PETROLCHIMICA
SISTEMI PRODUTTIVI

PSP Skin Effect Heating Systems

General Guidelines
Installation, Testing and Maintenance

PETROLCHIMICA
SISTEMI PRODUTTIVI

Skin Effect Heating System

Contents Page

1.0 Introduction

This manual is intended to provide general guidelines for the installation, testing and maintenance of a PSP Skin Effect heating system. Read and carefully follow all installation procedures. In addition to this document, refer to any detailed project specific information and/ or drawings. In the event of any conflict between this document and the project specific information, contact PSP for clarification.

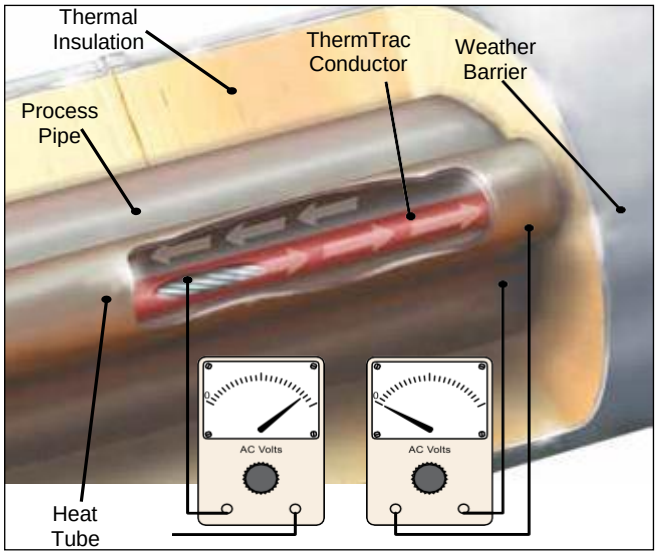
This symbol is intended to alert the user to the presence of important installation, operation or maintenance instructions within the guide.

1.1 Application

A PSP Skin Effect heating system is ideally suited for long pipeline heating applications involving movement of materials to and from tank farms, process units and loading/unloading facilities. The versatility of the system makes it ideal for temperature maintenance, freeze protection and heat-up applications. Adaptable to varying site conditions both above and below ground, a PSP system can traverse terrains with significant elevation changes. A PSP system provides a cost-effective alternative to conventional resistance heat tracing on long line piping by eliminating the need for an extensive power distribution system. A pipeline up to 25 kilometers (15 miles) long can be traced from a single power point.

1.2 Operating Characteristic

The operating principle of a PSP skin effect heating system is based on two phenomena, proximity effect and skin effect. The heating device is a ferromagnetic pipe, called a “heat tube”, through which a specially designed skin effect conductor has been pulled. The heat tube and insulated conductor are joined together at one end, while at the opposite end the heat tube and the conductor are connected across an AC voltage source (typically 50 or 60 Hz). The impressed AC voltage will generate a current in the conductor which will return through the inside surface of the heat tube. The concentration of the return current on the inside surface of the heat tube is due to the magnetic flux linkages originated by the currents in the insulated conductor and the ferromagnetic pipe. This current penetrates into the heat tube a distance termed the “skin depth.” Due to the phenomena described, there is virtually no measurable voltage on the outer surface of the heat tube, allowing the piping system to be grounded. The heat generated in a PSP system is primarily the result of the resistance that occurs on the inner skin of the heat tube. While the electrical current is concentrated on the inner surface of the heat tube, the heat generated will dissipate from the tube into the attached carrier pipe to increase the surface temperature of the pipe and its contents to a designed level.



An additional advantage of the PSP Skin Effect system is it’s ability to work with a cathodic protection system. Skin effect utilizes an alternating AC power source, while cathodic protection requires a DC potential. Since no voltage exists between the outer wall of the pipe and ground, there is no relationship between the skin effect system and the cathodic protection.

1.3 Reliability

When in use under normal operation, the system will automatically keep the product within the pipeline at the preset temperature range. Typically, long pipelines are located in areas where access is limited and any frequent maintenance and troubleshooting can be costly in both time and money. Since one skin effect circuit can heat trace over six times the length of pipe that a conventional resistance heat tracing circuit can, the power distribution and temperature control requirement are significantly reduced. Less equipment to maintain greatly contributes to long term reliability.

1.4 Certifications/Approvals

PSP skin effect heating systems can be operated safely above or below ground, in hazardous areas.,
IEC 60079-7: 2006, EN 60079-7:2007, IEC 60079-31: 2008, EN 60079-31:2009 and IEEE 844-2000. The installation must comply with PSP requirements and be installed in accordance with national and local regulations and per the latest version of IEC/EN 60079-14.

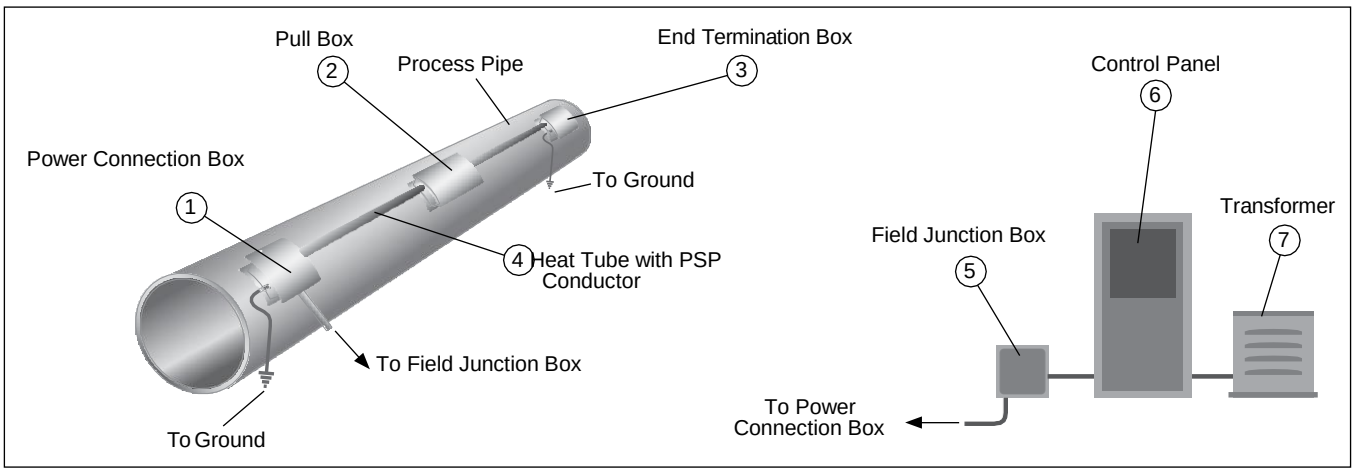
Factory Mutual Research
Ordinary Locations
Hazardous (Classified) Locations
Class I, Division 2, Groups B, C and D
Class II, Division 2, Groups F and G
Class III, Divisions 1 and 2
Class I, Zone 2, Group IIC

DEKRA 12ATEX0175 X
II 2 G Ex eb IIC T6...T2
II 2 D Ex tb IIIC T85 °C...T300 °C

International Electrotechnical Commission
IEC Certification Scheme for Explosive Atmospheres
DEK 12.0055X
Ex eb IIC T6...T2
Ex tb IIIC T85 °C...T300 °C

1.5 Typical PSP Heating System

The basic skin effect heating system consists of the heat tube attached to the process pipe by either welding or by banding straps. The ferromagnetic heat tube shall be solidly grounded at both ends. The heat tube and skin effect conductor are electrically connected at one end, while at the opposite end the heat tube and skin effect conductor are connected across the AC voltage source. The heat tube and process pipe shall be covered with a thermal insulation system that is suitable for the pipeline operating conditions as well as the environmental conditions.



(1) **Power Connection Box:** Located at the power feed end of the PSP circuit, the power connection box permits the connections that supply electrical energy to the system. An external tab on the box permits grounding of the system.

(2) **Pull Box:** Located periodically along the heat-traced pipe, this box permits access for installing the PSP conductor. The box is sized to provide for expansion/contraction of the conductor, and versions of the box allow the heat tube to cross over the carrier pipe if necessary at elevation or directional change points.

(3) **End Termination Box:** The design and construction of the end termination box allows the PSP conductor and heat tube to be joined together thereby allowing electrical current to return to the power connection box via the inside surface of the heat tube. An external tab on the box permits grounding of the system.

(4) **Ferromagnetic Heat Tube:** Used to produce heat based on the two phenomena of proximity effect and skin effect.

(5) **Field Junction Box:** Located between the Power Connection Box and the Control Panel it provides an access point to terminate the PSP conductor and the power feed wiring.

(6) **Control Panel:** Typically consists of all electrical power, control and monitoring devices.

(7) **Transformer:** Custom transformer equipped with over and under voltage taps.

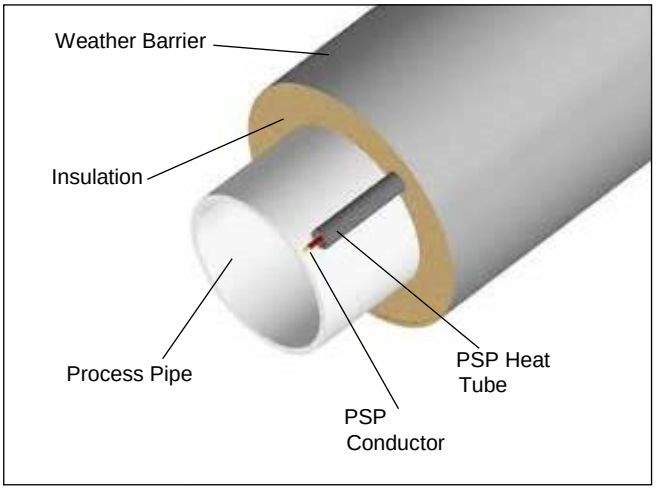
1.6 Thermal Insulation System

Choosing the right thermal insulation for the PSP skin effect heating system is critical for proper temperature maintenance and long life. When selecting an insulation type for a specific application, the following characteristics should be considered:

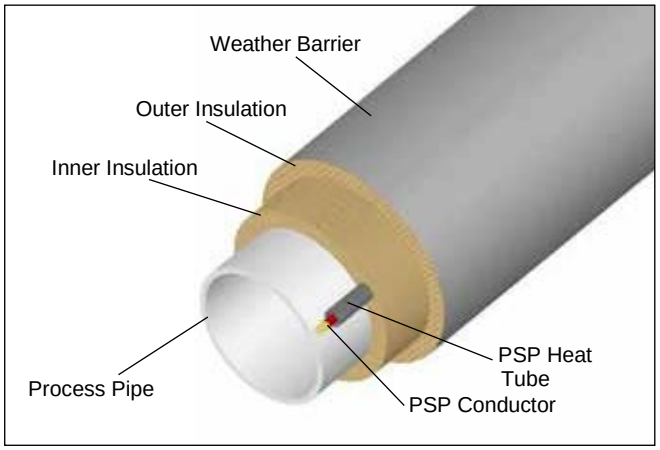
- Operating Temperature of pipeline
  — Maximum Exposure Temperature
  — Minimum Exposure Temperature
- Heat Retention
  — Insulation Thermal Conductivity
  — Insulation Thickness
  — Insulation Size
  — Moisture Resistance
- Mechanical Properties
  — Compressive Strength
  — Thermal Expansion/Contraction
  — Shock Resistance
  — Dimensional Stability over Use Temperature Range.
- Piping Location
  — Above or Below Ground Piping
  — Installation Waste Factors
- Prefabricated Insulation Systems (pre-insulated pipe sections)
  — Reduced Installation Labor
  — Improved Consistency in Field Performance

A properly designed and installed weather barrier also plays a vital role in the effectiveness of the thermal insulation system. Some of the characteristics that should be considered when selecting a weather barrier are mechanical strength, maximum/minimum service temperature, corrosion resistance, fire resistance, etc.

For low to moderate temperature applications, a single layer of thermal insulation with appropriate weather barrier is typically suitable for PSP skin effect heating systems. The thermal insulation system can be field installed or provided as part of prefabricated insulated piping sections.

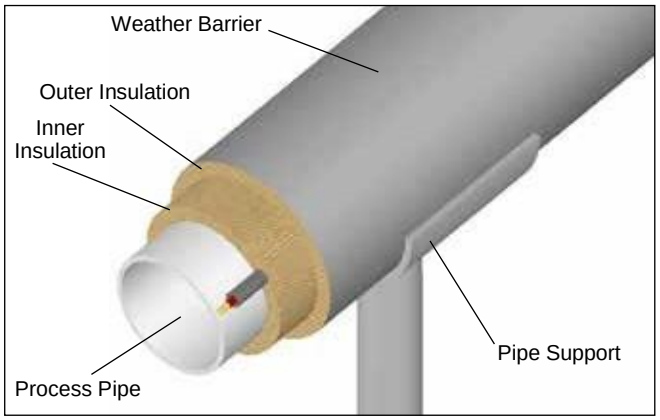


For high temperature applications, such as sulfur, asphalt, etc. multilayer insulation systems are preferred. These systems can be field installed or provided as prefabricated/preinsulated piping sections. For systems using preformed pipe sections, the seams and joints should be staggered and rotated to avoid gaps in the insulation.



1.7 Typical Pipe Supports

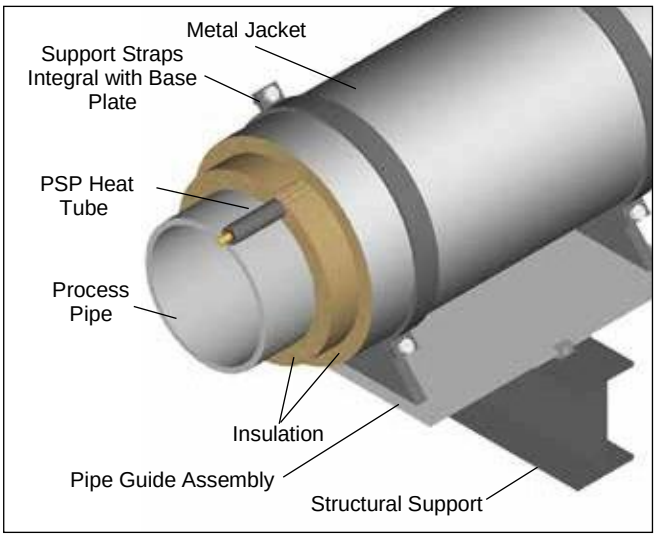
For optimum skin effect heating system performance, special attention must be given to the uniformity of heat loss along the entire length of each control circuit. To operate at an optimum level, the maximum allowable variance in the level of the energy balance per unit length should not vary more than 10%. Of special concern are pipe supports. Pipe supports are generally considered as a primary source of significant heat loss. To ensure uniformity of heat loss, care must be taken to design and select suitable pipe supports to meet both structural and thermal performance criteria.



Typical Inverted Tee Pipe Support

The ideal support for thermal performance is one that is fully insulated, with no metal to metal contact between the support and the process pipe.

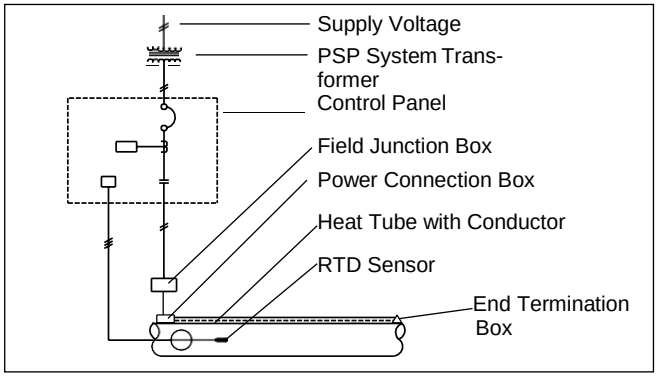
Specific details for pipe supports to be used on the project should be provided prior to the detailed designed stage to ensure that they are sufficiently insulated and/or isolated from the process pipeline.



Typical Isolated Pipe Support

1.8 Transformer and Control Panel

The PSP Transformer and Control Panel is designed to meet the requirements of each specific project based on the available voltage, load requirements, number of circuits and the operating environment. The system typically consists of a specialty transformer equipped with over/under primary taps and additional power adjustment taps on the secondary side. Load contactors, circuit overload protection and other protective devices also form a part of the system. Scott T type transformers may be used to balance a three-phase power supply and feed two PSP circuits when the application allows. The control panel typically includes temperature control and monitoring with high and low temperature alarms, over current safety protection and current/voltage monitoring.



Typical Wiring Diagram, Single Phase Power Supply

2.0 Installation Procedures

This portion of the manual outlines the basic requirements for the installation, testing and maintenance of PSP skin effect heating system. In addition to this document, refer to any detailed project specific information and/or drawings. Read complete instructions before attempting to install the PSP system. In the event of any conflict between this document and the project specific information, contact PSP for clarification.

NOTE: All welding shall be carried out by a qualified welder. Certification requirements shall be the same as for the welding of the process pipe. For welded heat tube installations, welding rods and equipment shall be suitable for welding the specified heat tube to the process pipe. Care shall be taken during the welding process not to burn through the heat tube or process pipe.

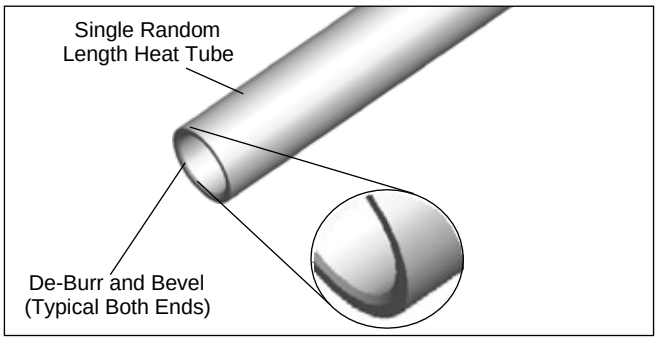
2.1 Receiving, Storing and Handling

Check the PSP conductor, accessories and equipment to make sure the proper types have been received. All conductors are printed on the outer jacket with a part number. Visually inspect for any damage incurred during the shipment. Conductor, accessories and equipment should be stored in a clean and dry environment until ready for installation. The ends of the heat tube should be sealed with plastic plugs to prevent dirt or moisture ingress prior to installation. Care must be taken when handling Petrolchimica cable reels. Do not lift reels between the reel flanges with the fork of a forklift as this may damage the cable.

2.2 Heat Tube Preparation

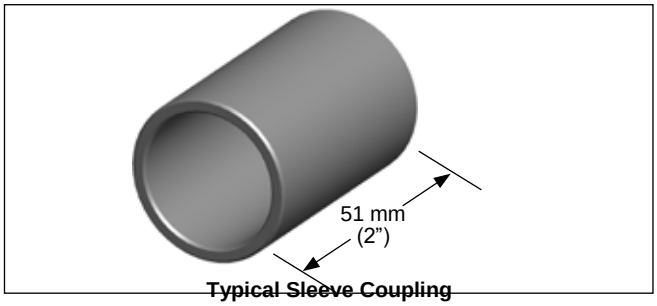
Prior to welding, inspect the heat tube to ensure that it is free of any dirt or moisture. Remove the protective plastic end seal from the heat tube and bevel the internal edges on both ends using a reamer.

Failure to properly complete this step could result in damage to the PSP conductor during conductor installation or operation.



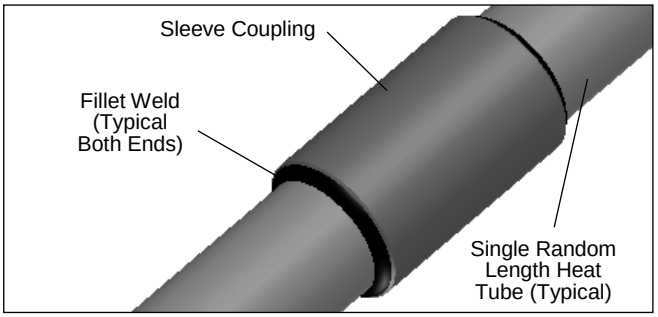
Typical Heat Tube

When the process pipe consists of double random lengths and the heat tube is a single random length, two (2) heat tubes must be joined together prior to attaching to the process pipe. Special sleeve couplings, supplied by PSP, shall be used to join the two sections of heat tube together.



Typical Sleeve Coupling

When joining two heat tubes sections together, the internal edges of the tube must be aligned to prevent bends or “dog legs”. Fillet weld the heat tube coupling 100% of circumference to provide an air tight seal and a proper electrical connection. The welds should not be full penetration welds. The weld size should be approximately 4.75mm (3/16”) and should penetrate to 40-60% of the heat tube. See below.



Typical Heat Tube Joint

After welding the heat tube joint, a visual inspection should be carried out. Inspection should check to ensure that the heat tube is straight and that the weld joint is properly cleaned. All welds must be cleaned. Remove any slag and use a wire brush to clean.

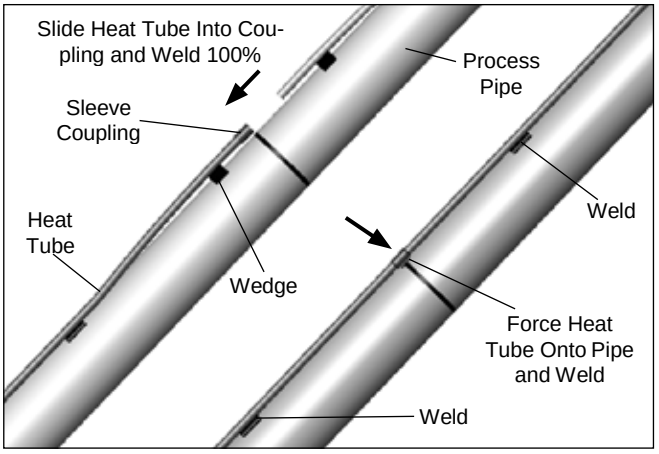
In addition to a visual inspection, the heat tube shall pass a ball pig test. The steel ball shall pass through the heat tube after joint welding the two sections. The diameter of the ball shall be sized as per the table in section 2.10. Refer to Section 2.9 Heat Tube Inspection/Check List for detail of the ball pig test.

If the ball does not pass through the heat tube, the tube must be cut and repaired. Failure to properly complete this step could result in damage to the PSP conductor during conductor installation or operation.

2.3 Heat Tube Installation Methods

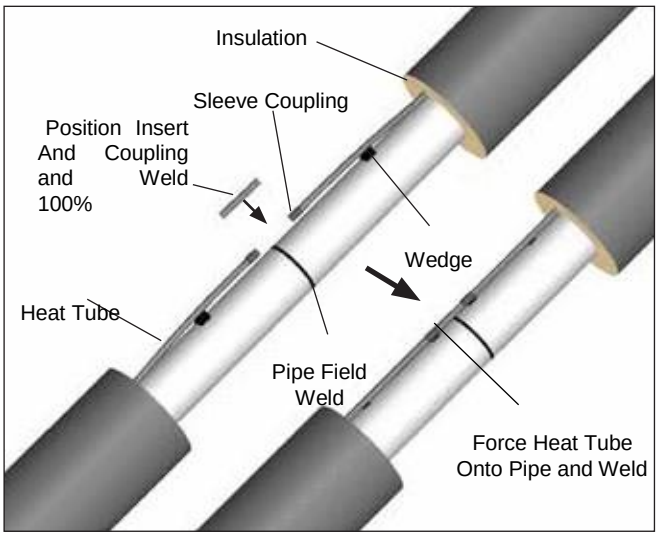
There are typically two methods used for the installation of the heat tube on the process pipe, **Field** installation and **Shop** installation.

For field installation, the heat tube is attached to the process pipe after the pipe is constructed and joint welds are made. The heat tube shall be attached to the process pipe as indicated by the project specific installation details. A single heat tube sleeve coupling shall be used to join the heat tube sections together. For the heat tube section that has been welded to the process pipe, bend the tube up slightly from the pipe surface using wedges or a pry bar. Slide the sleeve coupling over the raised end of the tube. Insert the next section of heat tube and continuously weld around the entire circumference of the coupling/heat tube. The heat tube coupling is then forced down onto the process pipe for heat transfer continuity. Continue welding the heat tube to the process pipe. Repeat this process for the next heat tube section.



Field Installation

For shop installation (prefabricated pipe sections), the heat tube is attached to the process pipe prior to pre-insulation. The heat tube shall be attached to the process pipe as indicated by the project specific installation details. The heat tube is typically terminated 150mm (6”) short of the process pipe ends to allow for field welding of the pipe. Welding of the heat tube is typically terminated 450mm (18”) short of the process pipe ends to allow for installing and welding of the heat tube sleeve couplings. A split coupling method with an additional insert shall be utilized to join the heat tube sections. Using wedges or a pry bar, bend the heat tubes up slightly from the pipe surface. Slide the couplings over the tube ends and position the insert. Slide the couplings to the center on the joint. Continuously weld around the entire circumference of the coupling/heat tube. The heat tube coupling is then forced down onto the process pipe for heat transfer continuity.



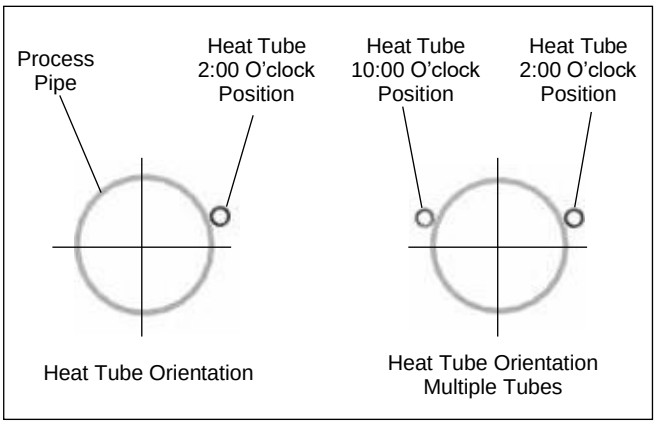
Note: For shop installations where the process pipe consists of double random lengths and the heat tube is a single random length, two heat tubes shall be joined together prior to attaching to the process pipe. The single sleeve coupling method shall be used to join the two sections of the heat tube together. (See Section 2.2).

2.4 Attaching Heat Tube to the Process Pipe

The heat tube may be attached to the process pipe by either steel bands or welding. Refer to the project engineering details for specific attachment method.

The heat tube must be installed on the process pipe in a horizontal plane, i.e. if the heat tube starts at the 2:00 o'clock position, it must stay at the 2:00 o'clock position, and end at the 2:00 o'clock position, except at elbows. Any bends in the heat tube, not specified on the Design Installation Drawings, must be straightened.

NOTE: When shop fabricating pipe sections, refer to the project specific details.



Typical Heat Tube Orientation

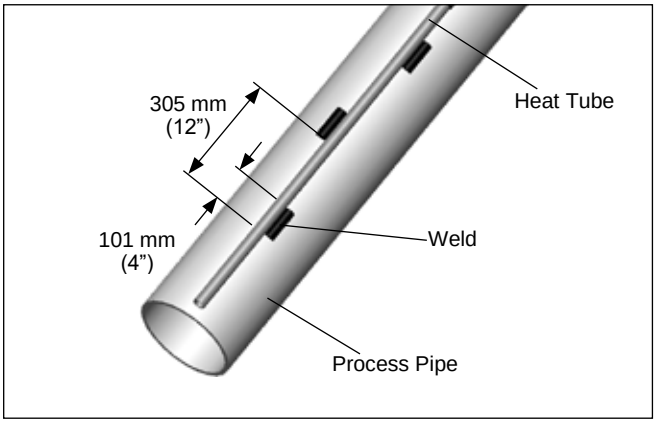
2.5 Welding Heat Tube to the Process Pipe

NOTE: The following procedures apply to attaching the heat tube to the process pipe in the field.

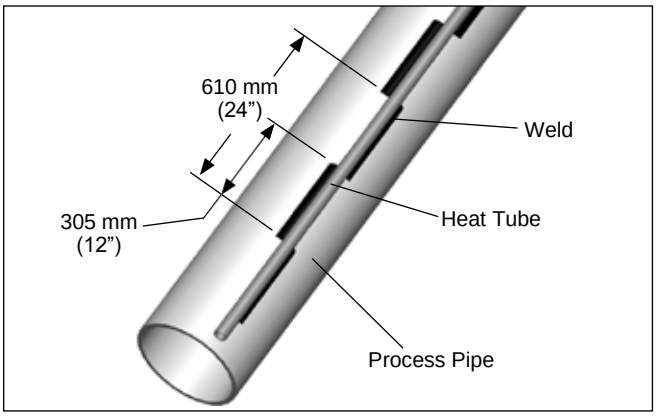
Position the heat tube on the process pipe and temporarily secure it by tack welding on approximately 3 meter (10') centers on alternate sides. The heat tube shall then be attached to the process pipe by means of welding. Refer to the Project Design Isometric Drawings for specific details of weld coverage. After welding, remove any slag with a chipping hammer and use a wire brush to clean.

Undercuts and/or craters in the welds shall not be allowed on either the process pipe or heat tube. Failure to comply with this requirement could result in damage to the PSP conductor and/or pipeline.

NOTE: Upon completion of welding, follow recommended project procedures for coating the heat tube and/or welds, if required.



Typical Welded Heat Tube Attachment 33% Weld Coverage

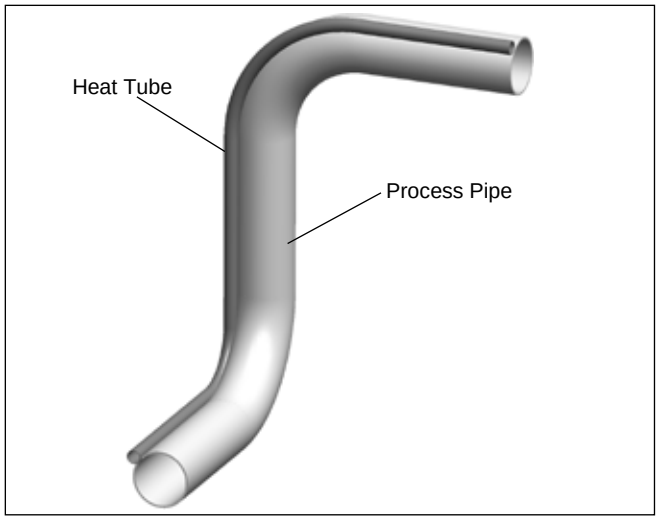


Typical Welded Heat Tube Attachment 100% Weld Coverage

2.6 Heat Tube Installation on Elbows

Installation of the heat tube on elbows shall be such that there is continuous contact between the process pipe and the heat tube. The heat tube should be run along the side or outside on the elbow.

NOTE: Do not route the heat tube on the inside of elbows. Maintain a minimum bending radius of 6 to 8 times the O.D. of the heat tube.



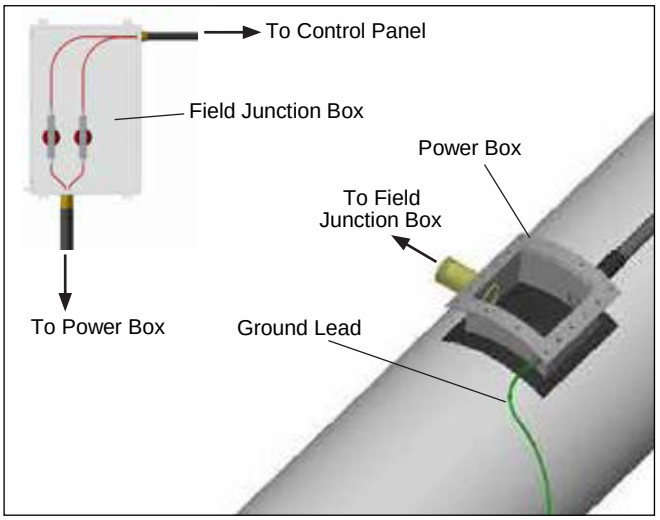
Typical Heat Tube Attachment on Elbow

2.7 PSP Box Installation Procedures

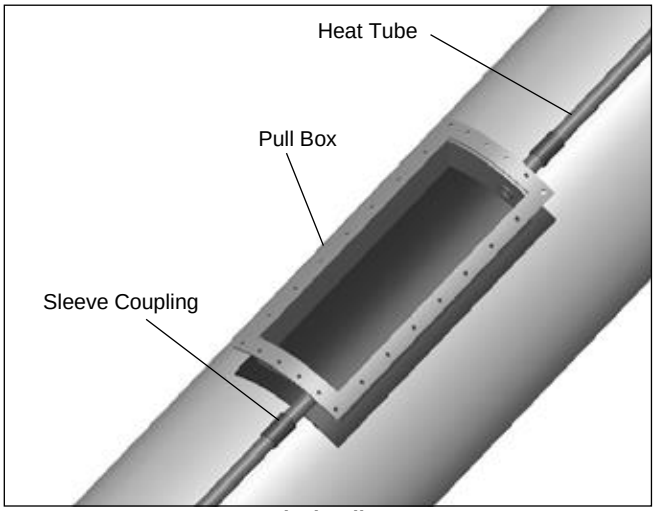
The attachment of the power, pull and end termination boxes shall be in the same general manner as described for the heat tube. Refer to the Project Design Isometric Drawing for specific details and location of boxes. After power, pull and end termination boxes are installed, ensure that the box lids are also installed to prevent moisture from entering the heat tubes.

The heat tube must be welded to the power, pull and end termination boxes in the same manner as the heat tube couplings.

For power connection to the Petrolchimica System, locate the field junction box no more than 3 meters (10') from the power box.

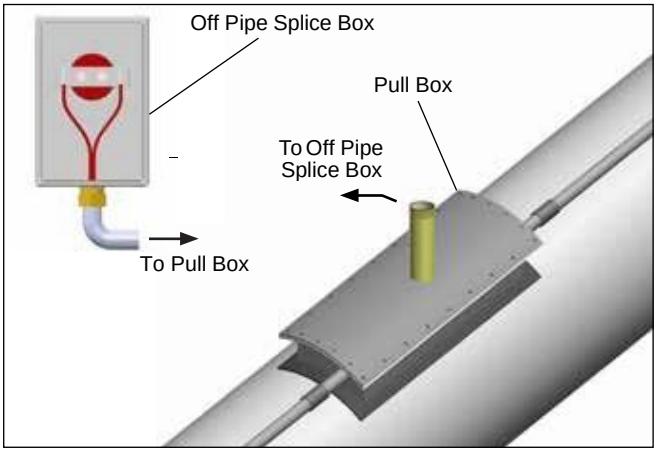


Typical Power Box to Field Junction Box

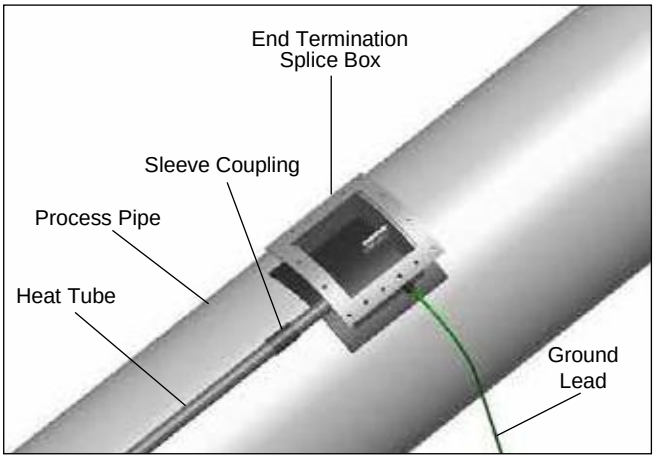


Typical Pull Box

For some applications, the PSP conductor splice may be required to be made off the pipe. This is generally required for high temperature applications.



Typical Off Pipe Splice Box



Typical End Termination Box

The locations of all boxes are shown on the Project Design Isometric Drawings. Boxes shall be installed away from any heat sinks such as pipe supports, anchors, etc. In general, the following guidelines are used for locating boxes and conductor pulling lengths.

- The maximum straight length, without elbows, between 2 pull boxes is approximately 75 meters (246').
- In case of 1 elbow (90°) between 2 pull boxes, the maximum length between the 2 pull boxes should not exceed approximately 60 meters (197').
- In case of 2 elbows between 2 pull boxes, the maximum length between the 2 pull boxes should not exceed approximately 45 meters (147').
- In case of 3 elbows between 2 pull boxes, the maximum length between the 2 pull boxes should not exceed approximately 30 meters (98').
- In case of 4 elbows add 1 pull box between elbow 2 and 3, and follow the rule for 2 elbows between 2 pull boxes.

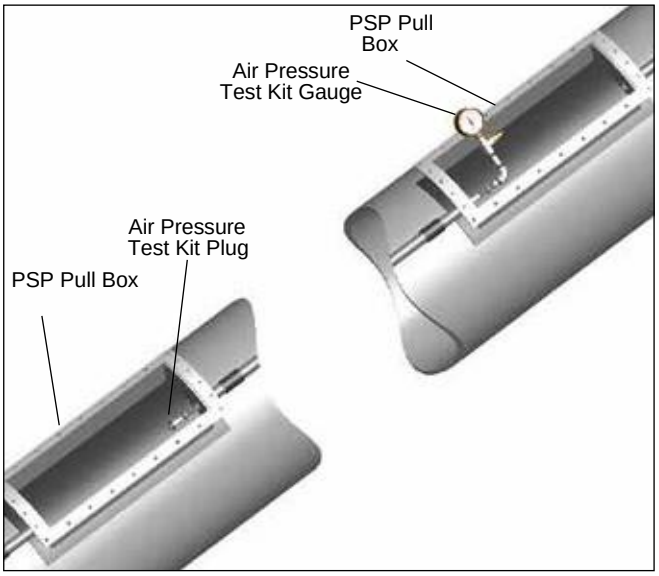
2.8 Heat Tube Inspection / Check List

After all welding is completed, a visual inspection should be carried out. Inspection should check to ensure that the heat tube is attached per Section 2.3 and that weld joints have been properly cleaned. Remove any slag with a chipping hammer and use a wire brush to clean. Make sure that all box entries are free from burrs and that they are beveled.

An air tightness test shall be conducted using nitrogen gas or compressed air at a pressure of 0.7kg/cm^2 (10 psi). This test will help to ensure that all heat tube field weld joints are structurally and electrically sound. A poor weld joint can generate a hot spot and eventually lead to the failure of the Petrolchimica conductor dielectric. A poor weld may also allow water accumulation in the system.

The test shall be conducted between two (2) Petrolchimica Boxes, with the use of a pressure gauge. If a leak is detected, soapy water shall be dropped over all welds within the section to determine the location of the leak so that it can be repaired. The air tightness test shall be repeated until the entire length of installed heat tube has been successfully tested.

NOTE: Power, Pull and End Termination Boxes are not designed to be air tight and therefore are not included in the air tightness test.



Typical Heat Tube Air Pressure Test

With the heat tube attached to the process pipe, the ball pig test is performed on the heat tube to ensure there is sufficient clearance for safe insertion of the PSP conductor. This test ensures welds do not penetrate internally into the heat tube and that the heat tube has not been physically damaged. The diameter of the ball shall be sized as per the table in Section 2.10.

The ball is attached to the center of a pull rope so the ball can be pulled to either end of the heat tube. If the ball gets lodged, the location is easily determined and removal of the ball is not difficult.

NOTE: If the ball does not pass through the heat tube, the tube must be cut and repaired.

As a final step, remove any dust, filings, etc. by blowing out the heat tube with dry compressed air.

After the cleaning procedure, seal the ends of the heat tube with plastic plugs and install box lids until ready to install the Petrolchimica Conductor.

Insure that the Attachment A Inspection Report Form Heat Tube and Box Installation has been completed for each section of fabricated pipe. Retain the report as a permanent record.

2.9 Special Tools

Description	PSP P/N
Heat Tube Air Pressure Test Kit for 3/4” and 1” heat tube.	65030
1” carbon steel ball, with hole for pig test. Approx. size 22mm (.873”).	386121
3/4” carbon steel ball, with hole for pig test. Approx. size 19mm (.75”).	386111
Pulling Rope 6mm x 183m (1/4” x 600’)	44277

2.10 Corrosion Protection

After welding of the complete skin effect system, all exposed metal shall be coated with a temperature appropriate paint or epoxy.

3.0 Installation of the PSP Conductor

3.1 Preparation for Pulling the Conductor

A pull rope, 6-8mm (1/4” to 3/8”) polypropylene, must be installed inside the heat tube. This pull rope is required to facilitate the cleaning of the heat tube and the installation of the Petrolchimica Conductor.

NOTE: To install the pull rope, an air gun (mouse blower) or a fish tape can be used to first install a small pulling line between two (2) boxes. The pulling line will be used to install the pull rope.

A small piece of cotton cloth shall be attached to the pull rope. This cloth will be pulled through the heat tube to clean and “PIG” the line. If any moisture is apparent on the cloth after it is pulled through the heat tube, additional cloths must be pulled until no moisture is apparent.

3.2 Installing the PSP Conductor

The pipeline must be completely tested and released prior to installing the conductor.

No welding shall be allowed on the pipeline once the installation of the conductor begins.

The minimum installation temperature for PSP conductor:

Fluoropolymer .....-40ºF (-40ºC)
Polyolefin .....-40ºF (-40ºC)

The minimum bend radius for PSP conductor is 6 times the O.D. of the conductor at -40ºC (-40ºF).

Attach the PSP conductor to the pull rope using appropriate cable gripper or other suitable means. Refer to Section 3.10 for appropriate cable grippers.

Unless specified by the manufacturer, the installation contractor must first determine the location where each reel of PSP Conductor shall be installed based on the conductor reel lengths and distance between pull boxes. The distance between the start of the conductor pull and the end of the conductor pull shall be at least 16' less than the length of conductor noted on the reel.

There should be at least one person stationed at each pull box to assist in the conductor pull. The conductor reel shall be placed on a spool stand, which will allow easy pulling of the conductor. The reel should be positioned so that there is no binding or twisting of the conductor. While slowly pulling on the pull rope, from the closest pull box, gently insert the conductor into the heat tube of the first box. Avoid dragging the conductor across sharp or abrasive edges. As more conductor enters the heat tube, the pull rope should be installed or pulled to the next pull box.

Maximum Pulling Force

Force kg (lbs)	Conductor Size mm² (AWG)
240 (529)	34 (2)
157 (333)	21 (4)
95 (209)	13 (6)
60 (132)	8 (8)

Do not exceed the maximum recommended pulling force.

Carefully guide and monitor the passage of the conductor through each pull box. Inspect the conductor for any excessive abrasion or cuts as it passes through the boxes. Any damaged cable must be reported to a Petrolchimica engineer. Do not install cable that has been compromised in any way. Ensure that sufficient conductor length is provided within the pull box for the expansion allowance. Refer to section 3.6.

NOTE: Where the PSP system traverses terrain with significant elevation changes, a strain relief fitting may be required. These fittings shall be used inside the PSP pull box. Contact PSP for additional information.

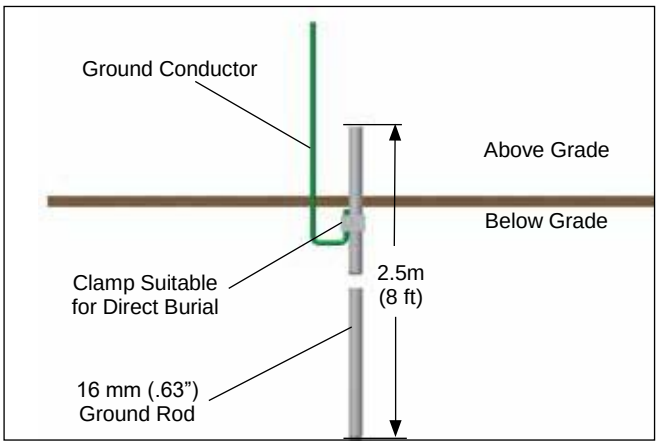
Splice the PSP conductor following the instructions which are provided with each splice kit. Only use PSP splice kits and recommended crimping tool for splicing PSP conductors. Record on the Design Isometric Drawings the location of each splice. Keep a record of the installed lengths of the PSP Conductor. The total length of the conductor will be necessary to calculate the exact amount of W/m (Watts/ft) applied to the pipe and to adjust transformer voltage taps, if required. Record the installed lengths on Attachment B Inspection Report PSP Conductor and Splice Connections.

3.3 Grounding Requirements

The Field Junction Box, Power Connection Box and End Termination Box will require grounding with suitably rated conductors to a known and proven plant ground or by grounding rods. All connections are to be protected from airborne corrosion and tested according to local grounding regulations. Resistance readings are to be recorded and shall be within the maximum acceptable values established by the site electrical department. Particular attention shall be given to ensure that all ground paths installed on the skin-effect system measure approximately the same resistance value.

All exposed earth cables are to be protected against mechanical damage, and labelled:

Do Not Remove – Safety Electrical Grounding



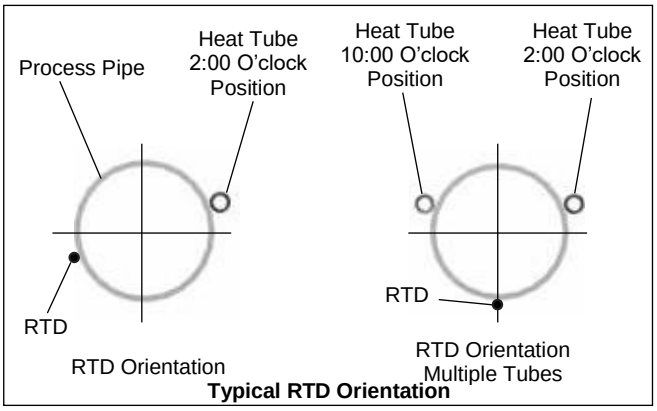
Typical Grounding Detail

3.4 Circuit Protection Requirements

Over-current protection (typically fuses) are required for each branch circuit. This protection must isolate all power conductors from the supply. Refer to local code requirements for appropriate fuse sizing.

3.5 RTD Installation

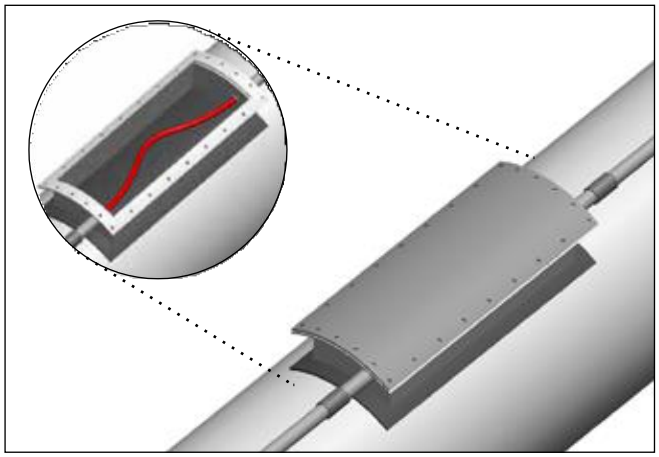
The RTD Temperature Control Sensor and RTD Temperature Limit Sensor (if required) shall be installed on the process pipe with attachment bands. The RTD shall be at least 3 meters (10') from any support or Petrolchimica box. Below is an illustration of a typical RTD placement. Refer to the Project Design Isometric Drawings for actual location and specific details for the RTD attachment.



Typical RTD Orientation

3.6 Conductor Expansion Allowance

Carefully guide and monitor the passage of the conductor through each pull box. Ensure that sufficient conductor length is provided within the pull box for the expansion allowance. Create as much of an "Ω" as possible in each pull box. Loops and "S" curves should not be used for expansion allowances.



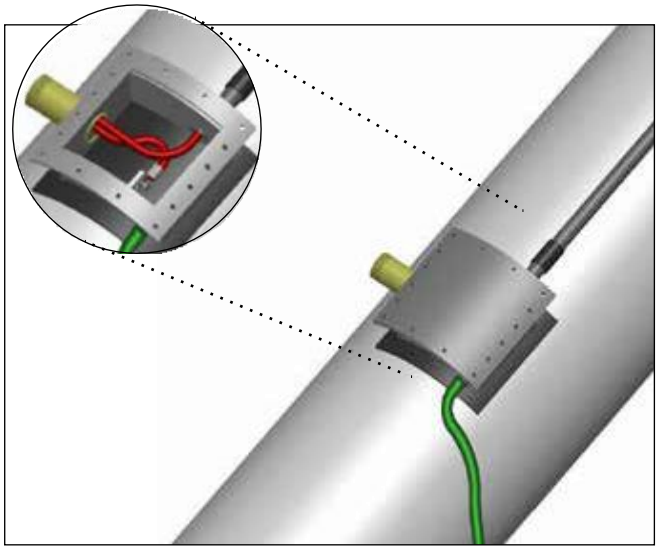
Typical Expansion Allowance

Where the conductor is spliced, an expansion allowance **is not** to be made within the splice box.

3.7 Making Conductor Power Termination

NOTE: All PSP conductor terminations shall be made using PSP components, kits and recommended tools. For in-line splice connections, refer to the installation instructions provided with each individual splice kit.

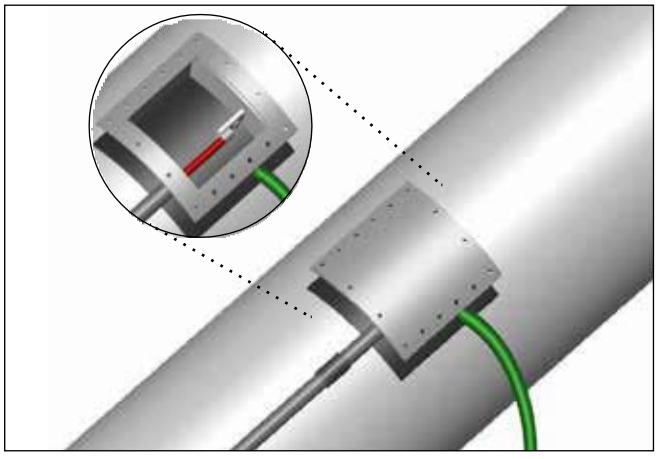
The Power Connection Box is located at the power feed end of PSP circuit. Electrical power from the Field Junction Box is fed to the system through the Power Connection Box. An internal tab is provided for connecting the return path conductor. An external tab on the box permits grounding of the system. Refer to Section 3.9 for appropriate termination lug and torque value.



Typical Power Connection Box

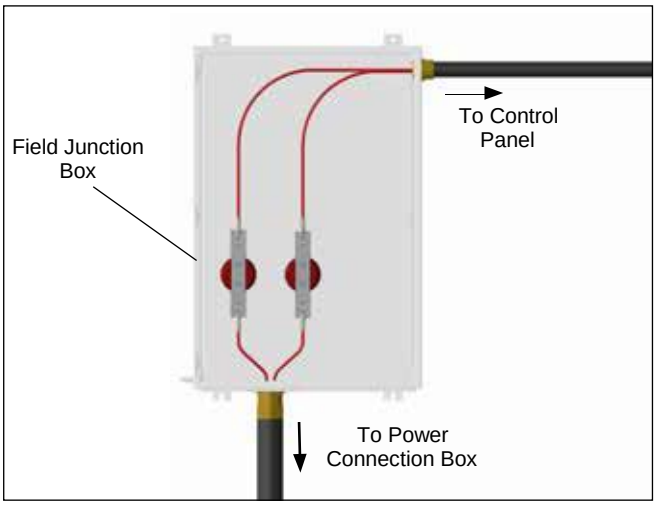
3.8 Making Conductor End Terminations

The End Termination Box is located at the end of the PSP circuit. The design and construction allows the Petrolchimica conductor and heat tube to be joined together thereby allowing electrical current to return to the power connection box via the inside surface of the heat tube. An external tab on the box permits grounding of the system. Refer to Section 3.9 for appropriate termination lug size and torque value.



Typical End Termination Box

The Field Junction Box is located between the Power Connection Box and the Control Panel. It provides an access point to terminate the PSP conductor and the power feed wiring. Refer to Section 3.9 for appropriate termination lug size and torque value.



Typical Field Junction

3.9 Petrolchimica Conductor Terminations

All PSP conductor terminations shall be made with PSP approved termination lugs.

Reference Chart

		PSP Conductor Termination Lug
Part No.	**Conductor**	
65058	8 AWG	Connection and Termination Lug Kit 8AWG
65056	6 AWG	Connection and Termination Lug Kit 6AWG
65055	4 AWG	Connection and Termination Lug Kit 4AWG
65052	2 AWG	Connection and Termination Lug Kit 2AWG
65051	1 AWG	Connection and Termination Lug Kit 1AWG

The torque values listed below are adequate for the bolt sizes given. Values are based on using stainless steel bolts with a coarse thread type.

Bolt Size	Torque Value
Size 1/4”	6-8 Nm (4-6 ft · lb_f)
Size 5/16”	8-16 Nm (6-12 ft · lb_f)
Size 3/8”	20-27 Nm (15-20 ft · lb_f)
Size 1/2”	34-41 Nm (25-30 ft · lb_f)

3.10 Special Tools

Description	PSP P/N
Wire Pulling Grip, for cable diameters 6-9 mm (.25-.36”).	38143
Wire Pulling Grip, for cable diameters 9-12 mm (.37-.49”).	38160
Wire Pulling Grip, for cable diameters 13-15 mm (.50-.61”).	38165
Wire Pulling Grip, for cable diameters 15-19 mm (.62-.74”).	38161
Pulling rope 6 mm x 182 m (1/4”X600’).	44277
Mouse fitting for 1” heat tube.	38163
Mouse fitting for 3/4” heat tube.	38159
Crimping tool (Greenlee K-Series Cat. No. K05-1SPGL).	10037
Heat Gun, Model 4A162 (120VAC), 649º C (1200º F)/1100 watts or equivalent.	65119
Heat Gun Baffle or equivalent.	65120

4.0 Test Procedures

4.1 Testing Requirement

All PSP conductor cables and associated components shall be tested in accordance with the requirements set forth herein. The following “Inspection Report Forms” shall be completed:

a) Inspection Report Heat Tube and Box Installation
b) Inspection Report Petrolchimica Conductor and Splice Connections
c) Final Inspection Report Pre-Commissioning

4.2 Insulation Resistance Test

Ensure all grounding has been properly checked prior to the start of testing procedures.

After each section of the PSP conductor has been pulled into the heat tube but before splicing/terminating, an insulation resistance measurement shall be made on each section of PSP Conductor. The Insulation Resistance Test shall be conducted using a Vdc Megger, measuring between cable conductor and heat tube. Minimum resistance reading of 100 megohms/km should be recorded.

NOTE: Insulation resistance test shall also be repeated after making any conductor splices.

PC Conductor - Test Voltages For Megger

Conductor Voltage Rating (Vac)	* Minimum Test Voltage (Vdc)
1000	4.8 KV
1500	6.4 KV
2000	8.0 KV
2500	9.6 KV
3000	11.2 KV
For Other Conductor Voltage Ratings Contact PC	

***** Recommended test voltage - reference IEEE Standard 844-2000

With the PSP conductor completely installed and all conductor splices made, but before making the power and end terminations, a final Insulation resistance test shall be conducted on the entire circuit.

The completed inspection report forms shall be signed by the person performing the inspection and provided as permanent record to the client.

At the completion of all tests, terminate cable ends and make sure that all junction boxes, controllers, etc. are properly closed so that no moisture can penetrate.

NOTE: For the PC Power Connection Box, Pull Box and End Termination Box, the torque value for the cover bolts is 9-11 Nm (80-100 inch pounds). The lid bolts should be torqued in a crisscross sequence to ensure even pressure distribution throughout the lid and gasket.

Apply “Electric Heat Tracing Caution” labels to the insulation vapor barrier on 3 meter intervals or as required by code or specification.

Special considerations should be taken to note the location of all splices (e.g. station locations, GPS coordinates, etc.)

For underground systems, all box locations should be noted.

5.0 Control Requirements

5.1 Controlled Design

For Zone 1 and Zone 21 Applications:

The device applied as a temperature limiter for the controlled temperature design shall comply with the requirements of clause 4.5.3.1 of IEC/IEEE 60079-30-1.

The temperature sensors for temperature control and limitation shall comply with the types of protections listed in clause 1 of EN/IEC 60079-0 certified as Category 2 G or 2 D or as EPL Gb or Db equipment.

Refer to the project drawings or design data charts for the temperature set point of the temperature limiting device which relates to the specified maximum surface temperature or temperature class T6 to T2.

For Zone 2 and Zone 22 Applications:

The device applied as a temperature limiter for the controlled temperature design shall comply with the requirements of clause 4.5.3.2 of IEC/IEEE 60079-30-1.

The temperature sensors for temperature control or limitation shall comply with the types of protections listed in clause 1 of EN/IEC 60079-0 certified as Category 3 G or 3 D or as EPL Gc or Dc equipment.

Refer to the project drawings or design data charts for the temperature set point of the temperature limiting device which relates to the specified maximum surface temperature or temperature class T6 to T2.

5.2 Stabilized Design

Refer to the project drawings or design data charts for all design parameters that ensure temperature stabilization at lower values than the specified maximum surface temperature or temperature class T6 to T2.

5.3 General

All design information shall be retained as a record of system documentation for each controlled designed system for as long as the system is in use. The set point in the system documentation shall be checked during commissioning of the system. Use PN50253 for guidance during commissioning of the system.

6.0 Maintenance Procedures

Once the heat tracing system has been installed, an ongoing preventative maintenance program should be implemented using qualified personnel. Support documentation should be maintained which provides general information and an operating history of the specific circuit in the system.

The results of the operational testing described in the Commissioning Manual form the testing “baseline” or normal range. Subsequent measurements should be recorded periodically and compared to this baseline data to help identify any potential problems.

An insulation resistance test should be conducted periodically. The PSP conductor shall be tested with a DC hi-pot test at 80% of the initial test voltage.

During maintenance, when any PSP box located within the electromagnetic envelope (power box, pull/ splice boxes or end-termination box) is opened, the gas- ket must be replaced if it has become attached to both surfaces of the lid and base.

Petrolchimica recommends that a visual inspection be carried out on a routine basis. The inspection should consist of observing for any damaged thermal insulation, loose electrical connections, corrosion, etc. Temperature controllers should be inspected for proper operation.

De-energize the system prior to opening any electrical or splice boxes

Inspection Report
Heat Tube and Box Installation

Client:	
Project Name:	
Location:	
Project Reference No:	
PSP Ref. No:	
PSP Drawing No:	Sheet No: Circuit No:

Circuit Section –_____

From PC Box No:		To PC Box No	

Description	Reference Document	Accept / Reject	Insp. By	Date
Heat Tube Size	Project Specific Design Drawings			
Heat Tube Type/Grade	Project Specific Design Drawings			
Heat Tube and Coupling Ends are De-Burred and Beveled	Installation Manual			
Heat Tube Welded or Strapped as per Design	Project Specific Design Drawings and Installation Manual			
AL Tape has Been Applied to Prevent Ingress of PUF Insulation (Pre-Insulated Pipe Only)	Project Specific Design Drawings			
Air Tightness Test	Installation Manual			
Ball Pig Test	Installation Manual			
Confirm Location Of PC Boxes	Project Specific Design Drawings			
Visual Inspection of PC Box Attachment	Installation Manual			
All Welds, Boxes and Heat Tube has Been Corrosion Protected	Project Specific Design Drawings			

This Circuit Section is released for thermal insulation.

Released By: _____ Date: _____

(Print name)

_____

(Signature / Title)

Inspection Report
Petrolchimica Conductor and Splice Connections

Client:			
Project Name:			
Location:			
Project Reference No:			
PSP Ref. No:			
PSP Drawing No:	Sheet No:	Circuit No:	

Circuit Section –_____

From PC Box No:		To PC Box No	

Description	Reference Document	Accept / Reject	Insp. By	Date
Confirm that the correct conductor type and size have been installed.	Project Specific Design Drawings	_____M (Ft.)		
Record actual installed conductor length	N/A	_____M (Ft.)		
Visual Inspection of splice connections.	Specific Splice Kit Installation Instructions			
Insulation Resistance test DC IR Test Voltage_____V Value_____MΩ	Installation Manual			
Visual Inspection of pull box for sufficient conductor length for expansion allowance.	Installation Manual			
Visual Inspection to ensure all PSP Boxes are properly closed with gasket installed (proper torque).	Installation Manual			

This Circuit Section is released.

Released By: _____ Date: _____

(Print name)

_____

(Signature / Title)

Final Inspection Report
Pre-commissioning

Client:	
Project Name:	
Location:	
Project Reference No:	
PSP Ref. No:	
PSP Drawing No:	Sheet No: Circuit No:

Description	Reference Document	Accept / Reject	Insp. By	Date
Pull/Splice box labels are placed on insulation lagging				
Final conductor Insulation Resistance test. DC IR test voltage_____V Value_____MΩ	Installation Manual			
Visual Inspection – system grounding points.	Project Specific Design Drawings			
Visual Inspection – RTD temperature sensor location.	Project Specific Design Drawings			
Visual Inspection – thermal insulation system.	Project Specific Design Drawings			
Visual Inspection - Field Junction boxes properly wired and all terminals are tight (proper torque)	Equipment layout drawings.			
Visual Inspection – Control/Power Panel properly wired and all terminals are tight (proper torque).	Equipment layout drawings.			
Control Panel Set Points Verified	Project Specific Design Drawings			
Visual Inspection - Transformer properly wired and all terminals are tight (proper torque).	Equipment layout drawings.			
Redline Mark-Ups of Skin Effect System Drawings Accurate	Project Specific Design Drawings			

This Circuit is released for commissioning.

Released By: _____ Date:

(Print name)

_____

(Signature / Title)