INSTALLATION AND OPERATION MANUAL FOR SKIN EFFECT ELECTRICALLY TRACED PIPING SYSTEMS

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PRINCIPLES OF OPERATION

The skin effect current tracing system is an electrically traced pipe heating system designed to provide heat to the carrier pipe evenly along the insulated pipe line.

The skin effect current tracing system generates heat in the ferromagnetic heat tube via I^2R loss of the return current flow, as well as hysteresis and eddy current losses. Additional heat is also produced by the I^2R copper loss in the insulated skin effect current tracing cable.

The skin effect current tracing heat tube is welded to the carrier pipe. The low thermal resistance of the weld provides excellent heat transfer to the carrier pipe.

Temperature sensing is at the carrier pipe in a thermal well attached to the carrier pipe. Pipe temperature is continuously monitored by a temperature controller located in the control enclosure. Constant temperature is maintained by cycling the tracing system on and off as required. When the pipe temperature drops below the maintenance temperature setting on the temperature controller, the tracing system is turned on and remains on until the pipe temperature reaches the maintenance temperature setting. This closed loop temperature control system provides only the required heat energy to maintain the pipe at the set temperature.

SYSTEM COMPONENTS

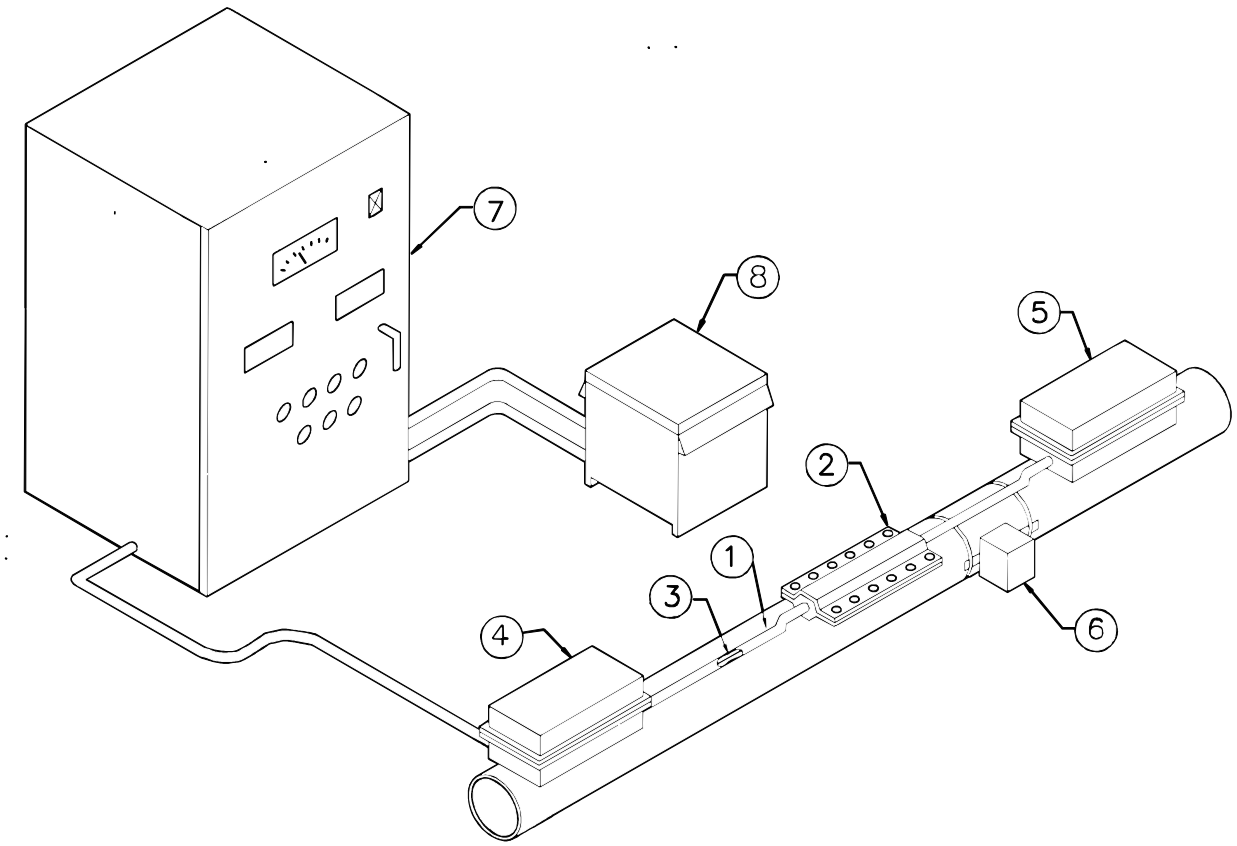
The system components are shown on Figure 1. The skin effect current tracing tube is attached to the carrier pipe. See the enclosed installation manual and the appropriate system drawings for details in making connection at the field joints.

Pull and splice boxes are provided along the line at major direction changes as well as at intervals necessary for easy skin effect current tracing cable installation and splicing. See the enclosed installation manual and system drawings for pulling and splicing details.

Feed and terminal boxes are provided to make electrical terminations and power feed connections to the skin effect current tracing system. Details are available in the installation manual and system drawings.

The control enclosure houses all the electrical power, control and indicating devices. Depending on the size of the power transformer, it may be externally mounted from the control enclosure. The system schematic and enclosed drawings detail the components used for your skin effect current tracing system.

Figure 1
System Components



1) SKIN EFFECT CURRENT TRACING TUBE
2) PULL OR SPLICE BOX
3) TRACING CABLE
4) FEED CONNECTION BOX
5) TRACE TERMINATION BOX
6) TEMPERATURE SENSOR
7) CONTROL PANEL
8) POWER TRANSFORMER

CONTROL OPERATION

The electrical controls for your skin effect current tracing system are designed to provide the desired control of the heating system as well as provide functional indications. The controls are housed in a heavy duty industrial enclosure designed for the classification of the area in which they are to be located. The system drawings give the NEMA classification of the control enclosure.

The skin effect current tracing system is provided with automatic and manual control modes. The manual mode is intended for use only during start-up, maintenance checks and troubleshooting of the electrical system. When using the manual control mode, care must be taken to continuously monitor the system operation.

In manual mode, the temperature controller is bypassed and the system will continue to heat as long as the manual mode is maintained. The temperature indicator and alarms are active in the manual mode.

The automatic mode provides closed loop temperature control and indication. The pipe temperature sensor provides a continuous signal to the indicating temperature controller. The temperature controller compares this signal to the reference signal (set point temperature). When the pipe temperature is above set point, the system will be “off”. When the pipe temperature is below the set point, the system will be “on”.

The temperature controller has low temperature and high temperature alarm contacts. Set point of these alarms is given under “Specification and Performance Data” in this manual. Additional information on the operation of the temperature controller can be found in the enclosed temperature controller manual.

Over-current or differential current protection may be provided on your skin effect current tracing system. See the enclosed system drawings for the type of protection provided.

Over-current protection senses a current above cold starting current. If the skin effect current tracing system current rises to the set value, the system will shut down and resetting of the system is required to restart.

Differential current protection senses the difference in current of two sections. If the current in one section rises over or falls below the other section, annunciation and system shut down will occur. After the cause of shut down is found and repaired, manually reset to “start” the system heating.

SAFETY CONSIDERATIONS

Your skin effect current tracing system is physically similar to a single conductor in a rigid steel conduit. While current flows inside the heat tube, the surface of the tube is current free. With no surface current, there is no voltage and the heat tube is essentially at ground potential. The piping system may be grounded anywhere along its length. The National Electric Code, Article 426-44 recommends the system be grounded at both ends.

The piping system normally operates at an elevated temperature. The thermal insulation should be kept in place to provide protection of personnel from contacting hot surfaces.

Only qualified personnel should operate and service the electrical controls. The control system is provided with a safety disconnect means. This should be locked out (open) during line and/or system maintenance.

SENSOR INSTALLATION

Junction Box Preparation

Sensor Kit Materials

(1) 4" x 4" stainless steel junction box
(2) 1/2" conduit hubs
(1) CGB connector
(1) 8.5" make-a-clamp

1. Make (2) 1/2" (nominal) knock-outs on the junction box.
2. Cut off (2) pieces of stainless steel banding material; use attached chart for proper length.
3. Attach the bands to the junction box, using the stainless steel 1/4" truss head stove bolts, lock washers and nuts.
4. Install the Scru-Tite hubs in the knock-outs.
5. Install the CGB fitting into one of the hubs (see Figure 3). Do not tighten the cord grip at this time.
6. Attach the breeze connectors to the bands.

Washer-Type Sensor Installation Using Existing Field Joint

1. Full weld the 3/8" x 3/4" stainless steel bolt of the pipe, as shown in Figure 2.
2. Install sensor as shown in exploded view, Figure 2. Be careful to align sensor parallel to pipe. Tighten nut sufficiently to compress the Belleville washers. Do not over tighten, as this may prevent removal of sensor after operation. It may be desirable to use a high-temperature anti-seize compound on the threads.
3. Route sensor lead wire along pipe to edge of field joint, then perpendicular to the pipe, as shown in Figure 3. Be sure that the Teflon insulated portion of the lead wire does not come in contact with the pipe. The transition point between the fiberglass and Teflon should be positioned about half the distance from the pipe to the jacket.
4. Insulate the field joint, such that the Teflon jacketed portion of the sensor lead wire exits the insulation through the end of the connector band, as shown in Figure 3.
5. Seal around the lead wire with high-temperature RTV sealant.
6. Strap the junction box to the pipe, as shown in Figure 3. Tighten the Breeze connectors, to hold the box firmly in position.
7. Route Teflon jacketed lead wire through CGB connector and into the junction box.
8. Make connections to field wiring as required.

BAND LENGTH TABLE

(Allows for Insertion of Fasteners)

Band should always be cut midway on small round hole for smooth fastener fit. This table is accurate for the diameters indicated.

Length to cut dia. on	Mark	Length to cut dia. on	Mark	Length to cut dia. on	Mark	Length to cut dia. on	
2"	2 1/2"	9"	24 1/8"	16"	46 7/8"	26"	77 1/4"
3"	5 1/16"	10"	27 7/8"	17"	49 7/16"	28"	83 5/8"
4"	8 7/8"	11"	30 3/8"	18"	53 1/8"	30"	89 7/8"
5"	11 7/16"	12"	34 3/16"	19"	55 3/4"	32"	96 3/8"
6"	15 3/16"	13"	36 3/4"	20"	59 1/2"	34"	102 5/8"
7"	17 3/4"	14"	40 1/2"	22"	65 7/8"	36"	108 7/8"
8"	21 1/2"	15"	43 1/16"	24"	72 1/8"	38"	115 1/4"

To determine lengths of a Make-A-Clamp band material, multiply diameter in inches x 3.1416, minus 4.5" for the adjustable fastener end, or determine circumference by measurement, less 4.5" for adjustable fastener end.

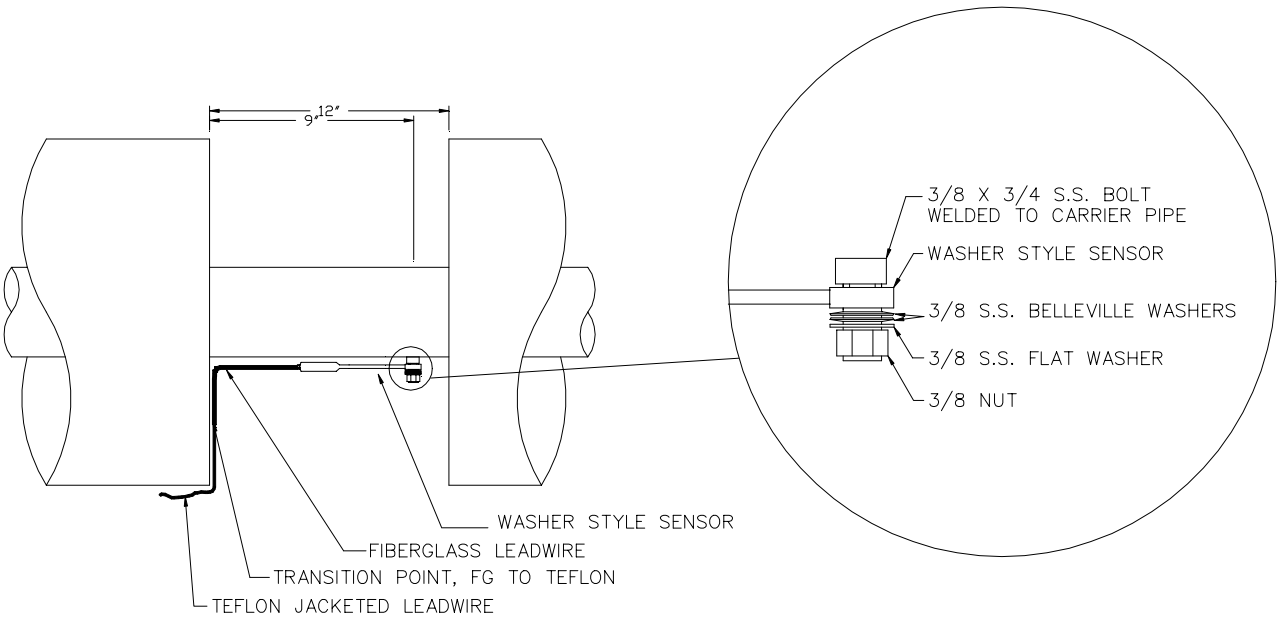


FIGURE 2
WASHER STYLE ISOLATED ASSEMBLY

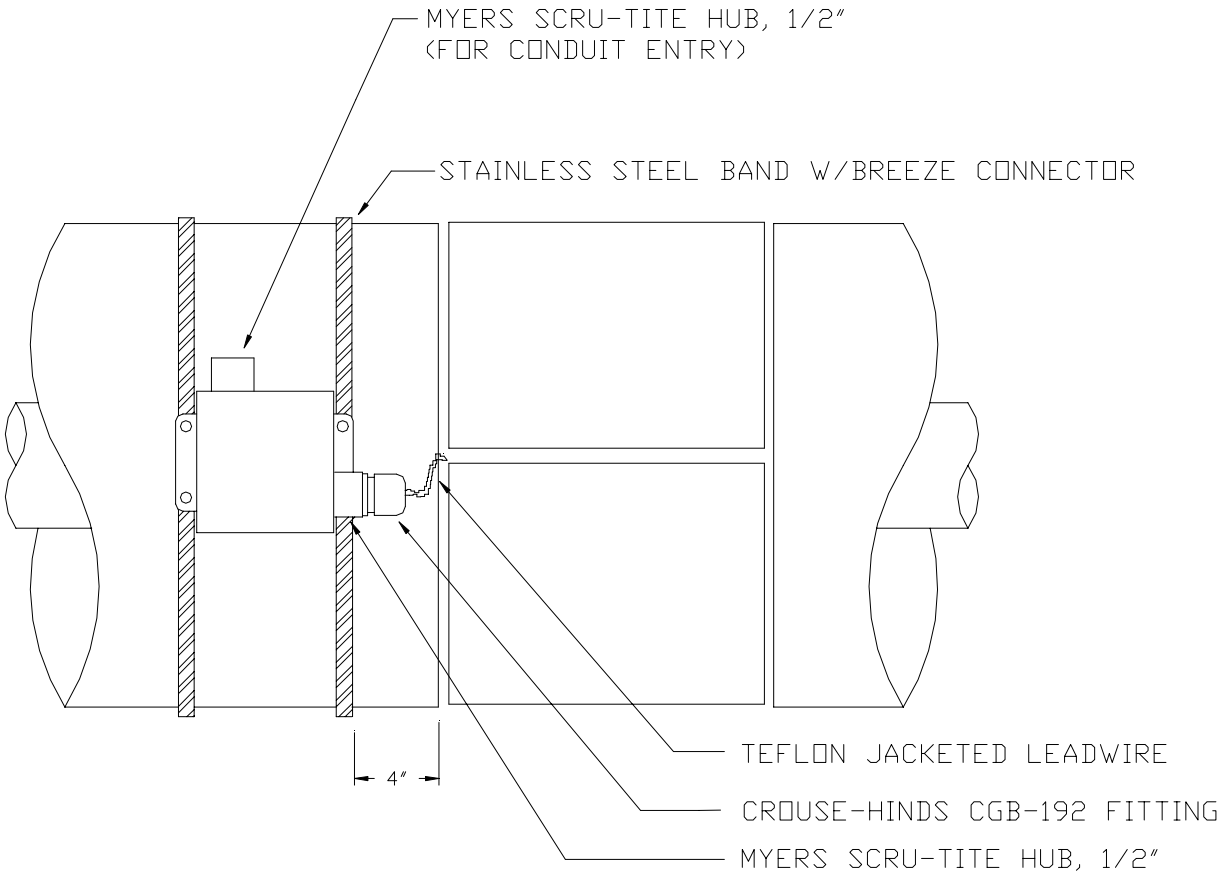


FIGURE 3
JUNCTION BOX INSTALLATION (BOTTOM VIEW)

WIRE SPLICING PROCEDURE FOR RICWIL SPEC RW-LV, 90 & 150°C, 600 VOLT WIRE

Splice kit materials:

- 1 roll Permacell P-2650 self-curing silicon rubber tape.
- 5 pcs. Long barrel butt connectors (see note for connector sizing).

Tools required:

- Wire stripping tool (preferably rotary type).
- Ratchet type crimping tool, set for the AWG size of the wire (not the connector size - see note 1).

Procedure:

1. Strip the insulation back for a distance of 1/2 the length of the butt connector, plus 1/16 inch, being very careful not to nick or damage the conductor in the process.

Remove all remaining conductor tape wrap.

2. Slide the butt connector onto the conductor until the end of the conductor reaches the center of the butt connector. Crimp the connector into place, using at least 2 crimps per end. Be sure to set the crimper for the AWG of the wire, which may be smaller than the AWG size of the connector - see note 1.
3. Apply the P-2650 silicon rubber tape over the connector, using a 50% overlapped wrap, until the tape extends at least 1 inch onto the wire insulation at each end. Build the tape until it is approximately 1/8 inch thick at the center of the splice (approximately 4 to 6 - 50% lapped wraps). Do not overly stretch the tape; stretch it only enough to provide a good lay.
4. Lay the completed splice back down into the pull box. Leave only enough slack in the cable to provide a slight “S” curve. There should be no more than 15 inches of cable remaining in the box when finished.

Note 1: For 90°C cables, the connector size is the same as the wire AWG; for 150°C cables, due to the flexible stranding of the conductor, the connector size is the next size larger than the wire AWG.

WIRE SPLICING PROCEDURE FOR RICWIL SPEC RW-LV, 150°C, 2KV WIRE

Splice kit materials:

- 2 rolls Permacell P-2650 self-curing silicon rubber tape.
- 5 pcs. Long barrel butt connectors.

Tools required:

- Wire stripping tool (preferably rotary type).
- Ratchet type crimping tool, set for the AWG size of the wire.

Procedure:

1. Strip the insulation back for a distance of 1/2 the length of the butt connector, plus 1/16 inch, being very careful not to nick or damage the conductor in the process. Remove any remaining conductor tape wrap.
2. Slide the butt connector onto the conductor until the end of the conductor reaches the center of the butt connector. Crimp the connector into place, using at least 2 crimps per end.
3. Apply the P-2650 silicon rubber tape over the connector, using a 50% overlapped wrap, until the tape extends at least 1 inch onto the wire insulation at each end. Build the tape until it is approximately 2/10 inch thick at the center of the splice (approximately 6 to 8 - 50% lapped wraps). Do not overly stretch the tape; stretch it only enough to provide a good lay.
4. Lay the completed splice back down into the pull box. Leave only enough slack in the cable to provide a slight “S” curve. There should be no more than 15 inches of cable remaining in the box when finished.

WIRE SPLICING PROCEDURE FOR RICWIL SPEC RW-LV, 250°C, 600 VOLT & 3KV WIRE

Splice kit materials:

- (1 roll) 1/2 inch wide, 5 mil thick, adhesive backed TFE Teflon tape.
- (1 roll) Permacell P-2650 self-curing silicon rubber tape.
- (5 pcs.) Nickel plated long barrel butt connectors.

Tools required:

- Wire stripping tool (preferably rotary type).
- Ratchet type crimping tool, set for the AWG size of the wire.

Procedure:

1. Strip the insulation back for a distance of 1/2 the length of the butt connector, plus 1/16 inch, being very careful not to nick or damage the conductor in the process. Remove any remaining conductor tape wrap.
2. Slide the butt connector onto the conductor until the end of the conductor reaches the center of the butt connector. Crimp the connector into place, using at least 2 crimps per end. Be sure to set the crimper for the AWG of the wire.
3. Apply the Teflon tape over the connector, using a 50% overlapped wrap, until the tape extends at least 1 inch onto the wire insulation at each end. Build the tape until it is approximately 1/10 inch thick at the center of the splice (approximately 10 - 50% lapped wraps).
4. Finally, apply 4 layers of the Permacell P2650 silicone rubber tape over the entire splice, 50% overlapped and extending 1 inch past the ends of the Teflon tape layer. Do not overly stretch the rubber tape; stretch it only enough to provide a good lay.
5. Lay the completed splice back down into the pull box. Leave only enough slack in the cable torovide a slight “S” curve. There should be no more than 15 inches of cable remaining in the box when finished.

RECOMMENDED CRIMPING TOOLS

Burndy:

Y1000 Hypress

- Hand operated hydraulic crimper. No dies to install or adjust. This is the best crimper available for the purpose of Skin Effect cable splicing.

Y35

- Hydraulic crimper. Requires proper die (selected to match the conductor AWG).

Thomas & Betts:

TBM8-750

- Hydraulically operated tool similar to the Burndy Y1000. The 750 requires a sepa rate hydraulic pump, while the 750M-1 is self contained. No dies to select or adjust.

TBM12M

- Manually operated hydraulic crimper. Also available with an electric pump. Requires proper die for conductor AWG size.

TBM5S, TBM6S, TBM8S

- Manually operated crimper. Note that the “S” suffix signifies the “SHURE STAKE” feature, which is the ratcheting feature. There are versions without the “SHURE STAKE” option; we do not recommend them.

TBM50S

- Manually operated crimper with nested dies built into the crimping head. The proper die for the conductor AWG must be selected prior to crimping. It has the “SURE STAKE” feature.

FEED POINT CONNECTION INSTRUCTIONS

Connection Kits are supplied to connect the customer's feed wire to the heat tube and cable. Follow the procedure below for connecting the feed cable to the heat cable.

Step 1:

Strip the insulation from the power conductor as necessary, being careful not to nick, score or break any strands. Use the single hole crimp lug and double crimp using one of the recommended crimping tools (see attached list)

Step 2:

Bolt the two lugs together as shown. Use silicon lubricant (by others) on mating surfaces, to prevent oxidation build up.

Step 3:

Use the supplied silicon rubber insulating tape to insulate the connection. Be careful not to tear the tape when applying it around the bolt assembly. Apply a minimum of 6 layers, 50% overlapped.

RECOMMENDED MAINTENANCE

GENERAL

A preventative maintenance program is essential in providing continuity of service with minimum downtime. A good maintenance program should be designed to inspect and test the most critical components, as well as, the components most suspected to fail early. A sound inspection program, combined with good maintenance records, should greatly improve the reliability of an electrical system.

POWER EQUIPMENT

The power equipment is defined as those components that carry, switch, transform, etc., the main energy that will keep the pipe line at its desired maintenance temperature. Since each power device is series connected to another power device, it is most critical each item be maintained and a spare be available for replacement. Typically, these are:

- Terminals
- Main circuit breaker
- Power transformer
- Power contactor
- Skin effect current tracing heating cable
- All power cable connecting the above components

Each of the above components should be inspected and tested as detailed as follows:

Terminals

Terminals are a mechanical connection that will heat up and cool every operational cycle. This can be several times/day. Temperature cycling will cause the electrical connection to loosen and result in a greater resistance to current flow. This resistance will cause increased heating and eventual burning of the cable insulation and/or terminal metal and early failure.

See that all terminals are tight. Inspect the terminals for signs of oxidation, burning, etc. Check the power cable insulation near the terminals for high temperature deterioration, melting, burning, etc. Look at the surface coating of the component and metal near the terminal for paint discoloration, blistering, and the like that would indicate “hot” terminals.

Check that all Belleville washers and other hardware are in place. Torque all 1/2" termination nuts and bolts to 30 foot-pounds with a torque wrench.

Circuit breakers

Operate the breaker a few times to insure the breaker will trip and is capable of reclosing.

Check alignment of the door to insure interlocking. Check all terminals and connecting cable as described above. Check the mounting hardware for tightness to minimize movement during current inrush and mechanical operation.

Power transformer

The power transformer is a dry type transformer that depends on air flow through the coils for cooling. The dustier the location, the more frequent the unit should be checked for dust accumulation. See that the ventilation areas are free from dust, dirt, leaves, and the like. Check the coil air ducts and clean as required with a vacuum cleaner or compressed oil free, dry air. Brush any accumulation of dirt from surfaces around the terminal locations. Do not use any liquid cleanser or water; dry clean only!

Megger the coils - primary to secondary, primary to ground and secondary to ground. Maintain a maintenance log of the megger values obtained and watch for changes in insulation resistance that would indicate a potential early failure. Inspect all cable and terminals, including the ground as detailed above.

Check the outer layer of the coils for any discoloration indicating coil overheating.

Check all mounting hardware to keep the core and coil firmly mounted in place.

Power contactor

The power contactor makes and breaks the current during every thermal cycle. Operation of the contacts will cause pitting and wear. The contacts need to be checked and replaced as required. All terminals and cables should be inspected as described above.

Skin Effect Current Tracing Heating Cable

The skin effect current tracing heat cable is enclosed in the skin effect current tracing tube and not easily visually inspected. Therefore, it is desirable to electrically check the cable by meggering and to maintain a log of the insulation values as suggested under “POWER TRANSFORMER” above. The cable connections at the feed and terminal connection boxes should also be checked for tightness and any indications of high heat as in “TERMINALS”.

Power feed cable

All interconnecting power cable should be meggered phase to phase and each phase to ground. A log of the meggered values should be maintained in order to detect and early change in insulation integrity.

CONTROL EQUIPMENT

Some control equipment components are critical to continuous operation while others are auxiliary functions that are not essential. It is on this premise that the components have been categorized below:

Critical to Operation

- Fuses
- Control transformer
- Selector Switch
- Control relays
- Pushbutton
- Temperature controller
- Temperature sensor
- Current transformer (optional)
- Over current or Differential current relay (optional)

Non-Critical to Operation

- Light Switch
- Panel Lights
- Pilot Lights
- Ammeters
- Voltmeters

Failure of a non-critical component does not interrupt service. A stock of spares is at your discretion. Non-Critical components aid in trouble shooting and should be maintained, however, their loss for a short period of time is not critical until replacement can be made.

For critical components, a spare of each is recommended. Since the time to replace a defective control component is minimal it is not economical to do extensive electrical preventative maintenance checks on these components.

Recommended electrical maintenance checks should be performed as described below:

Fuses

Check terminals and cable as described above.

Control transformer

Check terminals, cable, and visually inspect for signs of overheating.

Selector Switch and Push Button

Operate and check each of its functions. Check terminals for tightness and overheating; and check switch contacts for proper operation and any signs of wear.

Control Relays

Check contacts for pitting, dirt, and signs of wear. Operate and check for chatter and firmness of operation. Check terminals and cable as detailed previously.

Current Transformers

These are sealed units and can only be checked externally. Check terminals and cable as detailed previously.

Over Current / Differential Current relay operate the unit by varying the adjustment level to obtain a relay “trip”. Reset the adjustment to its previous setting. Check terminals and cable as described above.

Temperature Sensor

It is important that the temperature sensor is properly seated. Check the wire for frayed insulation and wear. Check the weatherhead for dryness. Check the fitting to insure pressure is maintained on the sensor. Check terminal connections for corrosion and clean as necessary.

Temperature Controller

This device should have a complete calibration and operative check. Follow the attached Calibration Procedure and readjust as required.

Meters

Although meters are not critical to the system operation, they serve an important function in monitoring the system's performance. The meters should be checked for accuracy by use of an external meter whose accuracy has been previously confirmed.

With a clamp on ammeter, check the current through each current transformer and verify the current readings on the panel meters. Check the secondary voltmeter reading by measuring the skin effect current tracing voltage at the output terminals. If the panel meters are not reading within plus or minus 5% then they should be so tagged and replaced.

Pilot Lights

All system functions with pilot light indication should be cycled and light indicator noted. All burnt out bulbs should be replaced.

Enclosures (Control, Transformer, Feed & Terminal)

Check all enclosures for dust, dirt, and vacuum as required. Check all enclosures for rust and any signs of moisture and repair as necessary. Check the door gasketing for ageing and replace as required. Check to see that the enclosure ground is properly installed and rust free.

MAINTENANCE INSPECTION FREQUENCY

The frequency of inspection for any component or system should vary depending on several factors:

1) Importance of the system operation.
2) Level of stocking spare parts.
3) Past reliability and or problem areas.
4) Level of importance of the component part.

As a start, we would recommend inspection frequency as per the attached chart. These may be modified as a maintenance history is developed. A maintenance log is most important in order to evaluate weak components and the frequency of preventative maintenance necessary to insure continued operation.

Maintenance/Inspection Chart

Component	Test	Frequency	Remarks
Terminals	Visual & Operational	Weekly for 1st Month then Monthly	A history is desirable, then frequency can be modified based on the findings
Circuit Breaker	Visual & Operational	Yearly	A history is desirable, then frequency can be modified based on the findings
Power Transformer	Visual; Meggered	Yearly	If atmosphere is dusty, clean on a more frequent basis
Stereo Heating Cable	Megger	Every Three Months	A history is desirable, then frequency can be modified based on the findings
Power Cable	Megger	Every Three Months	A history is desirable, then frequency can be modified based on the findings
Control Equipment (critical)	Visual & Operational	Every Three Months	A history is desirable, then frequency can be modified based on the findings
Control Equipment (non-critical)	Visual & Operational	Yearly	A history is desirable, then frequency can be modified based on the findings
Enclosures	Visual	Yearly	A history is desirable, then frequency can be modified based on the findings

TROUBLE SHOOTING GUIDE

The chart below will serve as a guide in trouble shooting the electrical system. (Refer to Recommended Maintenance Section for Descriptive checks). Should this guide prove inconclusive, contact the PERMA-PIPE Service Department for the service of a PERMA-PIPE technician.

SYMPTOM	CHECK
No power output to the system	1) Primary disconnect, breaker of fuses 2) Control circuit fuses 3) Temperature controller settings (if pipe temperature is equal to or above the set point, the system will be cycled off) 4) Fault lights for a shut down condition (such as over temperature or electrical fault) 5) Verify circuit continuity between the control enclosure and the pipeline.
System off due to over current or differential current	1) Megger the tracing cable to verify insulation integrity. 2) Megger the power feed cables 3) Verify the power transformer secondary voltage. 4) All power connections in the trans former, control panel, and at the pipeline.
System will not Temperature Cycle (on or off continuously)	1) The temperature sensor connections. 2) The temperature controller for proper setup and calibration. 3) Temperature sensor for proper contact with pipeline. 4) Thermal insulation for wetness.
Random behavior of alarms & control operation	1) All connections. 2) All power and tracing cables for possible intermittent faults. 3) Temperature sensor for moisture in the thermal well.

SYMPTOM	CHECK
System temperature stays above or below set point	1) Flow temperature of fluid in pipe. 2) Temperature sensor installation. 3) Temperature controller operation, calibration and setup.
System Intermittent	1) Connections for tightness. 2) For RFI interference on the controller. 3) Enclosure grounding. 4) For static electricity on the temperature controller.
System on Continuously	1) Temperature of fluid in the line. 2) System insulation integrity (loss of insulation and or wet insulation).
Temperature Controller Oscillate	1) For RFI or EMI present on the 2) Continuity of the temperature sensor lead shield. 3) Grounding of the temperature controller and temperature sensor. (NOTE: Shield should be grounded only at the controller).
Abnormally Low Temperature	1) Points of “No Power Output” 2) Current for below normal design value 3) Temperature controller operation (see Temperature Controller Manual)
Abnormally High Temperature	1) Setting of high alarm and temperature set points 2) Setting of thermocouple or RTD
Current Above Normal	1) Transformer tap settings 2) Cable for fault by meggering
Current Below Normal	1) Transformer tap settings 2) Power cable connections for a loose, high resistance condition

START UP

ELECTRICAL SYSTEM START UP

A factory trained PERMA-PIPE representative must be present to inspect the system for design integrity and assist in the initial start up of the electrical system in order for the equipment to maintain its design warranty. If this service was not specified in the original contract, it may be purchased separately. Contact the factory for details.

At start up time, operating and maintenance instructions are reviewed with the customer's designated personnel.

Damage Claims:

1. Open all boxes and inspect all material upon arrival.
2. Compare material received against packing list.
3. Claims for shortage or goods damaged in transit must be made within seven (7) days.

The filing of any claim for shortage or damage is the Purchaser's responsibility. We will file any necessary claim on the Purchaser's behalf upon receipt of the following:

1. Written authority to file such a claim.
2. Written acknowledgement of loss or damage by the carrier's freight agent or truck driver.

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

PRODUCT DESCRIPTION

RICWIL SKIN EFFECT CURRENT TRACING system is a factory fabricated pipe heating system consisting of a carrier pipe, insulation heat tube, outer protective jacket, power cable, power center and temperature controls. Necessary field splicing materials are also furnished.

A factory trained, experienced field installation instructor must be present at critical periods during installation. This instructor is NOT a supervisor. For insurance of proper operation after installation, PERMA-PIPE requires that our experienced installation instructors be used.

Note: When applicable, contract drawings take precedent over this manual's instructions.

IMPORTANT AND CRITICAL TO PROPER OPERATION

Overall line length and locations of feed boxes, terminal boxes and temperature sensor assemblies are critical for proper operation of the heating system. Any changes should be referred to PERMA-PIPE for analysis prior to installation

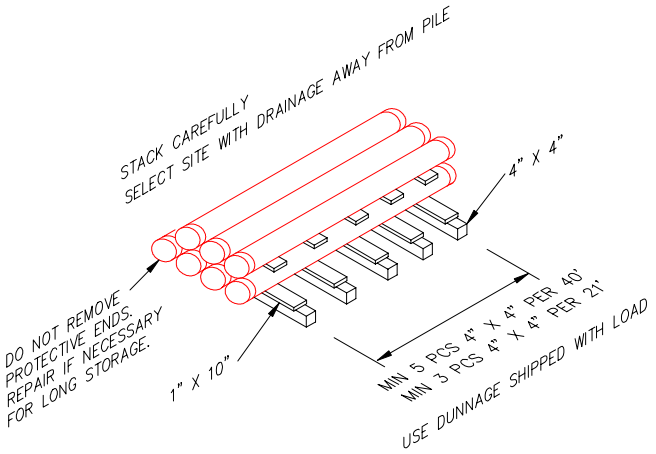
UNLOADING & HANDLING & STORING

Pipe sections are shipped carefully braced on trucks or gondola cars. Units should be unloaded by use of a crane using care to protect the units from jacket or insulation damage.

To unload, PERMA-PIPE recommends the use of 12" wide nylon slings. Special web slings and spreader bars are available from PERMA-PIPE if ordered with the original purchase order. Full credit will be allowed for these items when returned **with transportation charges prepaid per invoice instructions.** Do not drop. Lower carefully to the ground and avoid any contact that could damage the ends of the units. All preinsulated pipe is shipped with covered ends. Do not remove the protective cover until the pipe is ready to install. Repair all damaged covers prior to storing. The interior of piping must be kept dry at all times.

All electrical parts - i.e. sensors, power panels, cable, and material for field joints - must be stored in a dry protected location indoors.

Pipe can be stacked using the procedure shown in the dealing. Do not exceed a stack height of 6 feet. Be careful not to damage pipe ends. Keep all units off the ground and at a level above where possible flooding can occur. **It is important to keep not only the Insulation dry but also keep all water out of the heat tube.**



TRENCHING

The trench bottom should be smooth and free of sharp objects. The trench width should be sufficient for easy working on the pipeline. If the trench bottom is unstable, over-excavate the depth by 5 jacket diameters. The over-excavated trench should then be stablized to normal dimensions by the use of stable materials such as sand and gravel. In hard rock or shale, over-excavate the trench and stablize as described above. The lines shall be intalled at elevations shown on the contract drawings. 24" over the jacket top. For backfill instructions see page 6.

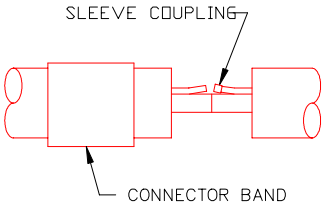
FIELD JOINT PROCEDURES

HEAT TUBE

The field joint connection of the heat tube is made after the carrier pipe joint has been made and tested. **Be sure the heat tube, and cable guide ends are burr free so that cable damage does not result during cable pulling. THE FIELD JOINT AREA AND THE HEAT TUBE MUST BE KEPT DRY AT ALL TIMES DURING INSTALLATION.**

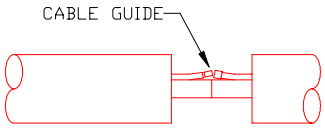
STEP 1

Place the sleeve coupling over the end of the heat tube. This must be done prior to welding the carrier pipe.



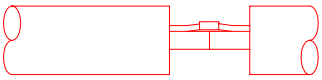
STEP 2

Place cable guide between the ends of the heat tube.



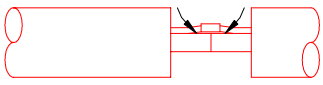
STEP 3

Slide the sleeve coupling over cable guide and center. Full weld around both ends of the sleeve coupling. **These welds must be air tight and tested at 5-10 psi to prevent entrance of foam during insulation of the field joint.**

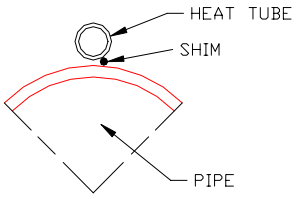


STEP 4

The heat tube must make welded contact to the carrier pipe. Force the heat tube down if the gap between the heat tube and carrier pipe is greater than 1/4". If the gap is greater than 1/8", but less than 1/4", use mild plate (minimum 1/8" thick) between the heat tube and carrier pipe. Then weld this plate to the carrier pipe and heat tube as a heat bridge. **Be sure the total unwelded distance at the field joint does not exceed 2".**



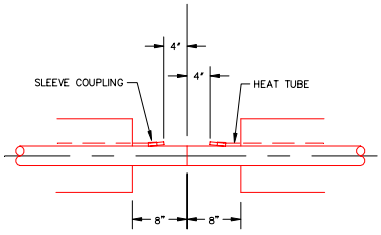
This area must have metal to metal contact of heat tube to pipe by welding except for 2" maximum accumulated distance.



HEAT TUBE FOR POLY-THERM

STEP 1

Bend up heat tube to provide clearance for each sleeve coupling and slide sleeve coupling on each heat tube.

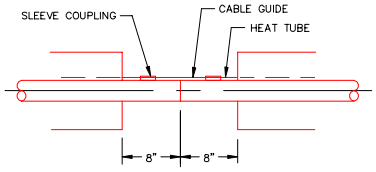


STEP 2

Locate cable guide (8" long). Make sure all ends of the heat tube and cable guide are chamfered and free from burrs. Put cable guide in place between heat tubes.

STEP 3

Slide sleeve couplings over cable guide, centered over the heat tube and cable guide joints. Weld ends of sleeve couplings. The welds must be air tight.



STEP 4

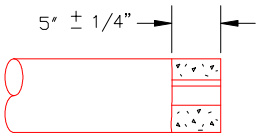
See STEP 4 above.

FIELD ALTERATION OF HEAT TUBE

It is imperative that field alterations to the heat tube follow the following step-by-step procedures to insure proper connections. **ANY FIELD ALTERATIONS MUST NOT AFFECT THE DESIGN LENGTH OF THE LINE.**

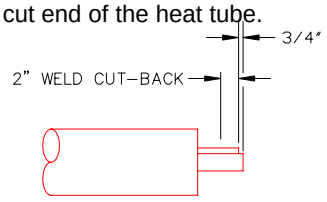
STEP 1

Cut jacket and insulation and remove the end cut. Jacket and insulation cut back should not exceed 5".



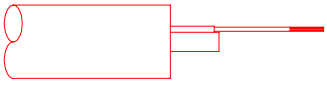
STEP 2

Shorten the heat tube back 3/4" from end of carrier pipe. Cut the heat tube weld from the carrier pipe with a hack saw back 2" from the cut end of the heat tube.



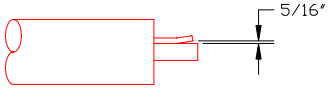
STEP 3

Use a round pry bar that closely fits the inside of the heat tube and bend the tube up away from the carrier pipe.



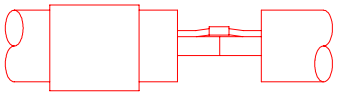
STEP 4

Use a stone or tapered reamer to remove any rough edges on the inside of the heat tube. Tube should be approximately 5/16" away from carrier pipe at the end of the heat tube.



STEP 5

Install cable guide and sleeve connector and finish the joint connection as per steps 3 and 4 of the heat tube field joint procedure.



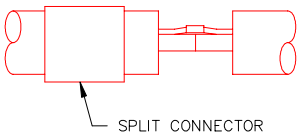
IMPORTANT AND CRITICAL TO PROPER OPERATION

Overall line length and locations of pull boxes, terminal boxes, and temperature sensor assemblies are critical for proper operation of the heating system. Any changes to the above should be referred to PERMA-PIPE for analysis prior to installation.

PVC JACKET AND INSULATION ABOVE GROUND

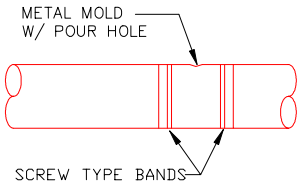
STEP 1

Slide the split connector over one end of the insulated pipe prior to making the carrier pipe and heat tube connections. Weld the carrier pipe and test as required. Make the heat tube connection per instructions on page 18.



STEP 2

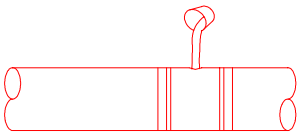
Center the metal mold over the uninsulated joint area with the pour hole on top. Draw the mold tight with the screw type bands as provided.



STEP 3

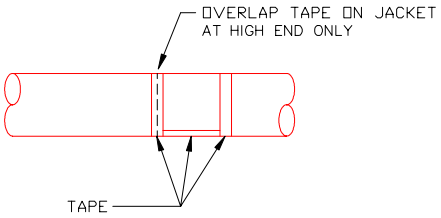
Mix the urethane foam per the directions provided with the foam. Note that the foam components must be stored in a cool place (50° to 70°F) until ready for use. For best foaming results, the ambient temperature should be between 60°F and 75°F. Note the personnel precautions for handling the urethane foam on the instruction sheet.

Pour the mixed foam through the pour hole in the metal mold. After the foam has set (approximately 5 minutes), trim all excessive foam and remove the metal mold.



STEP 4

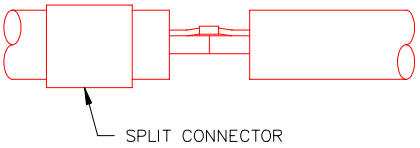
Center the split connector over the field joint area with the split located on the bottom. Using white tape supplied, tape the slit on the bottom. Circumferentially tape the high end of the connector only. (Field joints with pull boxes require longer connectors.)



PVC JACKET AND INSULATION UNDERGROUND

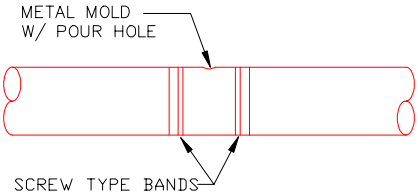
STEP 1

Slide the split PVC connector over one end of the insulated pipe prior to making the carrier pipe and heat tube connections. Weld the carrier pipe and test as required. Make the heat tube connection per instructions on page 18.



STEP 2

Center the split connector over the uninsulated area with the pouring slit on top. Hold in place with screw type bands supplied. (Use two or more bands to hold connector round.)



STEP 3

Mix and pour urethane foam into the pouring slit per STEP 3 under heading "PVC JACKET AND INSULATION-ABOVE GROUND."

STEP 4

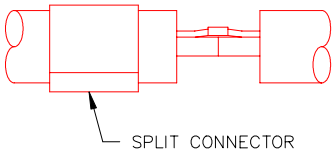
After the foam has set (approximately 5 minutes) trim excess foam from the joint area and remove the bands. Center the heat shrinkable sleeve over the connector with the shrink sleeve overwrap located on top over the trimmed foam area. Use a soft orange flame and work from center, moving the flame back and forth around the sleeve. All air pockets must be worked out from under the shrink sleeve. (Field joints with pull boxes require longer connectors and two shrink sleeves.)

METAL JACKET AND INSULATION

ABOVE GROUND

STEP 1

Slide the split connector over one end of the insulated pipe prior to making the carrier pipe and heat tube connections. Weld the carrier pipe and test as required. Make the heat tube connection per instructions on page 18.

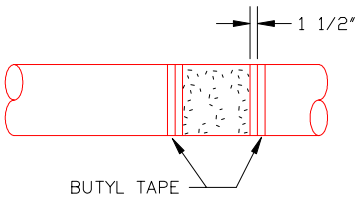


STEP 2

For attaching mold and pouring urethane foam follow STEPS 2 and 3 under the heading "PVC JACKET AND INSULATION - ABOVE GROUND"

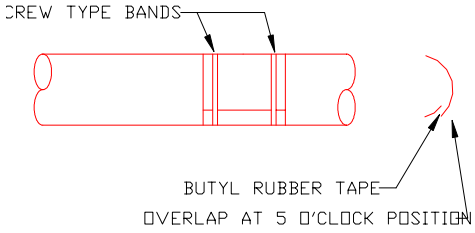
STEP 3

Wrap each end of the metal jacket with butyl rubber weather proofing tape as supplied.



STEP 4

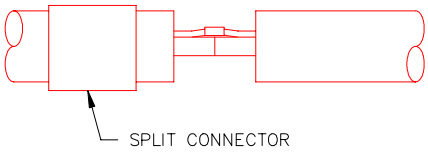
Center the split metal connector over the field joint area and hold in position with screw type bands as supplied. Locate the overlap at the 5 o'clock position. Under the overlap apply a strip of butyl rubber tape. Field joints with pull boxes require longer connectors and 3 bands.)



POLYETHYLENE JACKET AND INSULATION ABOVE GROUND AND UNDERGROUND

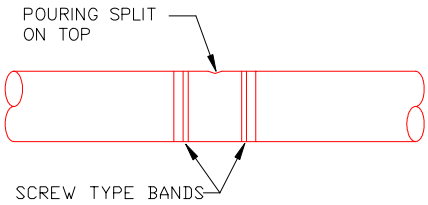
STEP I

Slide the split polyethylene connector over one end of the insulated pipe prior to making the carrier and heat tube connections. Weld the carrier pipe and test as required. Make the heat tube connections per instructions on page 18.



STEP 2

Center the split connector over the insulated area with the pouring slit on top. Hold in place with screw type bands supplied. (Use two or more bands to hold connector round.)



STEP 3

Mix and pour the urethane foam into the pouring slit per STEP 3 under heading "PVC JACKETS AND INSULATION - ABOVE-GROUND."

STEP 4

After the foam has set (approx. 5 minutes), trim the excess foam from the joint area and remove the bands. Center the heat shrinkable sleeve over the connector with the shrink sleeve overwrap located on top over the trimmed foam area.

Use a soft orange flame and work from center, moving the flame back and forth and around the sleeve. All air pockets must be worked out from under the shrink sleeve. (Field joints with pull boxes require longer connectors and two shrink sleeves.)

CARRIER PIPE AND HEAT TUBE TESTING

All carrier pipe joints should be tested prior to connection of the heat tube. Hydrostatically test the pipe as specified. (If not specified, hydrostatically test all piping at a minimum 1 1/2 times the design pressure. Do not exceed the maximum allowable test pressure of any non-isolated component.) Each field weld should be inspected for leakage while the line is under hydrostatic test pressure. The design of the heat tube permits x-ray inspection of the welds if required. Heat tube joints shall also be tested prior to foaming of the field joints. **Test heat tube welds by applying 5-10 psi air pressure and inspect for leakage by applying soap suds to the weld.**

CABLE

The power cable must be stored in a clean, warm, dry area prior to installation. It is important that the cable insulation is not damaged in any way during storage or handling prior to pulling the cable.

CABLE PULLING

Prior to pulling the cable thru the heat tube, the heat tube must be cleaned of all debris by pulling a nylon rag thru the tube. A steel ball must be passed thru the heat tube. See field service instructor for proper ball sizing. ALL WATER MUST ALSO BE REMOVED PRIOR TO WIRE PULLING. Water may be forced out and the heat tube dried by using dry nitrogen.The cable is pulled thru the heat tube in the same manner that other power is installed in the conduit. Dry wire lubricants may be used provided they are not a petroleum base that will harm the cable insulation. Pulling tension must be limited to the pull of two men. Mechanical pullers may result in excessive tension on the conductor and possible breaking and/or stretching of the conductor strands. Pull boxes have been installed at distances that will permit easy cable pull between boxes. The percentage fill is less than 50% which also permits easy pulling.

DURING CABLE PULLING THE CABLE MUST REMAIN DRY. Do not pull in the rain. Put plastic or other suitable material on the ground to prevent the cable from touching the ground. Pull the cable from a rotating reel, not over a stationary reel. Guide the cable into the end of the heat tube to prevent sharp bending of the cable by using a roller or funnel bolted to the end of the heat tube.

CABLE SPLICING

Extreme care must be taken to insure good electrical splices are made. Splices must be made properly to insure that the stranded copper conductor is not damaged, nicked, or strands severed during splicing. Care must be taken in the application of the electrical splice insulation to insure that both the thermal and electrical insulating integrity of the cable insulation is maintained.

Do not substitute cable splice connectors or insulation. Use only that which is provided in the splice kits. Carefully follow the detail instructions specific to and included with each splice kit.

Cable butt splice crimp connectors require the use of a crimping tool. Use only approved ratchet type tools as described in the splice kit instructions. Pliers, side cutters and other non-approved crimping tools will not provide adequate crimping of the copper conductors with the barrel connector. Poor electrical crimps will result in overheated splices and early system failure.

Keep the number of cable splices to a minimum.

More pull boxes are supplied than are necessary for splices. Note the cable reel lengths vs pull box distances before cable installation and splicing to minimize the cable waste.

Make cable splices in pull boxes only. Do not pull the splice out of the pull box and into the heat tube.

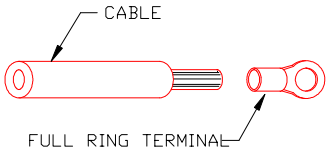
All cable splice locations should be noted on the jacket surface and on all applicable installation drawings

CABLE TERMINATING

Terminating kits are supplied to connect the power cable to the heat tube. Follow the step by step procedure below.

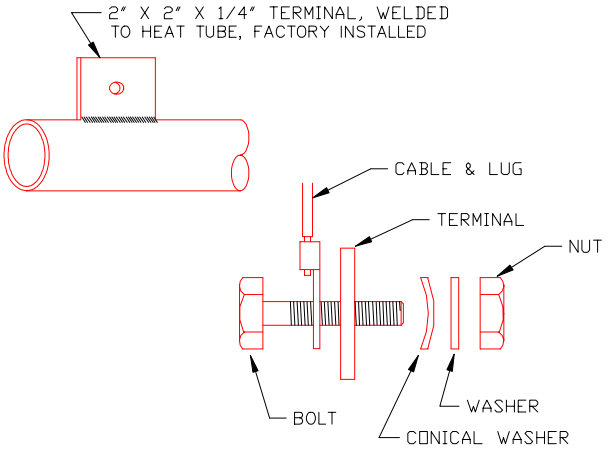
STEP 1

Strip the insulation from the power conductor as in STEP1 of cable splicing. Use the full ring crimp terminal and crimp as in STEP 2 for cable splicing



STEP 2

Assemble as shown below onto the terminal pad. Use silicon lubricant on the electrical conducting surfaces to prevent oxidation build up. Tighten the entire assembly.



CABLE TESTING

Intermediate testing of the pulled cable is required. Test the pulled cable for insulation integrity by meggering the cable. Megger instruments produce 500 VDC minimum and read the resistance of the insulation between conductor and ground. The actual megger reading will vary due to environmental conditions, line length, and insulation type. A value greater than 10 megohms should be obtainable. The PERMA-PIPE field installation instructor will advise you on proper megohm readings for your installation. **Note-Do not connect the terminating ends of the cable until after the megger test is performed.**

A.C. hi pot testing can be performed to test the insulation, however, since this is a destructive test, consult the factory for testing procedures prior to any A.C. hi pot testing.

CABLE PULL BOXES

Cable pull boxes are supplied and located along the line to permit easy cable pulling. These boxes, as well as feed and terminal boxes, must remain covered at all times to prevent the entrance of water and dirt during installation. It is good practice to provide a few inches of excess cable in the pull box.

After cable testing, install the provided gasket material around all box edges. Replace all the bolt assemblies, as provided, being careful to tighten them all down equally and snug. The gasket material will squeeze and conform to the box and result in a water tight seal. It is important that this seal be properly made to prevent the entrance of foam into the box during insulating of the field joint. It is required that pull box locations be noted on the jacket surface for future locating if necessary.

CRITICAL INSTALLATION PROCEDURES

HEAT TUBE

All heat tube connections must be made per instructions on page 18.

- Keep tube dry.
- Ends must be burr free.
- Tube connectors must be fully welded.
- Tube must have welded contact to the carrier pipe.
- Tube must be tested (air, rag, ball) prior to cable pulling.

CABLE

See instructions on page 21.

- Keep dry
- Pull with maximum tension of 2 man pull
- Splice in pull boxes only
- Use an approved crimping tool
- Test prior to pull box closure

PULL BOXES

See general instructions on page 22.

- Keep covered
- Do not stuff excessive cable in pull boxes
- Seal with gasket material supplied

TEMPERATURE SENSORS

See general instructions below.

- Do not bend well
- Keep well dry
- Insulate before energizing

POWER CENTER (TRANSFORMER & CONTROLS)

See general instructions below.

- Keep dry and clean
- Do not adjust controls

TEMPERATURE SENSORS

Carrier pipe temperature sensors are supplied to sense the actual pipe temperature. Sensor wells are provided welded to the carrier pipe. CARE MUST BE EXERCISED NOT TO BREAK, BEND OR DAMAGE THE WELLS. After the pipe line is installed, insert the temperature sensor into the well. Be sure nothing prevents positive seating of the sensor at the base of the well. Insert the spring loaded fitting and the weather head connection box on the top of the sensor. The connection box also serves as the junction box for the wire back to the control panel. See the electrical drawings for proper connection wire (not supplied by PERMA-PIPE from the sensor to the control panel).

POWER CENTER INSTALLATION

The power center enclosure is an industrial panel containing the necessary electrical power and control equipment. Handle and move with care. Power centers have been factory tested and calibrated. **DO NOT TRY TO ADJUST OR SET ANY CONTROLS.**

The location of this panel will be determined by the specifications and/or PERMA-PIPE's proposal. Do not install outdoors if the panel is designed for indoor use only.

Field power wiring is necessary to connect the primary source power to the control panel. If the panel does not have primary power protection and disconnecting means be sure this is provided at the power source.

Field secondary power wiring must be run from the cabinet to feed the box located on the traced pipeline. Use standard recommended NEC or other governing codes to determine proper primary and secondary cable and conduit sizes. Amperage rating of field wiring is supplied on the electrical drawings. Primary and secondary power wiring cable, conduit, etc., are not furnished by PERMA-PIPE.

POWER CENTER TESTING

Initial startup of a RICWIL heat traced system shall be done with the assistance of a trained PERMA-PIPE installation instructor to insure proper system operation.

All control and safety devices are operated and system operating values are checked against design calculations. At this time, operating instructions are reviewed with the customer designated personnel.

BACKFILLING - UNDERGROUND INSTALLATIONS

Partial backfill over the center portion of the pipe length immediately after installing the pipe. Tamp the backfill in 6" layers under and around the pipe to assure proper compaction and prevent flotation of the pipe. Leave joint areas exposed to allow for completion of the field joints. Backfilling of the trench shall be done on both sides of the jacket simultaneously in such a manner that unequal side pressures do not occur.

After field joints are completed, selected backfill should be hand placed and hand tamped to 12" minimum over the top of the jacket to a 95% compaction. The remainder of the backfill should be free of large boulders, rocks over 6" in diameter, frozen earth or foreign matter. The backfill operation can now be completed by any convenient available means. **Do not use wheeled or tracked vehicles for tamping.**

WARRANTY

Seller warrants to the original Buyer only that the products sold hereunder will substantially comply with the above referenced technical specifications for the products and that no product will have any defect in Seller's design, workmanship or material. Seller shall not be responsible for any faulty design or specifications furnished by Buyer. Seller shall not be responsible for and does not warrant the installation of the products. Seller agrees to provide field services as provided herein and warrants only that the information provided to Seller during such field service visits will be consistent with Seller's recommendations for installation. Seller specifically rejects all other warranties in the contract documents for the Project which may apply to Seller's products. The foregoing warranty shall be in effect with respect to each product sold hereunder only for a period of fifteen (15) months from the date of completion of testing of such product, but in no event more than eighteen (18) months from the date of shipment by Seller of such product; provided, however, no claim shall be permitted under the warranties contained herein unless Buyer shall give to Seller written notice of all respects in which Buyer claims the product be defective or at variance with specifications within ten (10) days from the date Buyer discovers or should have discovered a defect or variance from specifications, but in no event later than eighteen (18) months after shipment of such product, and unless Buyer shall afford Seller a reasonable opportunity to inspect such product after notice has been given. The foregoing warranties shall not apply to any products, or components thereof, which have been subject to abnormal or improper use, negligence or accident or which have been altered or repaired by someone other than Seller or Seller's authorized representative. No product shall be returned without seller's prior written consent. Buyer shall accept minor variations in dimensions or other variance from specifications provided that there is no impairment of function or useful life of the product. Seller warrants that its title to the product sold hereunder is good, and that the transfer thereof to Buyer is rightful. Seller's obligations under the warranties contained herein and in any other provision of this Agreement determined to constitute a warranty by Seller of the products to be sold pursuant hereto, and Buyer's remedies for any defective or non-conforming products shall be limited solely to the repair or replacement, as elected by Seller of defective or non-conforming materials. To the maximum extent permitted by law, Buyer irrevocably waives all claims against Seller for money damages relating to the condition, use and performance of the goods sold pursuant hereto, including claims based upon tort, strict liability, negligence and product liability. Notwithstanding the provisions of the preceding sentence, if money damages are assessed against Seller, in no event shall Seller's liability for such damages exceed the purchase price of product sold by Seller. IN NO EVENT, WHETHER BECAUSE OF A BREACH OF WARRANTY OR REPRESENTATION OR ANY OTHER CAUSE, WHETHER BASED UPON CONTRACT, TORT, WARRANTY, OR OTHERWISE, ARISING OUT OF THE PERFORMANCE OR NON-PERFORMANCE BY SELLER OF ITS OBLIGATIONS UNDER THIS AGREEMENT OR WITH RESPECT TO THE PRODUCTS SOLD PURSUANT HERETO SHALL SELLER BE LIABLE FOR LOST EARNINGS, INCOME OR PROFITS OR INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES. THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE AND, EXCEPT AS SPECIFICALLY SET FORTH HEREIN, ALL OTHER WARRANTIES AND REPRESENTATIONS, EXPRESS OR IMPLIED, ARE HEREBY DISCLAIMED AND EXCLUDED. NOTHING SHALL BE CONSTRUED AS AN ADDITIONAL WARRANTY UNLESS SPECIFICALLY DESIGNATED AS SUCH IN WRITING AND SIGNED BY THE SELLER, IN WHICH CASE SUCH ADDITIONAL WARRANTY SHALL BE SUBJECT TO THE PROVISIONS HEREIN AS TO DURATION AND LIMITATION OF REMEDY UNLESS SUCH ADDITIONAL WARRANTY EXPRESSLY VARIES SUCH PROVISIONS.