INSTALLATION AND OPERATION MANUAL FOR STEREO-HEAT ELECTRICALLY TRACED PIPING SYSTEM

PERMA-PIPE®

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PRINCIPLES OF OPERATION

The Ricwil Stereo-Heat pipeline heating system is a means of maintaining or raising the temperature of a product in the pipeline, depending on the system specifications.

The system utilizes the impedance heating principle in which an AC potential is applied directly across the length of the pipe. This potential causes current flow in the pipe wall, creating heat as the current encounters the pipe's resistance.

In addition to the pipe's resistance, the pipe's reactance and the skin effect principle also interact with the resistance heating of the pipe.

The reactance of the pipe is created by hysteresis, which is due to the reversing of the magnetism of the pipe at each alternation of current. If the pipe used is non-magnetic (such as stainless steel), the reactance will be very low due to the lack of magnetic material in the pipe's composition. In this case, the pipe can be considered a pure resistance.

The skin effect principle is also present in the reactance of the pipe. When an AC current flows through a conductor in close proximity to the pipe, the current in the pipe is concentrated in the outer regions of the pipe wall. This has the effect of increasing the resistance of the pipe, thereby producing more heat.

CONTROL OPERATION

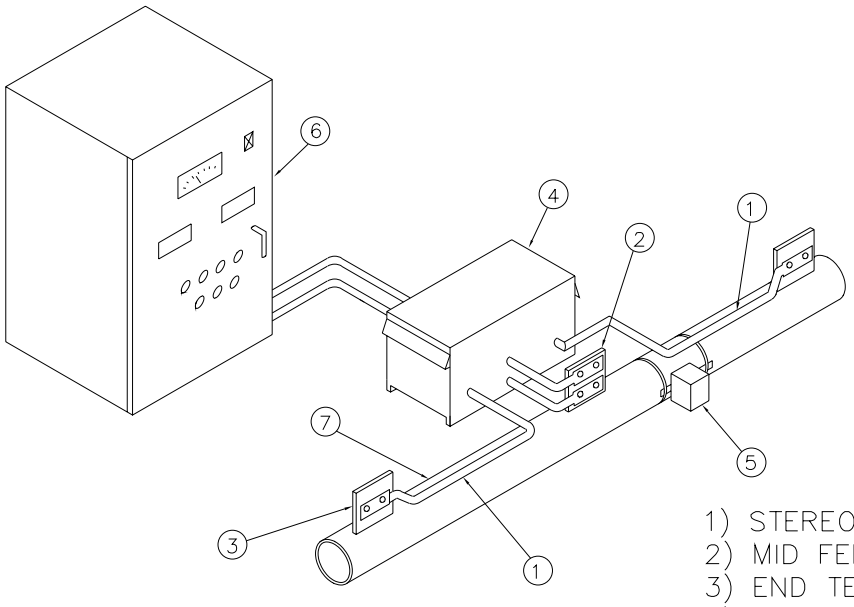
The control and power circuit components of the Stereo-Heat system are housed in heavy duty industrial enclosures specifically designed and approved for the classification of the area in which they will be located. See Figures 1 and 2 for a typical system layout. (For complete listing and description of all components, please consult the electrical Bill of Materials and the Shipped Loose schedule located on the drawings included with this manual).

The control devices which are used in the control cabinet consist of the temperature controller, relays, pilot devices, circuit breaker and all metering and instrument equipment necessary for efficient operation and monitoring of your Stereo-Heat system.

Precise control of the system is accomplished through the use of an indicating temperature controller and sensor located on the pipeline. Indicating lights, associated with the operation of the temperature control are power on, system heating, low temperature and over temperature.

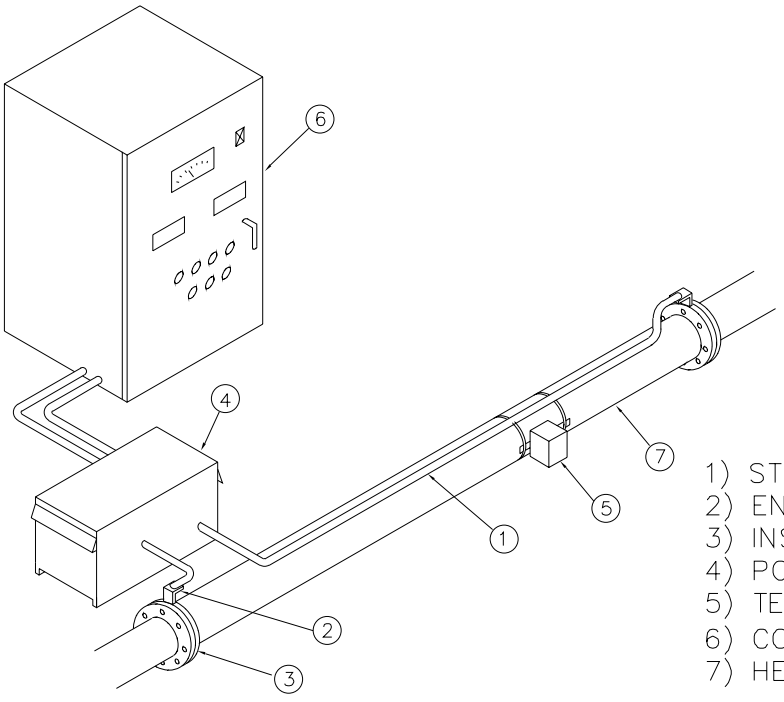
The over temperature indicating light is used to annunciate an alarm condition. Annunciation of this condition will also be associated with a shutdown of the Stereo-Heat system. Prior to any attempt to re-energize the system after alarm shutdown, the cause of the shutdown must be found and repaired to prevent any damage to the system or its associated components. For aid in troubleshooting of the system, please refer to Section 5, Troubleshooting.

Figure 1
Mid-Feed Stereo-Heat System



1) STEREO–HEAT TRACING CABLES
2) MID FEED TERMINAL
3) END TERMINAL
4) POWER TRANSFORMER
5) TEMPERATURE SENSOR
6) CONTROL PANEL
7) HEATED PIPE (INSULATION NOT SHOWN)

Figure 2
End Feed Stereo-Heat System



1) STEREO–HEAT TRACING CABLE
2) END TERMINALS
3) INSULATING FLANGES
4) POWER TRANSFORMER
5) TEMPERATURE SENSOR
6) CONTROL PANEL
7) HEATED PIPE (INSULATION NOT SHOWN)

The Stereo-Heat system has been provided with both an auto and manual control mode. The auto mode is for normal operation and the manual mode is intended for start-up, maintenance checks and troubleshooting of the system. When utilizing the manual mode, care must be taken to continuously monitor the system due to the fact that the temperature controller is not controlling the system and the system will continue to heat beyond main- tenance temperature set point. However, the temperature controller will continue to monitor the pipe temperature in the manual mode. In addition to monitoring pipe temperature, the alarm circuit is also functional in the manual mode and will still shut the system down in an over temperature situation. Therefore, care should be taken to insure that a qualified operator or maintenance sensor monitor the system continuously during use of the manual mode.

NOTE: Should a temporary local power failure occur, during the operation of the Stereo-Heat system, the system will immediately begin to re-heat as soon as the power has been restored.

INSTALLATION INSTRUCTIONS

PRODUCT DESCRIPTION

The Stereo-Heat impedance heating system is a factory assembled and tested electrical heating system complete with all power controls to provide automatic temperature control of the piping and contents. If the installation of this system is not understood by these instructions or by the applicable drawings and specification of the contract, contact the factory for advice prior to installation.

EQUIPMENT LOCATION

If the power transformer is an integral part of the control panel, the entire assembly must be located as close as possible to the feed point of the pipe system. This is necessary to minimize cable voltage drop. Unless otherwise specified, the length of cable from the transformer to the feed point must not exceed 10 feet.

If the power transformer is separate from the control cabinet, it is only necessary that the transformer be located close to the feed point. The control cabinet can be located remote as long as it does not become excessively far away from the temperature controller sensor.

PIPING

Since the pipe itself is heated electrically, be sure all pipe and fittings (material, size, wall thickness and length) are per the specifications. Do not arbitrarily substitute, add or delete pipe material or fittings.

Where piping runs through walls and/or floors, provide sufficient clearance for continuation of the insulation and the power cable through the same opening. Do not provide a separate opening for the power cable, since no magnetic material (such as steel pipe sleeves, grating or solid steel flooring) can completely encircle either the pipe or cable individually.

All expansion joints, flanges, supports, electrical connection points, and anchors must be per the contract drawings. Deviations will affect the electrical design.

Insure that all electrically heated piping is electrically isolated from ground. This includes all anchors and supports. Grounds can only appear as shown on the drawings.

INSULATION

The successful operation of this system is based on the thermal losses being no greater than their calculated value. Be sure the specified insulation is used and properly applied, without voids. All flanges and other heat sinking parts must be well insulated to prevent excessive heat loss and subsequent cold spots. Use only non-magnetic wire (such as stainless or aluminum) for banding insulation together. Do not use carbon steel wire.

JACKETING

Weatherproof jacketing must be of a non-magnetic material. As previously stated, no magnetic material can completely encircle the pipe. Due to the pipe being an electrical conductor, an enclosed circle of magnetic material will behave like a transformer, resulting in an induced current and heat generation in the material. Likewise, use only non-magnetic straps to band the jacketing.

Allow at least 1/2 inch clearance between metallic jacketing or banding material and any metal piping parts (such as terminal lugs, anchors, supports, flanges, etc.).

CONNECTIONS

Electrical power connection is made to the pipe through stainless steel terminal lugs welded to the pipe or to a flange. Do not modify or move these lugs without first contacting the factory. They must be located as shown on the contract drawings.

After the power cable is connected to the stainless lug, exposed portions of the terminals may be covered with a suitable electrical tape. High temperature silicone rubber or glass cloth electrical tape is recommended.

If a mid-fed system is provided, measure the installed pipeline length and divide by two to find the mid-point. The location of this point must be accurate with 5% of the line length in order to properly maintain current and heat input balance on both halves of the line. Check the current of both halves after start-up to insure current division is within 5%.

CABLE

The power cable size and length is specified on the contract drawings. If the cable is not furnished with the system, use only the size specified on the drawings. The system is designed to include the cable voltage drop; if the drop is excessive, the heat energy to the line will be reduced.

The power cable must be run parallel with and in close proximity to the pipe. Use non-magnetic strapping to hold the cable against the pipe insulation/jacketing. Do not route the cable away from the pipe as a reduced power factor will result, decreasing the actual power generated in the pipe.

INSULFLANGES

If insulflanges are required and applied, they must be properly installed at the specified locations. These flanges are supplied assembled as pairs and should remain assembled. Weld the flange to the pipe so that the orange flange is on the electrically heated portion. The black flange will, therefore, be on the electrically cold line.

The insulation and gasketing material used on the flange has been chosen based on temperature and electrical resistivity. Do not substitute. Likewise, the thickness of the material and its location in the flange is critical in order to maintain electrical isolation. Do not modify or disassemble the insulflanges in any way.

TEMPERATURE 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 4). 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 3.
2. Install sensor as shown in exploded view, Figure 3. 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 4.
5. Seal around the lead wire with high-tempera ture RTV sealant.
6. Strap the junction box to the pipe, as shown in Figure 4. 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.

RECOMMENDED CRIMPING TOOLS

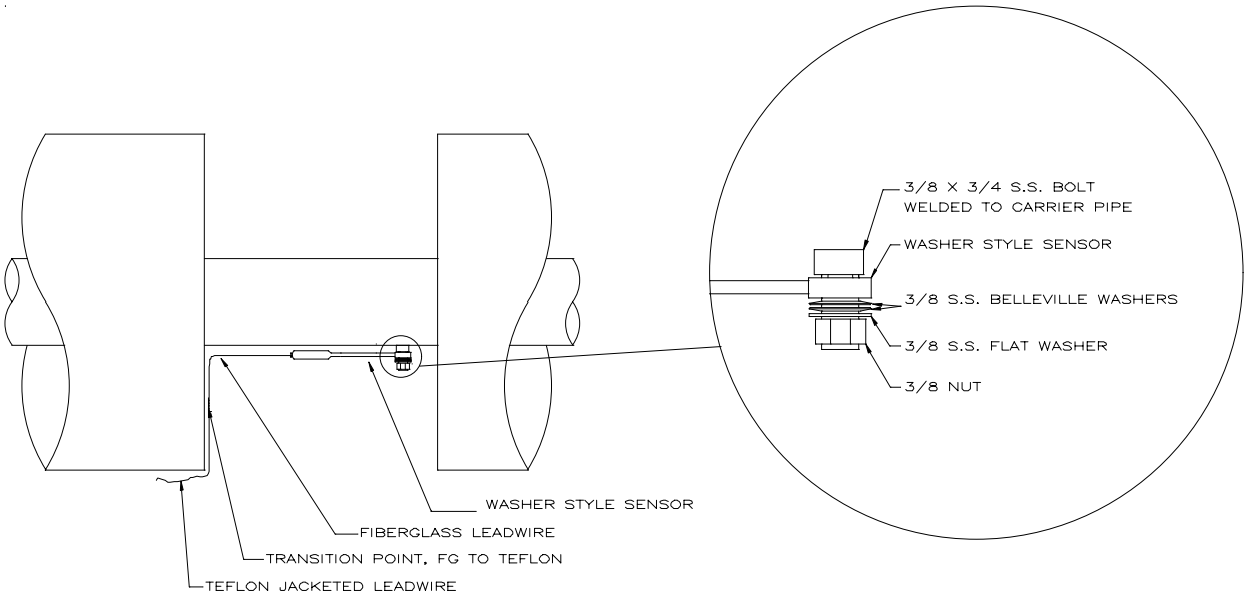


Figure 3

Washer Style Isolated Assembly

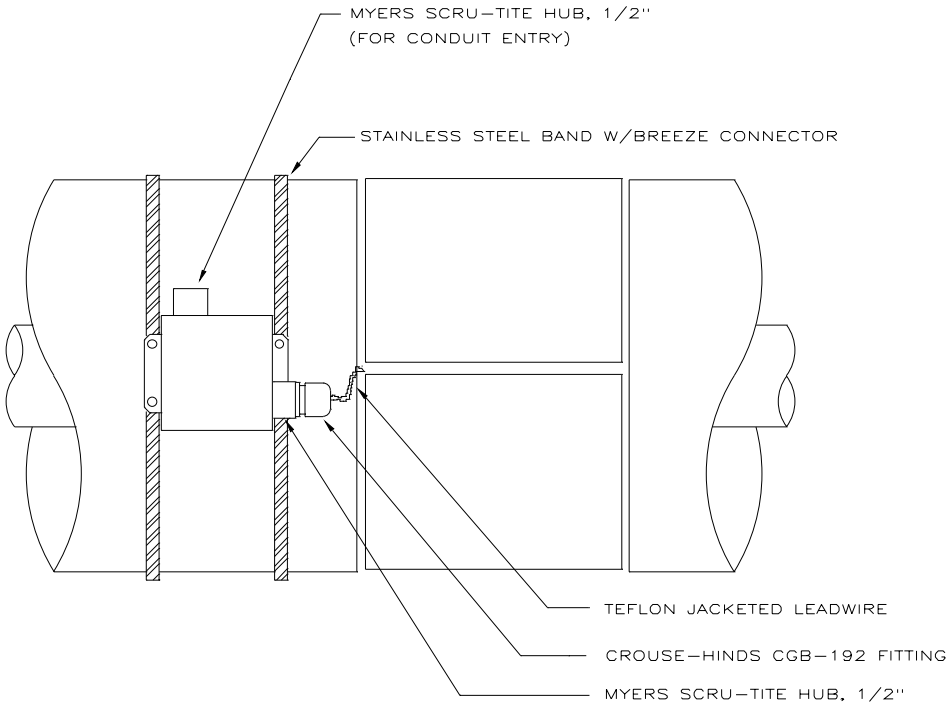


Figure 4

Junction Box Installation (Bottom View)

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.

Burndy:

Y1000 Hypress

Hand operated hydraulic crimper. No dies to install or adjust. This is the best crimper available for the purpose of Stereo 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 separate 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” ratcheting feature. There are versions without the "SHURE STAKE" option; we do not reccommend 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.

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. 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
- 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.

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 tem perature 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) Check 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 ther-mal 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 AND WARRANTY

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.

WARRANTY

Materials are sold f.o.b. Seller's Plant and title shall pass upon delivery to the carrier. Seller is not responsible for goods lost or damaged in transit and any claim shall be made by Purchaser to the carrier in accordance with the carrier requirements. Seller is not responsible for trucker delay in transit.

Seller warrants to the Purchaser that the materials sold to the Purchaser conform to specifications accepted by the Seller and are free from defects in material and workmanship at the time of delivery to the Purchaser. Claims for shortages or apparent defects must be made within thirty (30) days after delivery or before installation, whichever occurs first. No materials may be returned without the prior written consent of Seller.

With respect to latent defects, Seller shall at his option, repair or replace any materials which when installed in accordance with recommendations in the Seller's manual or installation instructions, current at the time of shipment, may prove defective under normal and proper operation and maintenance within one (1) year. After shipment to the satisfaction of Seller after inspection by Seller, Seller shall not be liable for losses, damages (consequential or otherwise), delays, labor costs, or any other cost or expense directly or indirectly arising from the use of materials. The Seller's liability being expressly limited to the replacement or repair of defective goods or an allowance of credit therefore. This express warrant is in lieu of and excludes all other warranties expressed or implied including without limitation, merchantability or fitness for a particular purpose. This warranty shall be void if:

1) Purchaser modifies, repairs, or in any way alters the materials delivered by Seller without the prior written consent of Seller.
2) If notice of any claim has not been given to Seller in writing within seven (7) days of discovery of the defect.