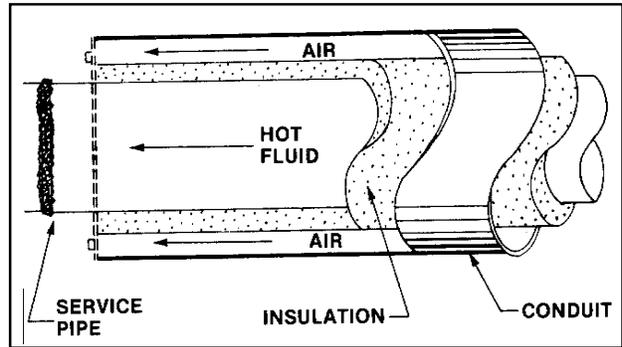
- Remove free-standing water in the bell hole and trench before lowering assemblies. Bell holes and bedding must be dry during pipe assembly installation.



- DO NOT** remove the protective end bags until the carrier pipes are to be welded.
- Lower Multi-Therm 500 assemblies into the trench. **DO NOT** drop piping. Two cranes may be required (see Section 6.04).

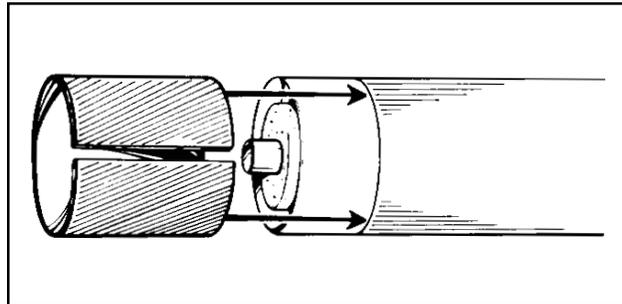


- Position each assembly with the word "TOP" facing up at the 12 o'clock position. For systems with leak detection, "TOP" marks are located on the carrier pipe ends.



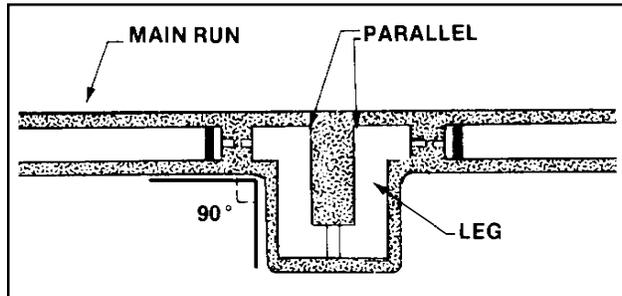
6.03 Pipe Connections.

NOTE: If carrier pipe weld is made before conduit closure sleeve is slipped over the



conduit, the closure sleeve must be cut in half, positioned correctly around the conduit, and then welded.

- Ensure the closure sleeves have been placed around the conduit before welding the carrier pipes together.
- Before continuing, verify the legs of the expansion loops are perpendicular to the rest of the run and parallel to each other. If

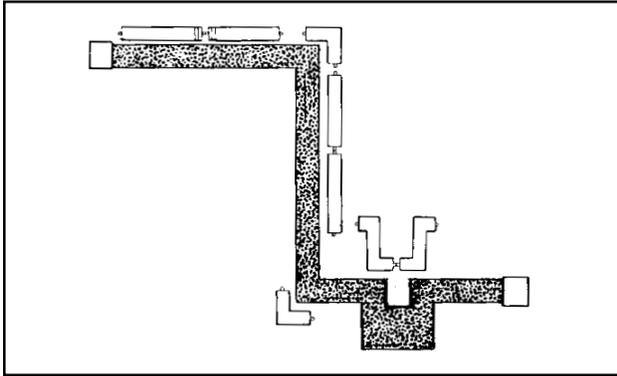


the legs of the loop are not positioned correctly, it will affect the cold springing and/or the length of the run.

6.04 Welding Procedure.

If sufficient lowering equipment is available, it may be easier to complete some field joints outside the trench.

NOTE: Joining sections of pipe outside of the trench may result in the need for two cranes to lower the joined piping into the



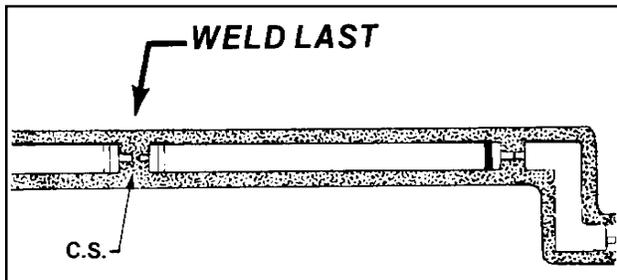
trench. Joining more than two 40' sections in this manner is **NOT** recommended. **DO NOT allow the piping to bow.**

Otherwise, proceed as follows:

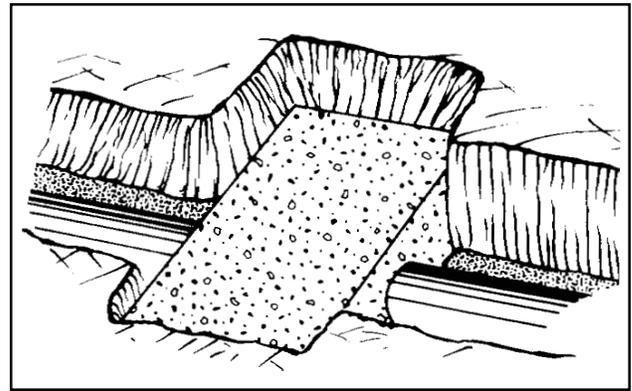
- Remove the protective end bags.
- Remove all shipping bars.
- Weld all straight assembly joints.
- Weld all expansion loop joints.
- **DO NOT weld the white-striped joints.**
- If a field joint closure is not completed

immediately after the carrier pipe connection, slide the steel closure sleeve over the joint, wrap the joint with plastic and, then, seal with tape to keep moisture, rain and dirt out of the pipe assembly.

NOTE: Commence cold springing only after all other welds are completed and the

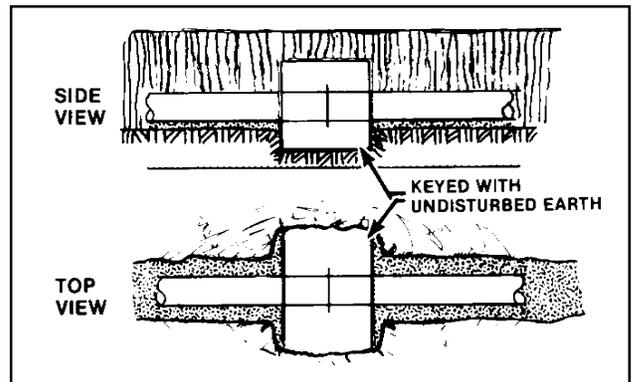


run is solidly fixed at both ends. PERMA-PIPE recommends that concrete anchor blocks be poured around each anchor and allowed to cure before cold springing.



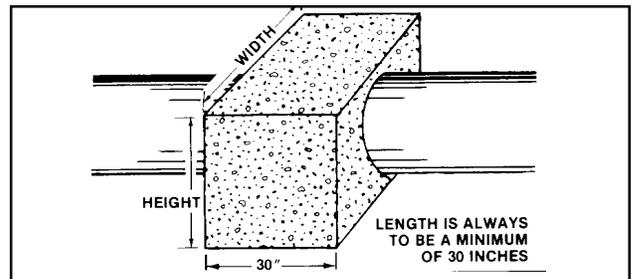
6.05 Concrete Anchor Blocks.

Poured concrete is the preferred method of



anchoring the Multi-Therm 500 assemblies.

- Pour concrete anchor blocks at each anchor point detailed in the PDL.



- Pour the concrete anchor through the bedding material into undisturbed earth in the base foundation or trench walls.

- Refer to Tables A and B for the recommended anchor block dimensions.

**TABLE A
MINIMUM CONCRETE ANCHOR
DIMENSIONS
SINGLE PIPE**

Conduit Size (Inches)	Concrete Dimensions	
	Height	Width
6 5/8	2' 3"	2' 7"
8 5/8	2' 5"	2' 9"
10 3/4	2' 7"	2' 11"
12 3/4	2' 9"	3' 1"
14	2' 10"	3' 2"
16	3' 0"	3' 4"
18	3' 2"	3' 6"
20	3' 4"	3' 8"
22	3' 6"	3' 10"
24	3' 8"	4' 0"

**TABLE B
MINIMUM CONCRETE ANCHOR
DIMENSIONS
MULTI-PIPE**

Conduit Combination (Inches)	Concrete Dimensions	
	Height	Width
16 + 6 5/8	3' 0"	4' 6"
+ 8 5/8		4' 8"
+10 3/4		4' 10"
+12 3/4		5' 0"
+14		5' 2"
+16		5' 4"
18 + 6 5/8	3' 2"	4' 8"
+ 8 5/8		4' 10"
+10 3/4		5' 0"
+12 3/4		5' 2"
+14		5' 4"
+16		5' 6"
+18	5' 8"	
20 + 6 5/8	3' 4"	4' 10"
+ 8 5/8		5' 0"
+10 3/4		5' 2"
+12 3/4		5' 4"
+14		5' 6"
+16		5' 8"
+18		5' 10"
+20		6' 0"
22 + 6 5/8	3' 4"	5' 0"
+ 8 5/8		5' 2"
+ 10 3/4		5' 4"
+ 12 3/4		5' 6"
+ 14		5' 8"
+ 16		5' 10"
+ 18		6' 0"
+ 20		6' 2"
+ 22	6' 4"	
24 + 6 5/8	3"	5' 2"
+ 8 5/8		5' 4"
+ 10 3/4		5' 6"
+ 12 3/4		5' 8"
+ 14		5' 10"
+ 16		6' 0"
+ 18		6' 2"
+ 20		6' 4"
+ 22	6' 8"	
+ 24	6' 10"	

**TABLE B
MINIMUM CONCRETE ANCHOR
DIMENSIONS
MULTI-PIPE**

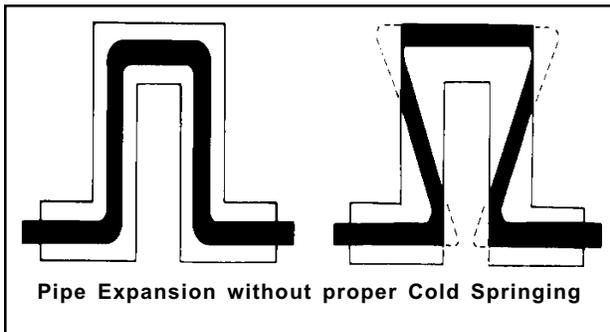
Conduit Combination (Inches)	Concrete Dimensions	
	Height	Width
6 5/8 + 6 5/8	2' 2"	3' 8"
8 5/8 + 6 5/8 + 8 5/8	2' 4"	3' 10" 4' 0"
10 3/4 + 6 5/8 + 8 5/8 +10 3/4	2' 6"	4' 0" 4' 2" 4' 4"
12 3/4 + 6 5/8 + 8 5/8 +10 3/4 +12 3/4	2' 8"	4' 2" 4" 4" 4' 6" 4' 8"
14 + 6 5/8 + 8 5/8 +10 3/4 +12 3/4 +14	2' 10"	4' 4" 4' 6" 4' 8" 4' 10" 5' 0"

NOTE: For other combinations of conduit:
Height: Use the height value from Table B for the largest conduit.
Width: For each additional conduit, add 6 inches plus the conduit diameter.

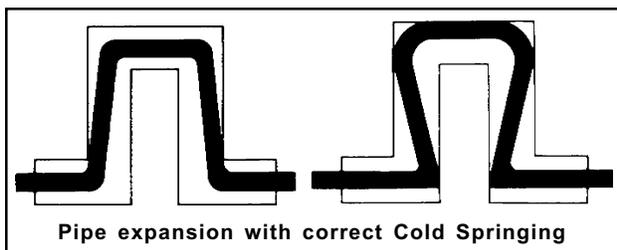
6.06 Cold Springing.

Cold springing is designed into the Multi-Therm 500 system by PERMA-PIPE to reduce the amount of oversized casing needed at elbows to allow for carrier pipe expansion. This significantly reduces installed cost of the system.

If cold springing is done incorrectly, the expansion of the carrier pipe will cause the loop to swell, as shown below, and destroy the insulation properties on that section of carrier pipe.



When cold springing is utilized, the legs of the expansion loop are pulled out as shown below. These carrier pipe ends are then connected to the rest of the run. Although the carrier pipe will now expand just as much when put into service, it will only move out a fraction of what it would without cold springing and, thus, allow the insulation to remain intact.



Cold springing requires the legs of the expansion loop not be allowed to pull back into their original positions before the line is put into service. PERMA-PIPE recommends that concrete anchor blocks be poured around each anchor and allowed to cure before cold springing.

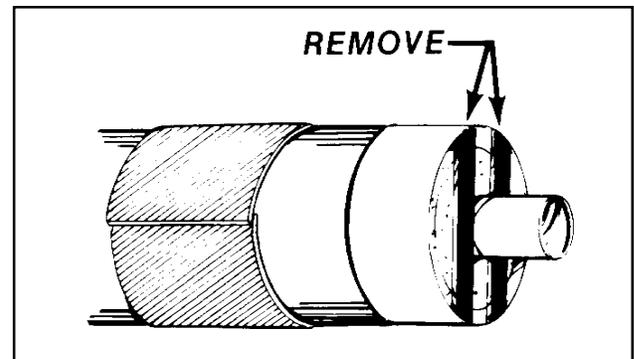
PERMA-PIPE realizes there are other ways to cold spring. However, care must be taken to prevent any movement of the

carrier pipe back into its original position. The amount that is effectively cold sprung in the field must be exactly the amount calculated and specified by the PERMA-PIPE engineers on the PDL.

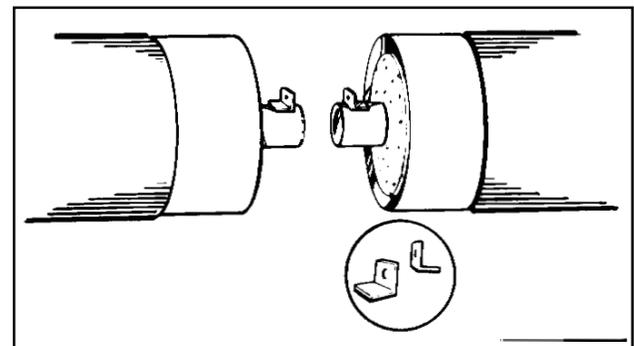
If time is taken to plan the installation, work can proceed at another location while waiting for anchors to be poured and cured.

Once the run has been properly fixed at both ends, either by concrete anchor blocks or by the bridge method of cold springing (see Section 6.07), join the carrier pipe using the following procedure:

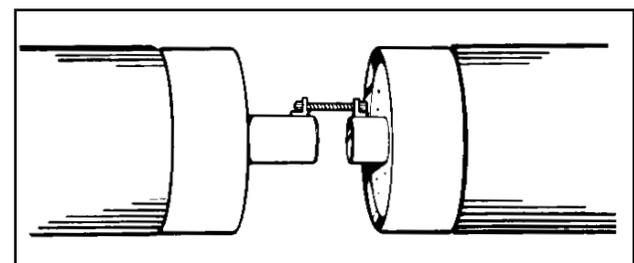
- Remove shipping bars with a cutting torch. **DO NOT damage the carrier pipe.**



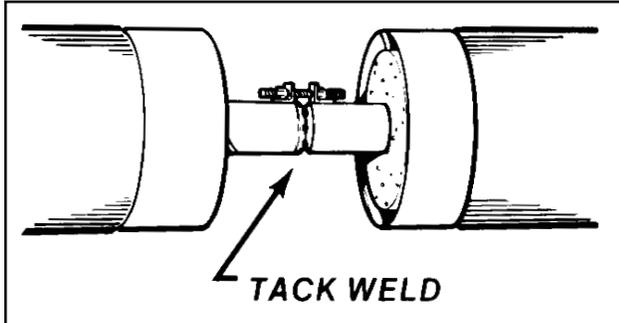
- Tack weld angles a half inch from the outer edge of each carrier pipe. For larger pipe sizes, multiple angles may be required. Angles are supplied by the contractor.



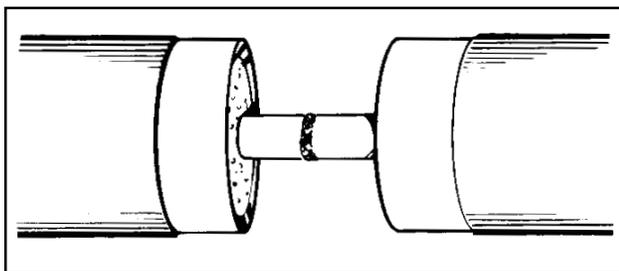
- Insert a bolt through the two angles.



- Place the nut on the bolt and tighten until the two pipes come together. Tack weld the pipe joint.



- Remove the angles. Butt weld the pipe joint.



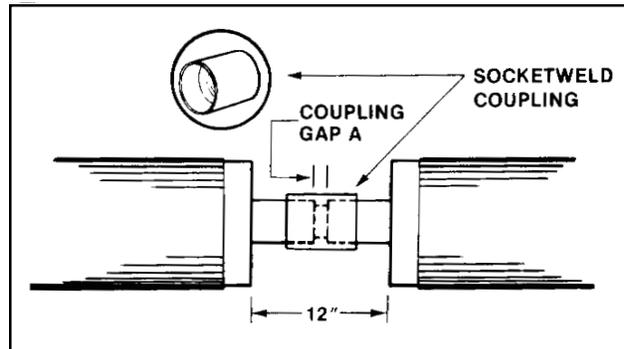
- Inspect surface for damage. Repair if necessary.

For 2-inch diameter and smaller steel pipe, socketweld couplings are required at the field joints. The couplings are supplied by the contractor. Refer to Table C for required coupling gap between carrier pipes.

**TABLE C
SOCKETWELD COUPLING GAP
(INCHES)**

Nom. Pipe Size	Gap A	Nom. Pipe Size	Gap A
1/4"	1/4"	1"	1/2"
3/8"	1/4"	1-1/4"	1/2"
1/2"	3/8"	1-1/2"	1/2"
3/4"	3/8"	2"	3/4"

If a field joint also has a cold springing gap, it should be added to the coupling gap (A). Before doing cold springing, the coupling should be welded to one of the pipes.

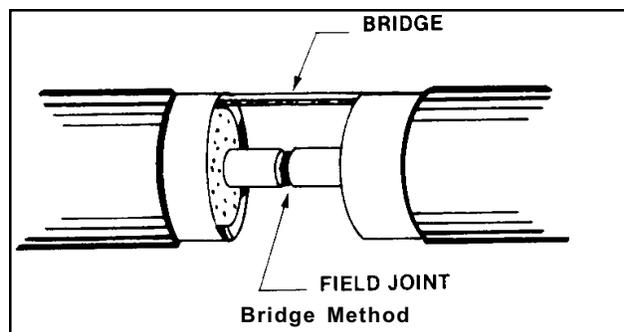


- Weld angles to each carrier pipe leaving sufficient space between angle and coupling to allow for cold spring.
- As before, use nut and bolt to draw the carrier pipes together and tack weld the free end of the coupling.
- Remove angles and complete the coupling socketweld.
- Inspect surface for damage. Repair if necessary.

6.07 Bridge Method of Cold Springing.

Occasionally, pouring anchors first is not possible or desirable. In this case, the PERMA-PIPE field representative must be consulted. The field representative might provide an alternative recommendation, such as the Bridge Method:

- Cut shipping bars off the ends of the assemblies.
- Position a shipping bar or similar piece of metal, the "bridge," between the two outer conduit casings, and then weld it to the inside edges of the conduit as shown below.



- Remove the weld scale from the welded joint. Great care must be taken to prevent damage to the carrier pipe. Any damage to the casing or the pipe must be repaired.

- **DO NOT remove the bridge from between the casings.** Complete the field closures with the bridges in place following the regular cold springing steps.

- Repeat this procedure at every field joint on the conduit run.

6.08 Hydrostatic Test of Carrier Pipe.

NOTE: Hydrostatic test of carrier pipe must be performed prior to the installation of containment pipe joints.

- After the carrier pipes are welded together, connect test caps at the ends of the pipe run. Pipe test caps are provided by others.

- Set all valves so the entire line can be tested.

- Completely fill the pipe with water.

- Vent all air from the carrier pipe.

- Bring the hydrostatic pressure up to 1½ times the operating pressure, unless otherwise stated by the pipe line specifications.

- Maintain the pressure for a minimum of two hours, allowing for temperature changes, unless otherwise stated by the pipe line specifications.

- Any faulty welds must be repaired and retested.

7.0 FIELD JOINT CLOSURE

7.01 Overview.

After completion of the hydrostatic test, each field joint will require a systematic application of insulation and welding procedure to properly close the joint. The standard Multi-Therm 500 field closure is completed in four parts:

1. Insulation of the carrier pipe
2. Conduit pipe sleeve installation
3. Insulation of the conduit pipe
4. A final fiberglass jacket hand lay-up or an alternate application of a shrink sleeve outer jacket (both methods of final closure are covered in this instruction manual).

NOTE: Consult the PAL-AT Installation Manual to ensure proper closure of assemblies equipped with leak detection systems.

7.02 Insulation of the Carrier Pipe.

PERMA-PIPE provides the following materials for carrier pipe insulation:

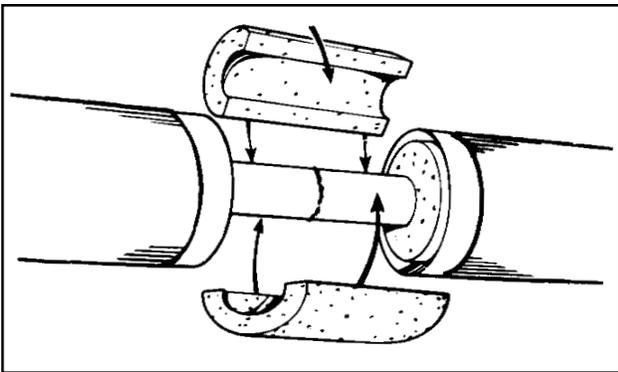
1. Pipe insulation
 2. Stainless steel banding and fasteners
- Installation contractor provides:

1. Come-along
2. Welding equipment

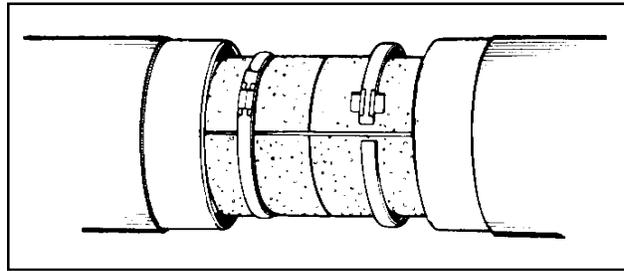
When all tools and materials have been staged, proceed as follows:

- Half-round pieces of insulation must be cut to length for use at each field closure.

Press two halves firmly together onto the bare pipe at the field joint.



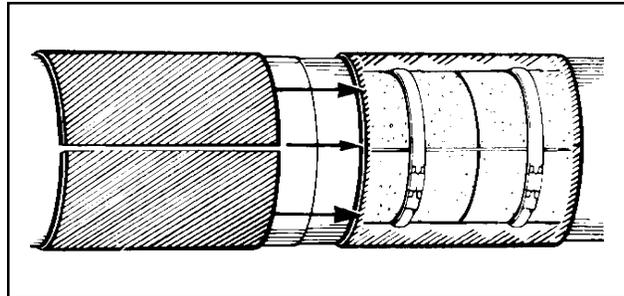
Tighten the strips of steel banding around the halves of insulation and secure with metal fasteners.



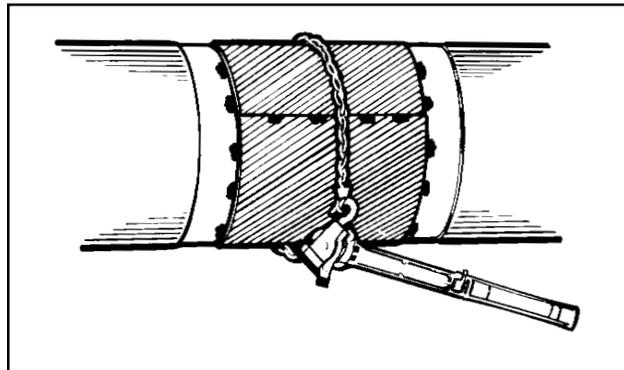
7.03 Conduit Pipe Sleeve Installation.

NOTE: For assemblies equipped with leak detection systems, **DO NOT commence conduit pipe sleeve installation without first consulting Section 4 of the PAL-AT Installation Manual.**

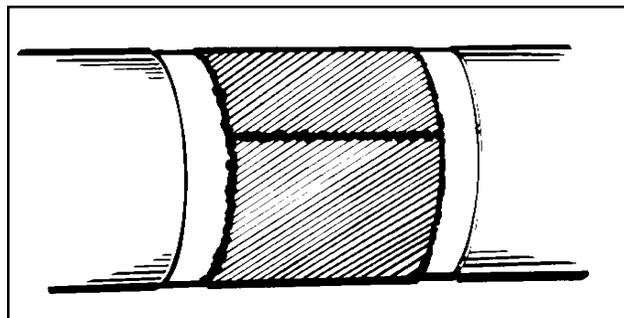
Center the closure sleeve over the joint.



Draw the closure sleeve tightly around the pipe using a come-along.



Tack weld the closure sleeve, then remove the come-along.



Clean the seam areas using a wire wheel grinder or brush. Lap weld the closure sleeve along the seam and edges. These welds must withstand the conduit pipe air test.

7.03.1 Conduit Pipe Air Test.

To perform a pipe air test, PERMA-PIPE furnishes:

1. Test cap
2. Rubber gasket

The contractor furnishes:

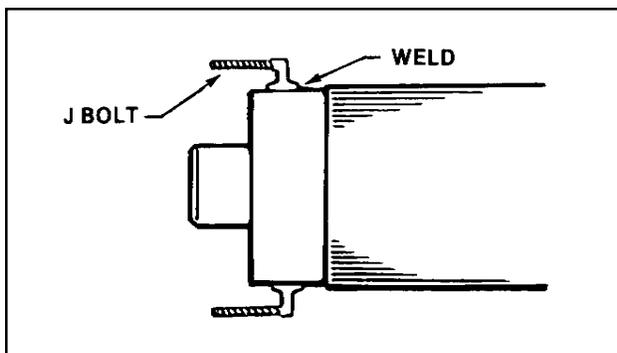
1. Pressure gauge
2. J bolts or threaded rod, nuts, washers

If the end seals are connected, no test caps are needed.

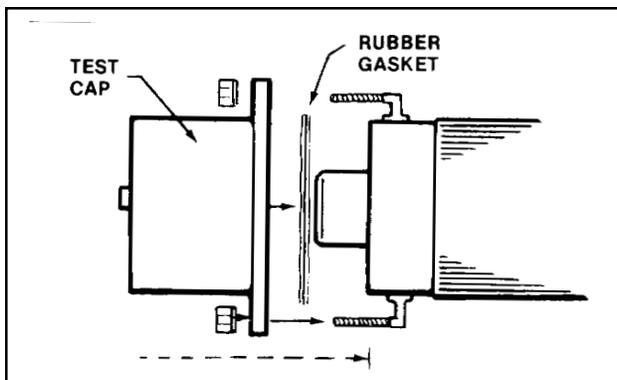
NOTE: The test caps are not designed for performing a pressure drop test. They are designed to permit only soap testing of the field joints.

To install test caps:

Tack weld the head of a J bolt to the edge of the pipe. Tack weld the head of a similar bolt to the opposite side of the pipe. Leave enough thread extending past the pipe end for the test cap to fit on.



Place the gasket over the open end of the test cap and lift the cap onto the bolts.

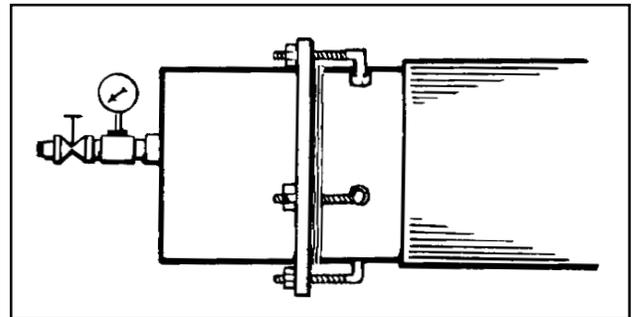


Mount the nuts and washers. Tighten nuts by hand.

Weld the other bolts onto the pipe to match the test cap holes. Place the nuts and washers on the bolts. Tighten nuts snugly.

Make a firm weld over the tack welds on the first two bolts.

Tighten all nuts carefully and evenly so that the test cap and gasket make a firm seal with the pipe.



Be sure the cap is tightly fastened. Make sure the drain and vent plugs are closed.

At this point, test cap installation is complete. Proceed with the conduit pipe air test:

Build up the test pressure in the system.

DO NOT exceed 15psi air pressure.

DO NOT stand in front of or in line with the test cap while the pressure is on.

Maintain test pressure during soap testing of field closure welds.

Soap test all welds to find pinhole leaks.

Mark and repair any leaks and re-test.

Release air pressure before removing the test cap or loosening the bolts.

Remove the J bolts and grind all rough weld edges.

7.03.2 Manhole Connections.

If the run ends at a manhole, it is necessary to perform the following operations:

Install a removable drain plug in the end plate drain hole (lower hole).

Install a venting pipe from the end plate vent hole (upper hole) to the vent ports of the manhole.

7.04 Insulation of the Conduit Pipe.

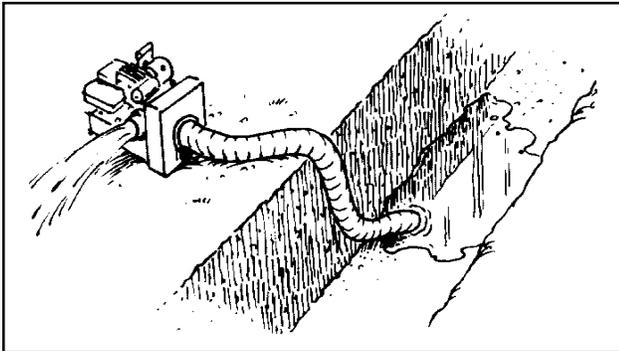
PERMA-PIPE provides the following materials for insulation of the conduit pipe at the field joint:

1. Insulation components A and B
2. Metal mold

The contractor furnishes:

1. Disposal paper mixing pails
2. Heavy duty gloves
3. Dry rags
4. Banding wire or rope
5. Mold release
6. Safety clothing
7. Tin snips
8. Wood rasp
9. Stir sticks

NOTE: DO NOT attempt insulating field closures in wet bell holes. If the bell hole is wet, pump dry before attempting field joint closure.



NOTE: Insulating components A and B must be stored in the 60° to 85° range before use. Insulation stored below 60° will not react properly. Insulation stored above 85° may result in spoiling.

The metal molds provided by PERMA-PIPE can be used for insulating at least 10 field joints given proper maintenance.

When all tools and materials are staged, proceed as follows:

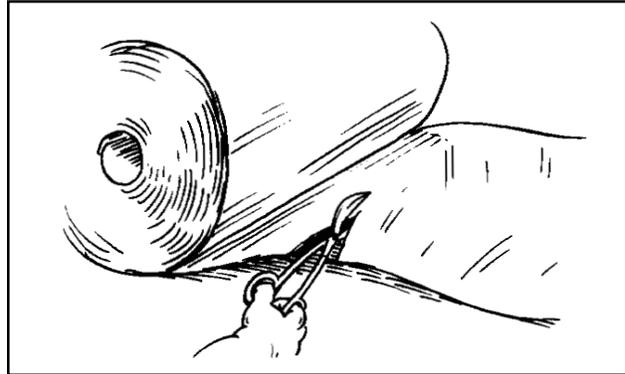
Cut the metal mold form material to the correct length from the bulk roll. Measure and cut, using tin snips, the metal mold material to a length (L) equal to 1-¼ times the circumference of the FRP jacket.

Example: 10-3/4" Dia. FRP Jacket

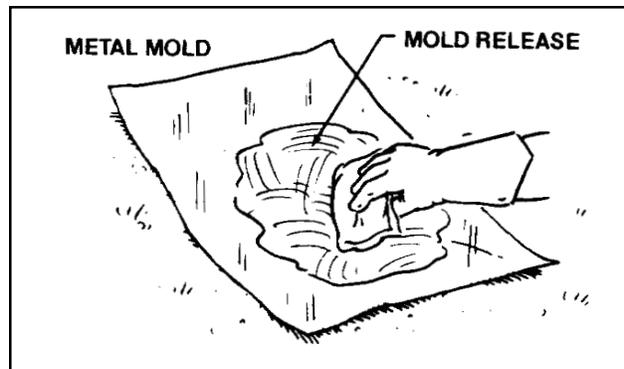
where: $C = \Pi \times \text{Dia.}$

$$L = 1.25 \times C$$

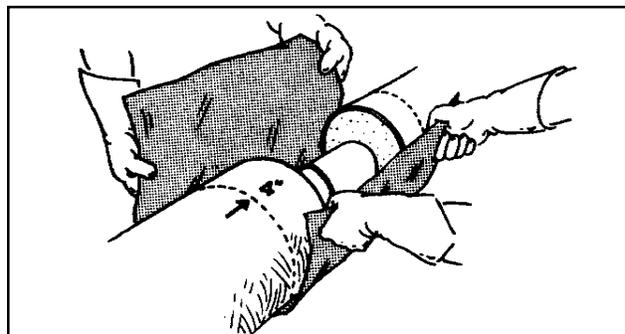
$$L = 1.25 \times 3.14 \times 10.75" = 42"$$



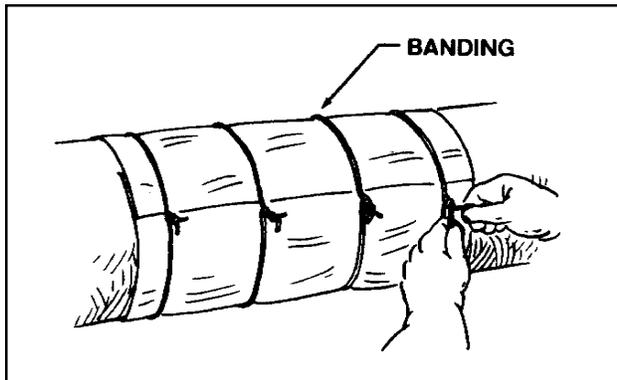
Prior to each use, coat the mold with a mold release. This is commonly found in fiberglass supply houses. Non-stick coating sprays, such as PAM™, can also be used. The entire inside surface of the mold must be coated. Insulation may stick to uncoated portions of the mold and cause damage to both the insulation and the mold when the mold is removed from the joint.



Wrap the mold material around the pipe. Center it around the field joint so that the mold extends 4 inches past each edge.



Tie a wire or rope band around the mold 2 inches from each edge. Use two more bands in the middle, evenly spaced from the first two.



NOTE: It is important to fasten the mold tightly around the field joint. Gaps between the mold and the FRP jacket will allow some of the rising insulation to escape. This could result in an incomplete pour and require mixing another small batch of insulation.

Using tin snips, cut three holes in the top of the mold between the banding. Make each hole about 3 inches in diameter.



NOTE: Each day before opening a shipping container of foam components, turn them upside down for about 15 minutes. This ensures that each component is properly mixed prior to being used.

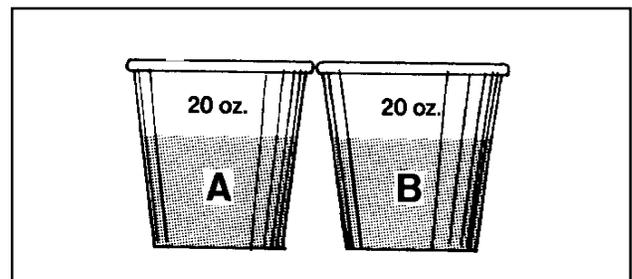
Refer to Table D for the insulation component amounts.

**TABLE D
INSULATION QUANTITIES (OZ)
PER COMPONENT**

NOMINAL CASING SIZE	INSULATION SIZE
	1 INCH
6	6
8	8
10	9
12	11
14	12
16	13
18	15
20	16
22	18
24	19
26	20
28	22
30	23
32	25
34	27
36	29

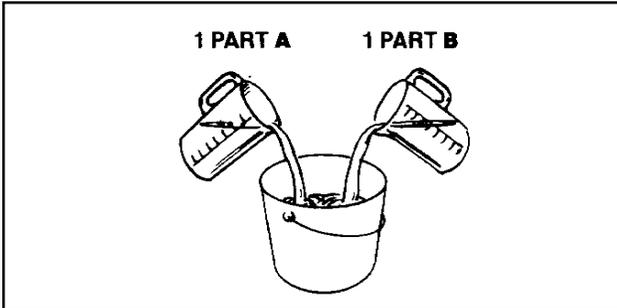
NOTE: Refer to the Material Safety Data Sheets (MSDS) for handling and emergency procedures and for safety precautions and protective equipment requirements.

Use a 1:1 mixing ratio. For example, if the amount given is 20 ounces, the mixture requires 20 ounces of Type A and 20 ounces of Type B. Two containers, each large enough to hold the given quantity, are required. Mark one "A" and the other "B."

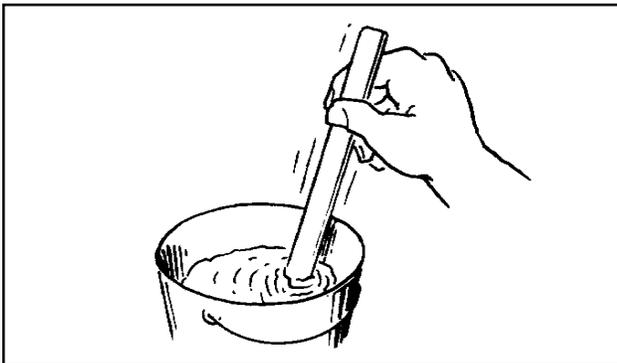


DO NOT combine the two mixtures until you are ready to begin insulating the field joint.

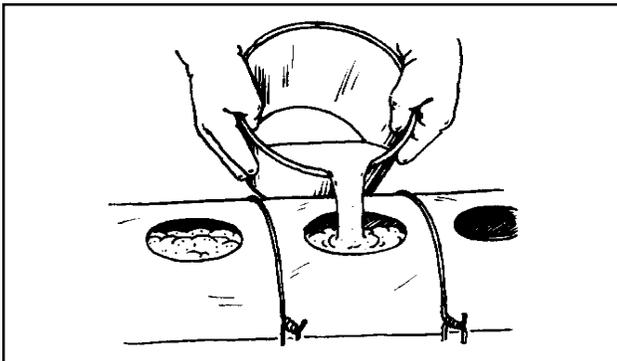
Pour the required amount of Type A into a measuring cup. Pour an equal amount of Type B into a second measuring cup. Combine the contents of both measuring cups into a mixing pail.



Immediately begin stirring the mixture. Stir vigorously for about 15 seconds. The insulation will begin rising in 15-30 seconds.

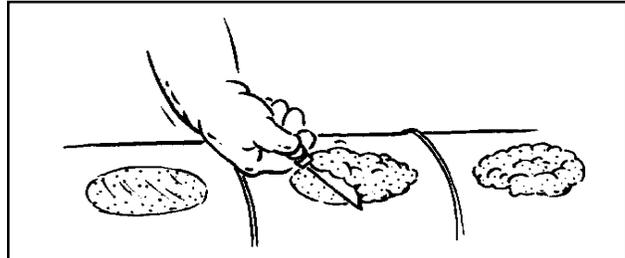


After 15 seconds of stirring, pour the mixture into the three holes at the top of the mold. The mixture will turn to foam and rise to the top filling the entire mold. The excess foam will push out through the top holes.



If the mold does not fill completely, remix small amounts of foam until it does. Also, adjust the amount of the mixture now needed for the remaining field closures.

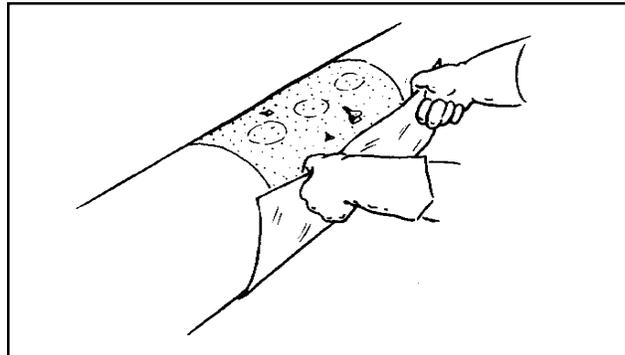
After the foam stops rising, cut the excess foam from the top of the mold.



Let the mold cool for about 10 minutes after the foam rises out of the top holes.

Discard the paper mixing pail.

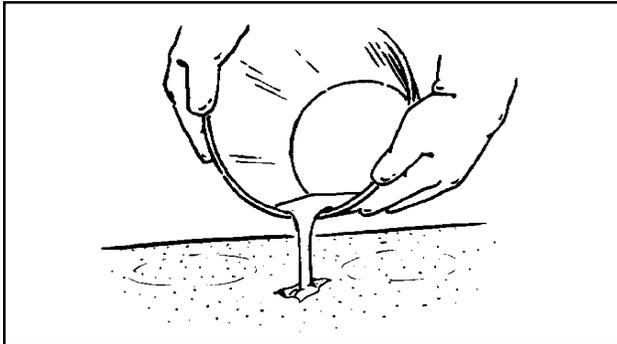
Remove the banding and carefully peel the mold off the insulation. Tearing the mold off may rip the insulation and require a repair procedure.



NOTE: The mold will be extremely hot. After removing the banding, peel the mold carefully off the insulation. If this is not done with care, the mold and the insulation will probably get damaged. If the mold sticks repeatedly, use additional mold release on the mold for the next pour.

After each use, clean the inside of the mold with denatured alcohol or a similar cleaning solvent to remove any dirt or insulation.

Patch any voids in the surface of the insulation by mixing another small batch of foam. As soon as it begins to rise in the container, apply to the void areas.



NOTE: If the fiberglass hand lay-up or shrink sleeve application is not completed immediately after insulating, plastic sheeting should be sealed around the field joint. If any of the insulation in the field joint or pre-insulated assembly becomes wet it must be removed and replaced. Water contaminated insulation cannot be dried out. This may require replacement of the entire assembly at the customer's expense.

7.05 Fiberglass Jacket Hand Lay-up.

PERMA-PIPE provides the following materials to install the fiberglass jacket hand lay-up:

- Fiberglass bi-ply mat
- Un-promoted resin
- Laminating roller
- Catalyst (BFF-50)
- Promoter dispenser
- Catalyst Promoter (DMA)

The installing contractor must furnish the following:

- Grinder and wheel
- Disposable mixing pail (1 gal.)
- Acetone or equivalent cleaner
- Heavy-duty rubber gloves
- Wooden mixing paddles
- Wire brush
- Dry rags
- Plastic drop cloths
- Sheet of plywood
- Paint brushes (3")

NOTE: The following precautions are recommended to ensure the best installation possible.

- Ensure that all field closure kit materials are properly stored.
- Keep all kit materials in their original shipping containers. Store these materials in a trailer or mechanical room. This trailer or mechanical room should be well-ventilated. Keep all materials away from any open flames, sparks or extreme heat.
- Store the resin and catalyst at 60° F to 85° F. **DO NOT store resin and catalyst above 100° F.**
- Take only enough materials to the site for the number of closures that will be made up in one working shift.

When all tools and materials are staged, proceed as follows:

Cut the fiberglass bi-ply material to the correct length. Measure and cut two lengths (L) of bi-ply equal to 1¼ times the circumference of each FRP jacket.

Example: 10-3/4" Dia. FRP Jacket
where: $C = \Pi \times \text{Dia.}$

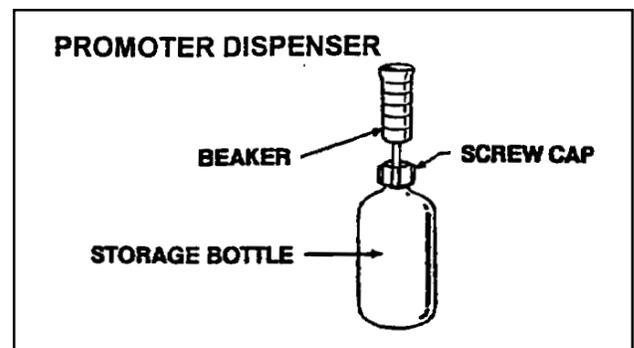
$$L = 1.25 \times C$$

$$L = 1.25 \times 3.14 \times 10.75 = 42"$$

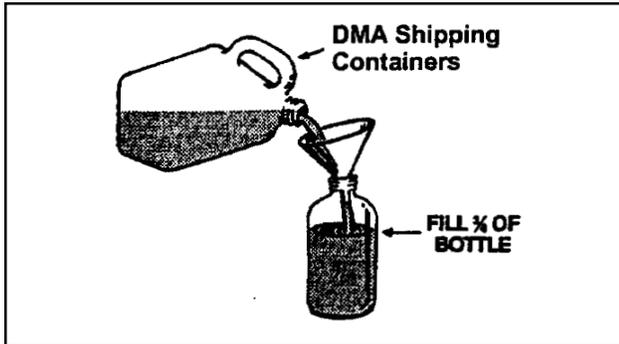
Sand the ends of the FRP jacket.

Lightly sand down any insulation that is not level with the top of the jacket. Wipe off any rain, dew or other moisture from the ends of the jacket. Use clean, dry, lint-free rags. These surfaces must remain dry during the fiberglass hand lay-up.

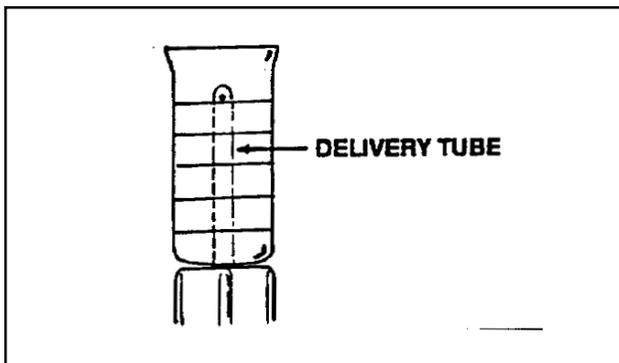
A Promoter Dispenser is provided for measuring promoter. The resin is shipped un-promoted to increase shelf life.



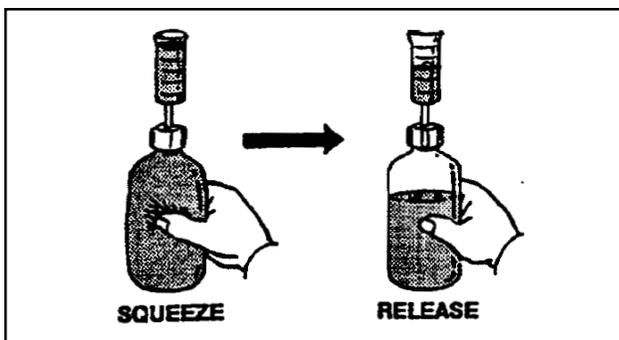
Unscrew the cap of the storage bottle and replace it with a funnel. Pour DMA into the storage bottle until it is about $\frac{3}{4}$ full. **DO NOT fill it all the way.**



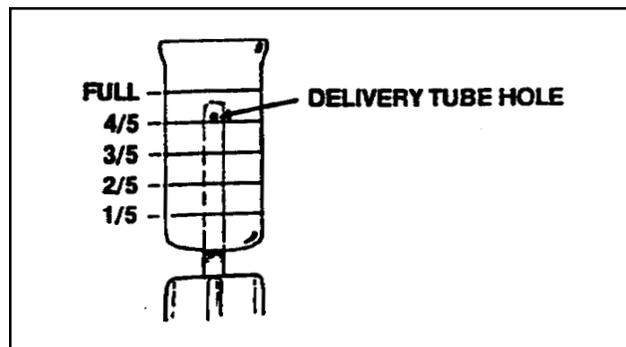
Remove the funnel and screw the cap back on tightly. Attached to the cap is the delivery tube. Slide the beaker onto the delivery tube.



To measure out a full beaker of DMA, slide the beaker all the way down. Squeeze the bottle until DMA fills the beaker. Release pressure on the bottle, and the excess DMA will return to the bottle.



To measure out a fraction of a beaker, slide the beaker so the delivery tube hole is at the desired level. Squeeze and release as described for a full beaker.



Open the 5-gallon pail of resin.

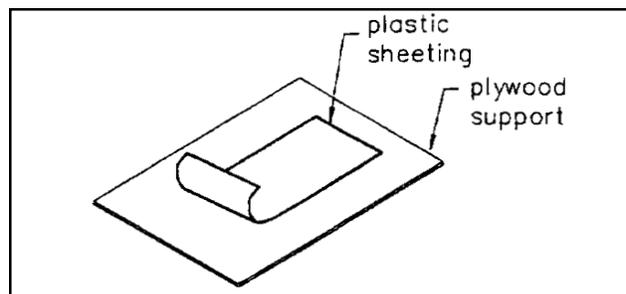
NOTE: If the resin is milky, jelled, or has dark sediment in the bottom, **DO NOT use.** Contain the PERMA-PIPE field service representative for fresh resin.

- Add 1 ounce of DMA per gallon of resin (1 oz = 30 cc's). 5 gallons of resin will require 5 ounces of DMA; 3 gallons of resin will require 3 ounces of DMA.
- Thoroughly mix the DMA into the resin.

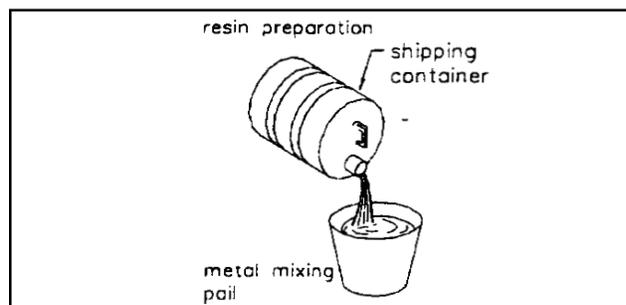
NOTE: DO NOT add DMA to more resin than will be used in one working shift.

Abrade 6 inches of the factory-applied fiberglass jacket on each side of the joint.

Place a sheet of 4 mil thick plastic on a sheet of plywood. The plywood and plastic should be 6 inches longer and wider than the longest cut piece of fiberglass.



Pour promoted resin from the shipping container into a mixing container (see resin quantities Table E).



**TABLE E
RESIN QUANTITIES**

Nominal Conduit Size	Resin (Qts.)	Nominal Conduit Size	Resin (Qts.)
6	3.0	22	9.0
8	3.5	24	10.0
10	4.5	26	11.0
12	5.5	30	12.5
14	6.0	36	14.5
16	7.0	42	17.0
18	7.5	48	19.5
20	8.5	54	22.0

NOTE: The resin should be kept at a minimum of 60° F for several hours prior to use.

Add the BFF-50 catalyst to the Promoted resin in the mixing container and thoroughly mix. A useful mixing tool is a low-speed drill with a formed wire as a bit (see catalyst quantities Table F).

**TABLE F
CATALYST QUANTITIES**

	Temperature (Degrees F)			
	60°	70°	80°	90°
Gallon	8 tbsps	6 tbsps	4 tbsps	2 tbsps
2 Cups	1 tbsps	1 tbsps	1/2 tbsps	1/2 tbsps

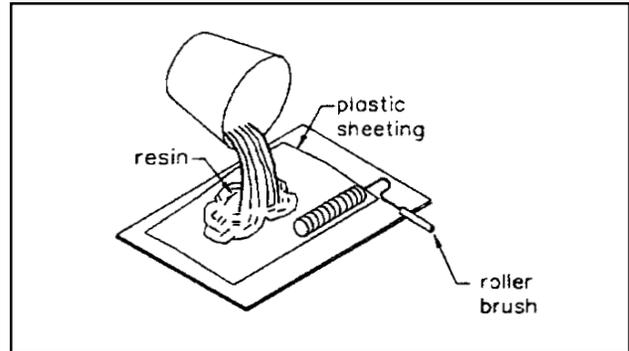
(1 tbsps = 15 cc)

NOTE

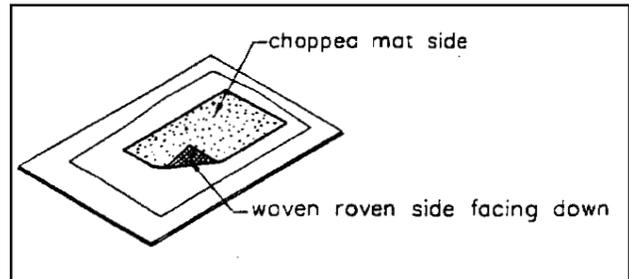
These quantities are approximate. Adjustments should be made as needed. To decrease the gel time, increase the amount of catalyst per gallon. To decrease the gel time, decrease the amount of catalyst per gallon.

The BFF-50 catalyst must be mixed thoroughly into the resin solution for these gel times to be obtained.

- Pour one third of the resin onto the plastic sheet. Spread the resin out so that it is 4 inches longer and 2 inches wider than the bi-ply that is to be wetted out.



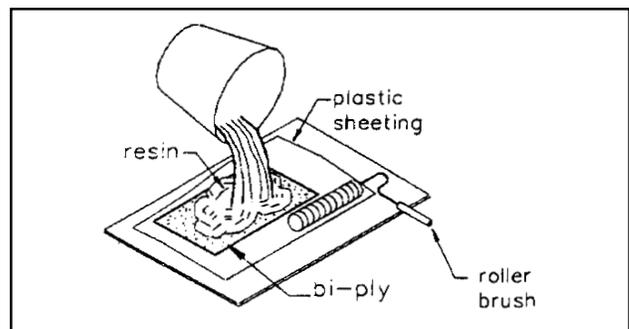
- Lay a piece of bi-ply onto the sheet with woven roving side face down. Center the bi-ply on the sheet.



- Pour half of the remaining resin onto the bi-ply. Spread the resin over the entire bi-ply surface using the metal roller supplied by Perma-Pipe.

NOTE: Use only the finned metal roller to spread the resin. Anything else could damage the bi-ply.

- Move the roller back and forth on the bi-ply until it appears transparent. Lay a second piece of bi-ply onto the first piece, "woven roving" side face down. Pour the remaining resin onto the bi-ply. Roll out the

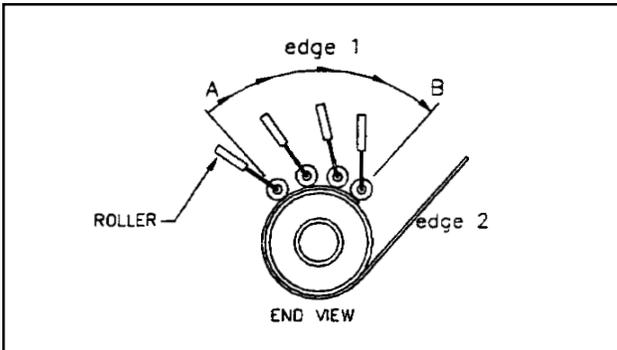


top piece until it appears transparent. Roll all excess resin from the bi-ply.

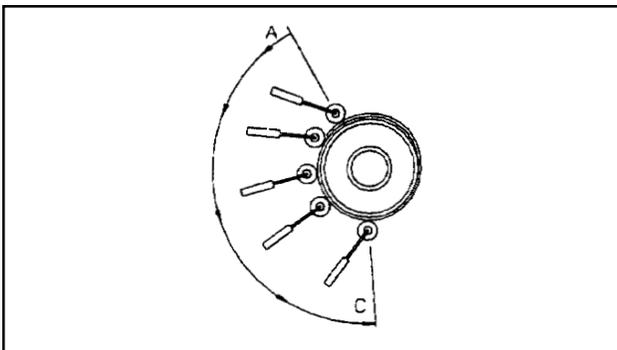
- Place the wetted bi-ply around the closure sleeve. Ensure that the bi-ply is centered so that it overlaps the factory-applied fiberglass jacket equally on both sides. Lay one edge of the hand lay-up onto the sleeve. Continue to hold the other edge. Roll the first edge with the finned metal roller to roll all trapped air out from under the bi-ply wrap. Start at the bottom and roll toward the top. **DO NOT let the bi-ply sag away from the sleeve at the bottom.** Continue to roll the wrap until it begins to set up.

NOTE: Once the glass begins to set up, **DO NOT continue to roll it with the finned metal roller.**

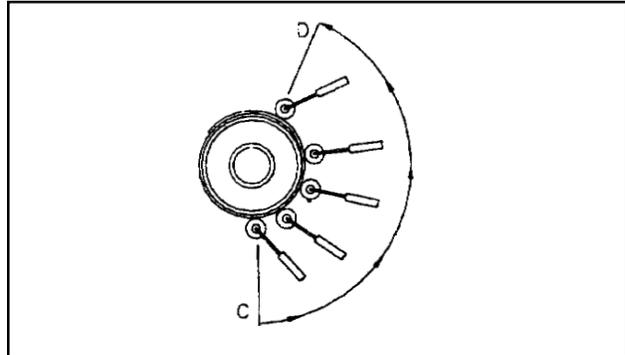
- Move the roller along the hand lay-up from point (A) to (B), pushing out any trapped air. Repeat from (A) to (B) along the entire hand lay-up width. Begin in the middle and move to the edges.



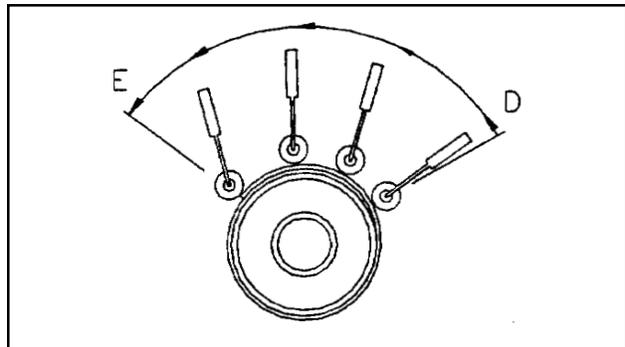
- Lay down edge 2 overlapping edge 1. Move roller down along the hand lay-up from point (A) to (C), pushing any air to the bottom.



- Continue moving roller up from point (C) to (D), pulling any air to the top.



- Move roller from point (D) to (E), pulling any air out of the hand lay-up.



- After the hand lay-up has hardened completely, abrade the complete surface for preparation of the second hand lay-up. Repeat the hand lay-up process. This second layer will create the equivalent protective coating as the factory-installed coating.

- Once the resin reaches its exothermal peak, mix a small amount of promoted resin with BFF-50 catalyst and paint the entire bi-ply wrap. Be sure to paint all seams. This will give the wrap a good clean, smooth finish and will help ensure a watertight seal.

- Let the bi-ply cure for a minimum of 24 hours before backfilling.

- Place the finned metal roller and any other resin-covered tool in a pail of acetone or equivalent cleaner after each field joint closure has been wrapped. Clean all tools thoroughly at the end of each shift.

7.06 Shrink Sleeve Method.

The Multi-Therm 500 system shrink sleeve offers an alternative method of providing complete protection at field joint closures with a minimum amount of labor. The shrink sleeve simultaneously forms a seal in two ways. The recovery (shrinking) of the sleeve is due to the heat that it absorbs. As the sleeve recovers, an adhesive sealant softens and forms a bond with the conduit insulation. The effectiveness of the seal is dependent upon how well these processes are completed.

NOTE: Before the start of shrink sleeve installation, review the following:

- When using the torch, the flame should be kept at least 6 inches away from the shrink sleeve and at an angle to the surface. Holding the torch at an angle allows the flame to bounce off the sleeve and decreases the local intensity of the heat. If the flame is held too close to the surface, the material will burn and the sleeve may tear around the burned areas.
- Stay within the chalk guidelines when wrapping to shrink the sleeve uniformly.
- When wrapping the shrink sleeve, leave a gap of approximately 1 inch between the sleeve and the bottom of the conduit. This gives the sleeve room to shrink properly. If the sleeve is wrapped snugly without a gap, it may pull apart or tear during heating.
- After wrapping the shrink sleeve, the closure strip should be preheated for about 5 seconds. **DO NOT overheat the strip because it will soften too much.** Apply the closure strip directly over the seam of the overlap and press down firmly. **DO NOT try to smooth the patch out.**
- Use your body as a shield to protect the flame from the wind. Keep the torch at an angle to the sleeve and pointed in the direction the wind is blowing to maintain a fairly even flame. **DO NOT increase the size of the flame--this could overheat the shrink sleeve.**

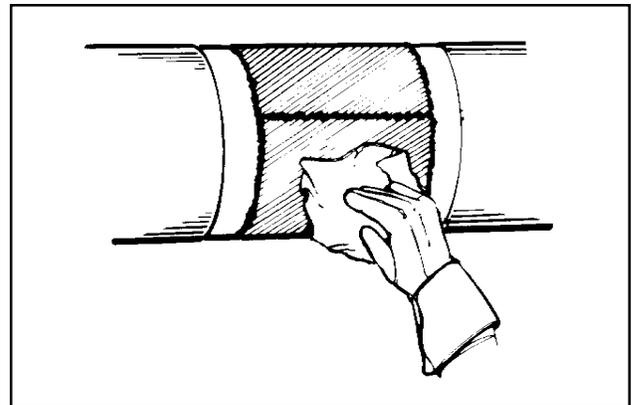
The PERMA-PIPE field representative may be on hand to demonstrate and check the application of the shrink sleeves.

PERMA-PIPE provides the shrink sleeve material. In order to heat the sleeve correctly, the proper propane equipment must be used, and PERMA-PIPE provides the necessary propane torch head, as well. The LP tank, hose fittings, unions, valve regulators, hand roller and gloves are provided by the installing contractor. If the installer supplies the propane torch, it must be approved by PERMA-PIPE field service or meet the following specifications:

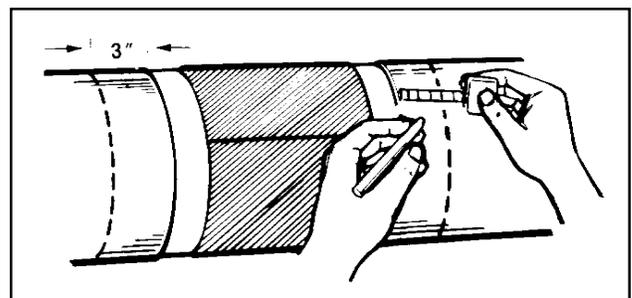
1. Heavy-duty hose for LP torch use
2. High capacity flame nozzle. For applications on outside diameters less than 18 inches, the minimum torch size is 150,000 BTU/hr. For applications on outside diameters greater than 18 inches, the minimum torch size is 300,000 BTU/hr.

When all tools and materials have been staged, proceed as follows:

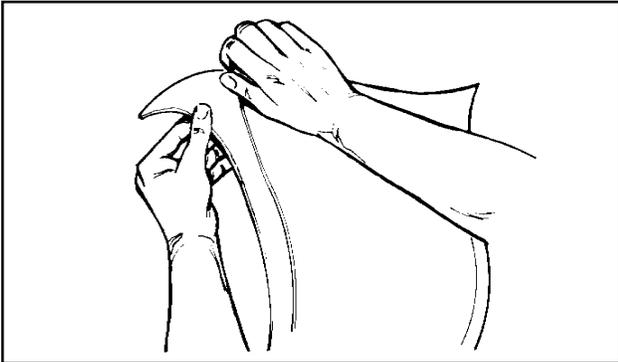
- Wipe off the field joint area.



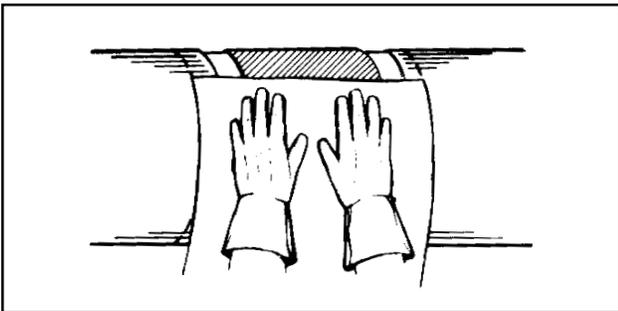
- With a measuring tape, chalk mark a guideline on the FRP jacket 6 inches from each edge of the jacket.



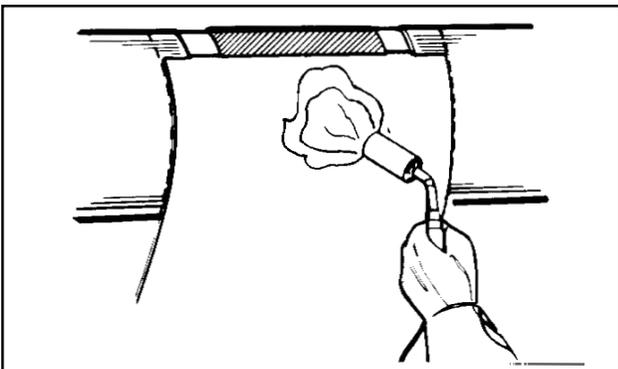
- Identify the correct sleeve size by the conduit size label on the backing material. Length of sleeve should be the circumference of the pipe plus 4 inches. The other edge will measure 32 inches. Hold this starting edge up and remove the first 6-10 inches of backing material.



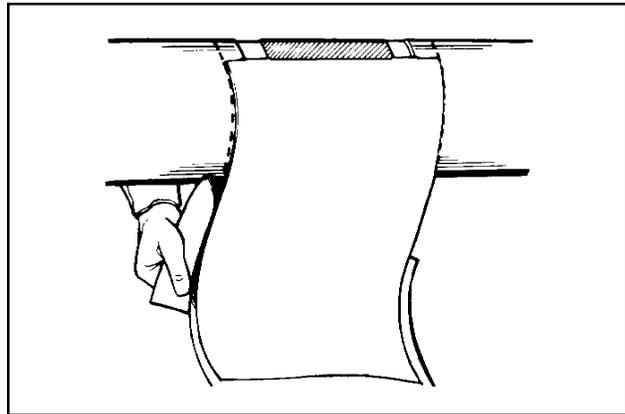
- Continue to hold the shrink sleeve right-side up. Press the top edge into place just below the top of the conduit so that the sleeve is centered between the chalk lines.



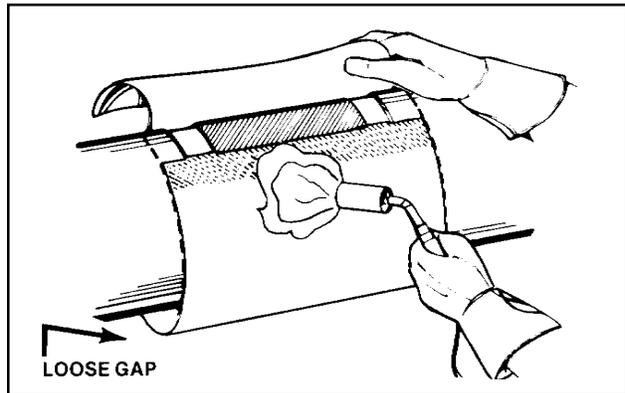
- Heat the top 2 inches of the sleeve with the torch until it becomes soft and adheres to the conduit insulation. Only use the torch provided or an approved substitute.



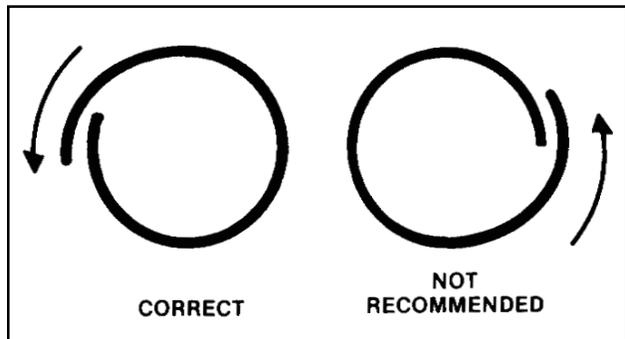
- Pull the remaining backing material off as the sleeve is wrapped around the joint.



- Wrap the sleeve around the conduit so the lower portion forms a loose gap that hangs about 1 inch from the bottom of the conduit. Stay within the chalk guidelines. Reheat the top 2 inches of the sleeve before overlapping. Keep the torch in constant motion. **DO NOT burn the surface.**

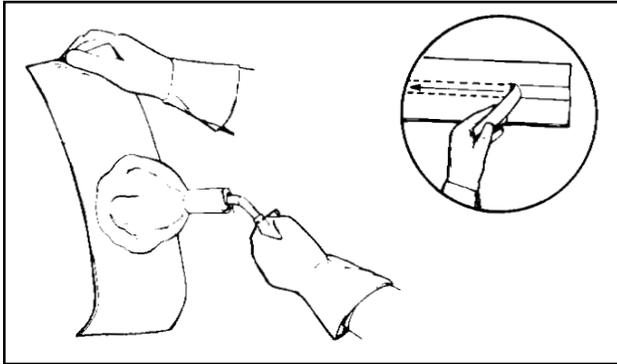


- Be sure to overlap downward.

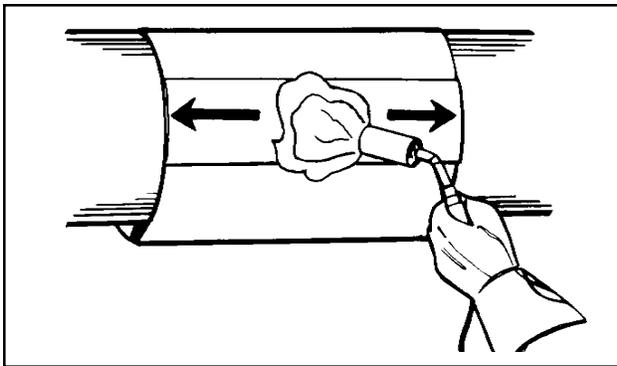


- Peel the back strip off the closure tape. **NOTE:** To prevent the corners of the closure tape from peeling up after application, cut a 1/2 inch triangle from each corner.

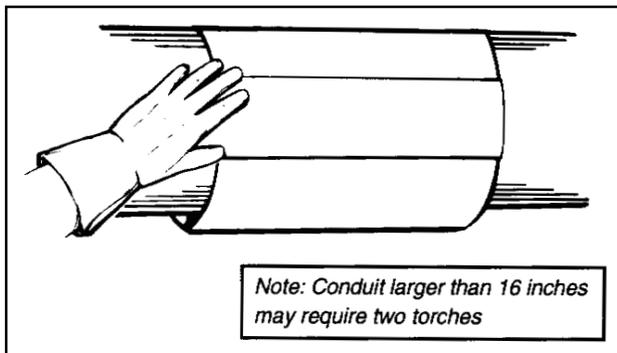
- Preheat the tape until it becomes limp. **DO NOT heat longer than 5 seconds.**



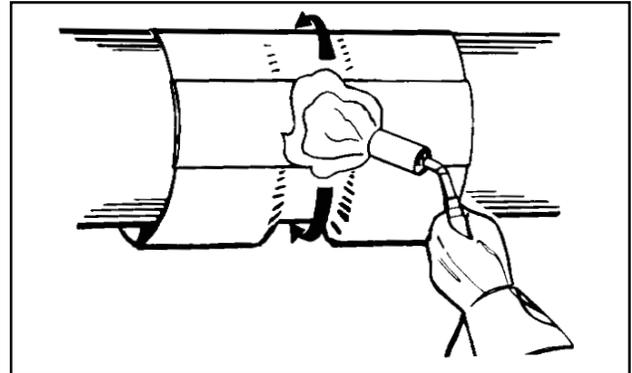
- Apply the tape across the seam made by the overlap. The sticky back strip should be face down.
- Heat the closure tape with a torch until it sticks to the rest of the sleeve. Keep the torch in constant motion. **DO NOT burn the surface.**



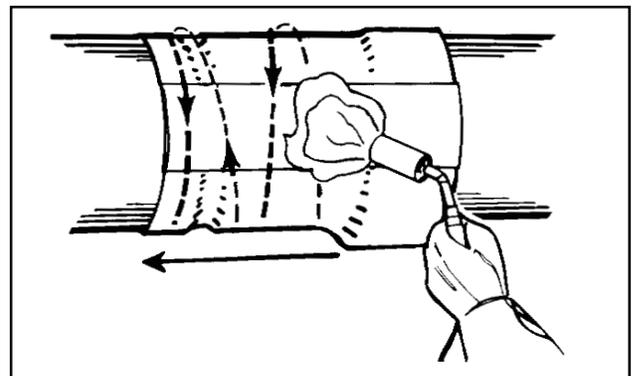
- Pat the tape down to achieve a good bond. Wear hot gloves while performing this operation.



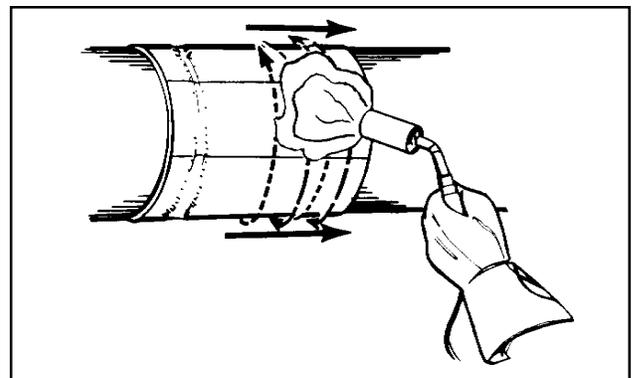
- Heat the center section of the sleeve all the way around until it shrinks. Keep the torch in constant motion. **DO NOT burn the surface.**



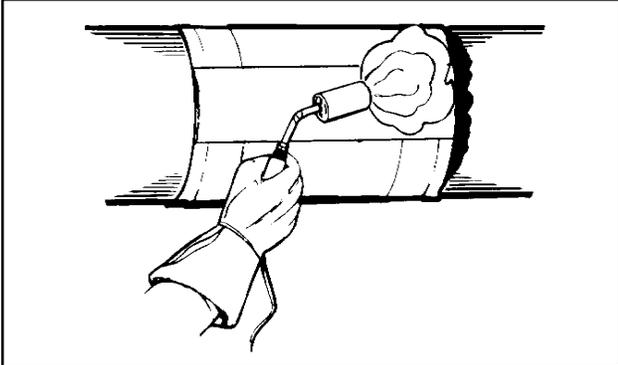
- When the center of the sleeve has shrunk, begin to move the torch with an up-and-down spiral motion around the sleeve toward the left edge.



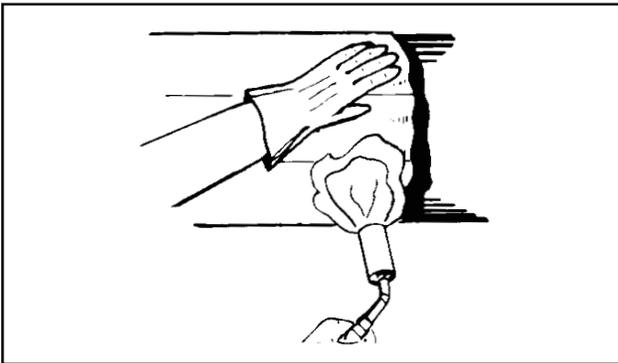
- When the left side has shrunk, heat the right side in the same up-and-down spiral manner. Keep the torch in constant motion. **DO NOT burn the surface.**



- Reduce the flame slightly and shrink the edges of the sleeve onto the conduit. Black adhesive escaping at the edges indicates a good bond.



- If the sleeve edge raises up, reheat and press down firmly. Keep the torch in constant motion. **DO NOT burn the surface.**



- While the sleeve is still hot and soft, use a hand roller to gently roll the sleeve surface and push any trapped air up and out of the sleeve. Reheat, if necessary.

8.0 ALTERATIONS AND REPAIRS

8.01 Alterations.

All field modifications to the Multi-Therm 500 system must be cleared with PERMA-PIPE. Changing the length or direction of the system may result in a faulty installation, requiring costly repairs in the future.

Every installation should have field verification of the submittal drawings. This will eliminate most dimension problems and will also allow PERMA-PIPE engineers time to modify the system design, if needed.

Even with field verification, there will occasionally be an installation that does not

run true to plan. If additional materials are required, the PERMA-PIPE field representative should be contacted immediately.

If it is necessary to lengthen or shorten a run, the field representative will specify where to make the modifications. The position of the modification will depend on the nature and location of the problem.

The PERMA-PIPE field representative must also be contacted before altering the direction of a run.

8.02 FRP Jacket Repair.

A casing has been severely scratched if fiberglass strands are exposed or the casing wall has been chipped or penetrated. Consult your PERMA-PIPE field representative, and perform the following repair procedure, if necessary:

- Mark a line 3 inches on either side of the damaged area. Measure the distance between the two lines.
- Mark a line lengthwise on one of the spare shrink sleeves, equal to the required width as determined in the previous step.
- Cut the shrink sleeve along the line.
- Press the top edge into place just below the top of the assembly so that the area to be repaired is in the center of the shrink sleeve. Follow the heating instructions for shrink sleeve application (Section 7.06).

NOTE: The shrink sleeve must cover the damaged area and extend 360° around the pipe with overlap.

8.03 Wet Carrier Pipe Insulation.

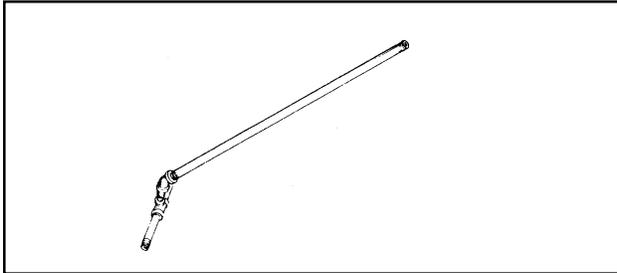
If the Multi-Therm 500 carrier pipe insulation gets wet, it must be dried before system start-up:

- Contact the PERMA-PIPE field representative.

9.0 BACKFILL PROCEDURES

9.01 Materials.

The most crucial part of the backfill process is the compaction of soil underneath and alongside the conduit. A hand tamping device can be constructed easily and economically by joining small diameter pipe. This tool will compact the soil firmly and evenly around the conduit and should be used instead of mechanical tampers when compacting to prevent damage to the conduit coating.



Multi-Therm 500 outer conduit is a flexible pipe capable of withstanding deflections of its geometric shape without structural damage. As the conduit deforms because of surface (live) loads and soil loads, the sides move outward against the soil, developing passive resistance pressure from the soil. This passive soil pressure can be great enough to increase the load-carrying capacity of a flexible conduit significantly. The extent of this increase is dependent on many conditions, particularly the type of soil and the degree of compaction. If PERMA-PIPE's recommended procedures are followed, a minimum burial depth of 2 feet can be established. It should be noted that shallower burial depths slightly increase heat losses.

Special analysis of minimum burial depths is required at taxiways, runways, railways and other areas of high surface loading conditions. It is recommended that the customer contact both PERMA-PIPE and the local authority for more specific instructions.

9.02 Backfill Description.

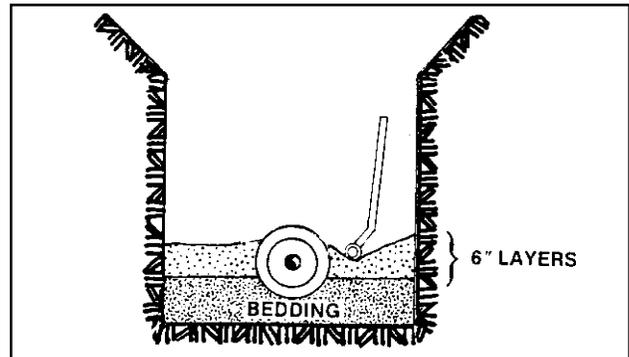
1. Sand or a sand-gravel mixture in which the gravel is either pea gravel or crushed stone without sharp edges.
2. Particles not larger than a half-inch in diameter.
3. 90% of the soil passing a No. 4 sieve.
4. 90% of the remainder retained by a No. 200 sieve.
5. Separate all unsuitable soil from the backfill soil.

9.03 Initial Backfill.

- Prior to backfilling, remove any foreign materials, such as shoring, braces and support blocks.

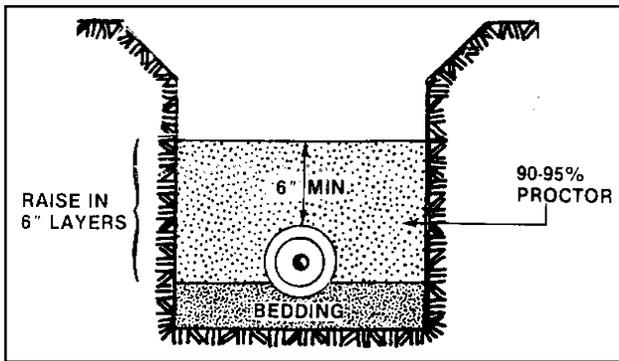
NOTE: DO NOT use frozen fill, sod, cinders or stones greater than a quarter inch in diameter as primary backfill.

- Carefully compact the area directly around the conduit in 6-inch layers.



- Proper compaction of the haunching materials, that section of the embedment extending from the bottom of the pipe to the springline, should be performed to provide soil densities as specified by the design engineer.

- Primary backfilling of selected earth should be packed and tamped to 6 inches minimum over the top of the jacket.



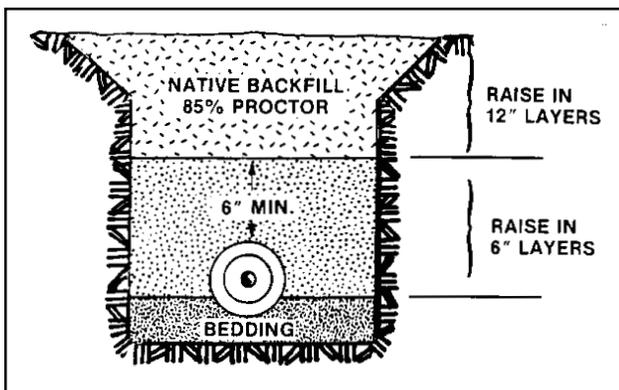
- Compact in 6 inch layers to 90-95% proctor. If surface loading conditions exist, backfill to grade in this manner.

NOTE: DO NOT use wheeled or tracked vehicles for tamping.

9.04 Final Backfill (85%) Compaction.

The backfill operation can now be completed by any convenient means. Remainder of backfill should be free of large boulders, and rocks larger than 6 inches in diameter, frozen earth, or foreign matter.

After placement and compaction of pipe embedment materials, the balance of backfill materials may be machine placed. Provide compaction to required soil densities. Use of mechanical compaction equipment to complete the final backfill is suggested, but **DO NOT use mechanical compactors until the conduit is covered with at least 12 inches of firmly compacted soil.**



Under normal conditions, backfill to grade in 1-foot lifts and compact to 85% proctor. Native soil can be used, provided it is non-organic and all particles are less than 1 inch in size.