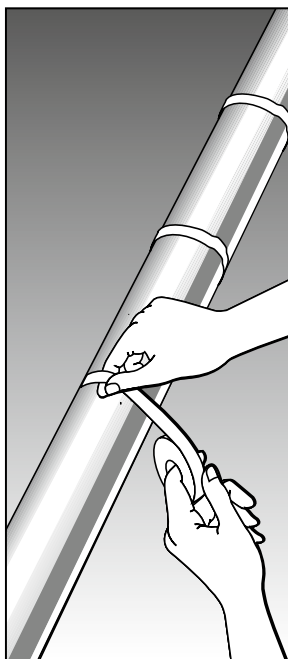


Raychem Installation and
Maintenance Manual

SELF-REGULATING
AND POWER LIMITING
HEATING CABLE SYSTEMS



1	General information	Pg. 1
2	Heating cable selection	Pg. 3
3	Heating cable installation	Pg. 4
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8	Heating cable testing	Pg. 21
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10	Heating cable damage	Pg. 24
11	Troubleshooting guide	Pg. 24

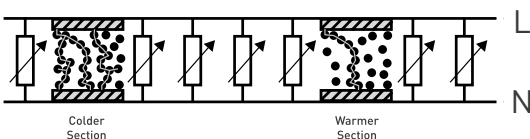
1 GENERAL INFORMATION

Use of the manual

The Installation and Maintenance manual is for Pentair Thermal Management self-regulating and power limiting heating cable systems on thermally insulated pipes and vessels only.

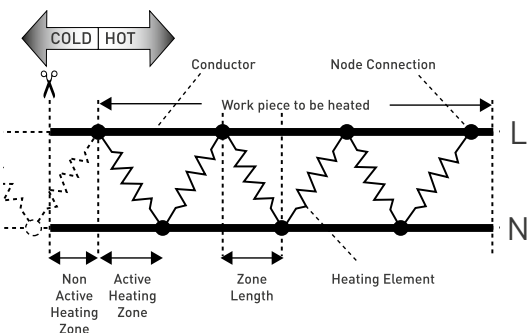
For information regarding other applications contact your Pentair Thermal Management representative.

BTV, QTVR, KTV & XTV Self Regulating Heating Cables



- Power output varies with temperature. As pipe temperature increases, power output decreases.
- At high temperatures, the polymer expands, reducing the number of the conductive paths, and thus reducing current flow.
- At low temperatures, there are many conductive paths, allowing current to flow between the conductors.

VPL Power Limiting Heating Cables



Important

For the Pentair Thermal Management warranty to apply, the instructions that are included in this manual and product packages must be followed. The installation must be compatible with local requirements applicable to electric heat tracing systems.

Conditions for Safe Use: Refer to Hazardous area certification

BASEEFA	
Certificate No.	Code
BTV: Baseefa06ATEX0183X	Ex II 2 GD Ex e II T6 Ex tD A21 IP66
QTVR: Baseefa06ATEX0185X	Ex II 2 GD Ex e II T4 Ex tD A21 IP66
XTV: Baseefa06ATEX0184X	Ex II 2 GD Ex e II T* Ex tD A21 IP66
KTV: Baseefa06ATEX0186X	Ex II 2 GD Ex e II 226°C (T2) Ex tD A21 IP66
VPL: Baseefa06ATEX0188X	Ex II 2 GD Ex e II T* Ex tD A21 IP66

*: please refer to schedule of hazardous area approval for details.

PTB	
Certificate No.	Code
BTV: PTB 98 ATEX 1102 X	Ex II 2 G/D EEx e(m) II T6 IP66 T80°C
QTVR: PTB 98 ATEX 1103 X	Ex II 2 G/D EEx e(m) II T4 IP66 T130°C
KTV: PTB 98 ATEX 1104 X	Ex II 2 G/D EEx e(m) II T4/T3/226°C(T2) IP66 T130°C, T195°C, T226°C
XTV: PTB 98 ATEX 1105 X	Ex II 2 G/D EEx e(m) II T4/T3/250°C(T2) IP66 T130°C, T195°C, T250°C

IEC Ex	
Certificate No.	Code
BTV: IECEx BAS 06.0043X	Ex e II T6 / Ex tD A21 IP66
QTVR: IECEx BAS 06.0045X	Ex e II T4 / Ex tD A21 IP66
XTV: IECEx BAS 06.0044X	Ex e II T* / Ex tD A21 IP66
KTV: IECEx BAS 06.0046X	Ex e II 226°C (T2) / Ex tD A21 IP66
VPL: IECEx BAS 06.0048X	Ex e II T* / Ex tD A21 IP66

*: please refer to schedule of hazardous area approval for details.

Rated Voltage

BASEEFA	BTV1, QTVR1, KTV1, XTV1, VPL1: 110V, 120V BTV2, QTVR2, KTV2, XTV2, VPL2: 230V, 277V, VPL4: 400V, 480V
PTB	BTV2, QTVR2, KTV2, XTV2: 230V, 254V

	BTV	QTVR	XTV-T3	XTV-T2	KTV	VPL
Minimum Bending Radius at 20°C	15 mm	15 mm	15 mm	15 mm	25 mm	20 mm
at -60°C	50 mm	50 mm	50 mm	50 mm	50 mm	20 mm
Minimum Installation Temperature	-60°C	-60°C	-60°C	-60°C	-60°C	-60°C
Maximum Maintain Temperature (power on)	65°C	110°C	120°C	120°C	150°C	See table below
Maximum Exposure Temperature (1000 hrs cumulative exposure power on)	85°C	110°C	215°C	215°C	215°C	-
Maximum Exposure Temperature (continuous power off)	-	-	-	-	-	260°C
Self-limiting Temperature in accordance with EN62086-1 5.1.11	T6	T4	T3	T2	T2	T*
Power Limiting Temperature (*By design)	-	-	-	-	-	T*

Maximum maintain (power on) temperature table

Cable	110 V	230 V	254 V	277 V	400 V	480 V
5VPL1-CT	235°C	-	-	-	-	-
10VPL1-CT	215°C	-	-	-	-	-
15VPL1-CT	190°C	-	-	-	-	-
20VPL1-CT	150°C	-	-	-	-	-
5VPL2-CT	-	230°C	225°C	225°C	-	-
10VPL2-CT	-	210°C	200°C	195°C	-	-
15VPL2-CT	-	180°C	155°C	105°C	-	-
20VPL2-CT	-	150°C	-	-	-	-
5VPL4-CT	-	-	-	-	230°C	230°C
10VPL4-CT	-	-	-	-	205°C	205°C
15VPL4-CT	-	-	-	-	160°C	160°C
20VPL4-CT	-	-	-	-	150°C	150°C

► Warning

As with any electrical equipment or wiring installation operating at line voltages, heating cable and component damage or incorrect installation that allows the penetration of moisture or contamination can lead to electrical tracking, arcing and potential fire hazard.

Do not connect heating cable conductors together or this will result in a short circuit.

Any unconnected heating cable end must be sealed with a Pentair Thermal Management approved end seal.

To prevent fire or explosion in hazardous areas, verify that the maximum sheath temperature of the heating cable is below the auto-ignition temperature of the gases in the area. For further information, see design documentation.

2 HEATING CABLE SELECTION

Check the design specification to make sure the proper heating cable is installed on each pipe or vessel. Refer to Pentair Thermal Management product literature and the TraceCalc software to select the proper heating cable for each thermal, chemical, electrical and mechanical environment.

3 HEATING CABLE INSTALLATION

3.1 Heating cable storage

- Store the heating cable in a clean, dry place
- Temperature range: -40°C to +60°C
- Protect the heating cable from mechanical damage

3.2 Pre-installation checks

Check materials received:

- Review the heating cable design and compare the list of materials to the catalogue numbers of heating cables and electrical components received to confirm that proper materials are on site. The heating cable type is printed on its outer jacket.
- Temperature exposure must not exceed that specified in Pentair Thermal Management product literature. Exceeding these limits will impair product performance. Check that expected exposure is within these limits.
- Ensure that the heating cable voltage rating is suitable for the service voltage available.
- Do not energize cable when it is coiled or on the reel.
- Inspect heating cable and components for in-transit damage. An insulation resistance test (see section 8) on each reel is recommended.

Check piping to be traced:

- Ensure all pressure testing is complete and pipework has final paint coating.
- Walk the system and plan the routing of the heating cable on the pipe.
- Check pipework against specification drawing. If different consult design authority.
- Inspect piping for burrs, rough surfaces, sharp edges etc. which could damage the heating cable. Smooth off or cover with layers of glass cloth tape or aluminium foil.

3.3 Heating cable handling

Heating cable handling tips:

- Paint and pipe coatings must be dry to the touch before heating cable installation.
- When pulling the heating cable, avoid:
 - ◁ sharp edges
 - ◁ excessive pulling force
 - ◁ kinking and crushing
 - ◁ walking on it, or running over it with equipment

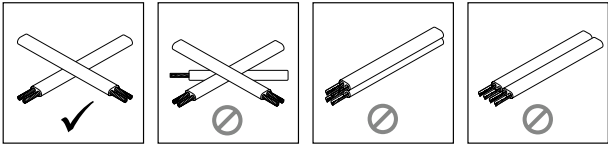
Heating cable pulling tips:

- Use a reel holder that pays out smoothly with little tension.
- Keep heating cable strung loosely but close to the pipe being traced to avoid interference with supports and equipment.
- Pay out designed length and mark (i.e. with fixing tape) on cable while still on reel.
- Leave the appropriate amount of heating cable at all power connection, splice, tee and end seal locations. (Refer to component installation instructions)
- ◁ **Add additional heating cable to trace the fittings and supports or for spiralling as required by the design specifications, or consult Pentair Thermal Management product literature for design.**
- Protect all heating cable ends from moisture, contamination and mechanical damage or other interference if left exposed before component installation.

3.4 Heating cable attachment recommendations

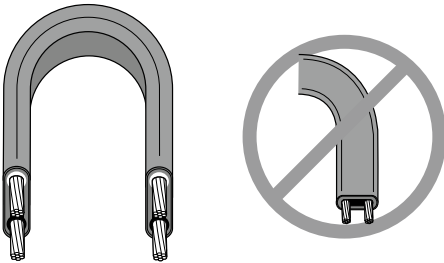
- The heating cable may be installed straight, spiralled or in multiple runs as required by the design specification, Pentair Thermal Management product literature or TraceCalc software.
- ◁ Do not use metal attachments, vinyl electrical tape or duct tape as heating cable damage may result.
- ◁ Self-Regulating technology allows for the multiple overlapping of the heating cable on to itself.
- Power Limiting technology dictates that the heating cable can be overlapped only once on to itself.

For VPL heating cable only:



- Fix in place with a minimum of two wraps the appropriate self-adhesive glass cloth tape (see figure 1) or plastic cable ties at 300 mm intervals and additionally where necessary.
- Plastic cable ties must have a temperature rating that matches the system exposure temperature.
- The heating cable's minimum bend radius must not be exceeded (refer to p. 2)

Bend the cable only in upright position



- The heating cable does not bend easily in the flat plane. Do not force such a bend, as the heating cable may be damaged.

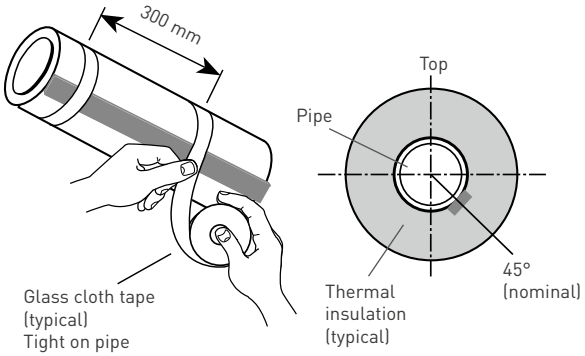
3.4.1 Straight tracing

- Straight trace the pipe unless the design calls for spiralling (see 3.4.2).
- On horizontal pipes fix on lower quadrant as shown in Figure 1 and not on bottom of pipe.
- To prevent overheating, be sure the location of the power limiting heating cable is planned so that the active heating zone will not extend into the component. Read the kit installation instructions and plan the component location before permanently attaching the cable to the pipe.

Ensure that the active heating zones are located where heat is required i.e. on the pipe.

- Thermally insulate and weatherproof to specification.

Figure 1

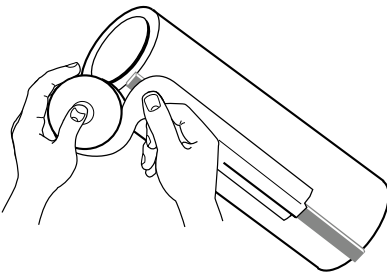


Pentair Thermal Management attachment tapes:

GT66 Self-adhesive glass cloth tape
General purpose tape.

GS54 Self-adhesive glass cloth tape
Recommended for use on stainless-steel and cupra-nickel surfaces and high temperature applications.

Figure 2



ATE-180 Aluminium tape
Use only if the design requires it.

ATE-180 improves the heat transfer and increases the power output of the heating cable.

Attach the heating cable to the pipe as shown in Figure 2.

3.4.2. Spiral tracing

- Alternative spiralling methods are shown in Figures 2a and 2b.
- Only spiral heating cable on pipe when called for by design.
- To prevent overheating, be sure the location of the power limiting heating cable is planned so that the active heating zone will not extend into the component. Read the kit installation instructions and plan the component location before permanently attaching the cable to the pipe.

Ensure that the active heating zones are located where heat is required i.e. on the pipe.

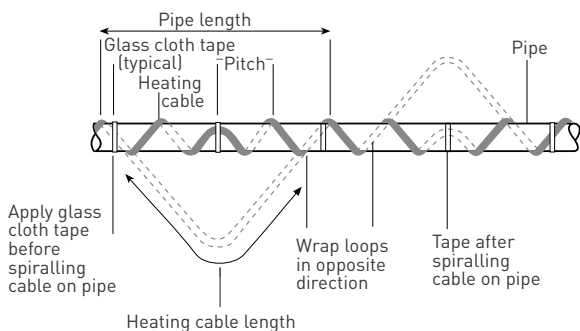
Spiral Pitch Table (mm).

NB (mm)	NPS (inches)	Spiral Ratio				
		1.1	1.2	1.3	1.4	1.5
25	1	250	170	140	110	100
32	1 1/4	310	210	170	140	130
40	1 1/2	350	240	190	160	140
50	2	430	300	240	200	180
65	2 1/2	520	360	290	240	210
80	3	630	430	350	290	260
90	3 1/2	720	490	390	330	290
100	4	800	560	440	370	330
125	5	990	680	550	460	400
150	6	1180	810	650	550	480
200	8	1520	1050	840	710	620

Example:

For pipe of 80 mm NB (3" NPS) requiring 1.3 metres of heating cable per metre of pipe, pitch is 350 mm.

Figure 2a



Heating cable length = pipe length x spiral ratio

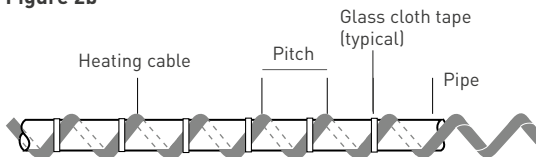
Refer to design specification for spiral ratio

Step 1 Make starting loop as shown

Step 2 Grasp loop and wind around pipe

Step 3 Space evenly and attach to pipe.
Thermally insulate and weatherproof to specification

Figure 2b



Refer to design specification for spiral pitch

Mark the pipe at the spiral pitch or use a simple length gauge

Fix the heating cable as installation progresses

Thermally insulate and weatherproof to specification

3.5 Cutting the heating cable

- ▶ Cut the heating cable to length after it is attached to the pipe. Before cutting it, confirm the tracing allowance as per Sections 3.3 and 3.6.
- ▶ Raychem heating cable can be cut to length without affecting the heat output per metre.

3.6 Typical installation details

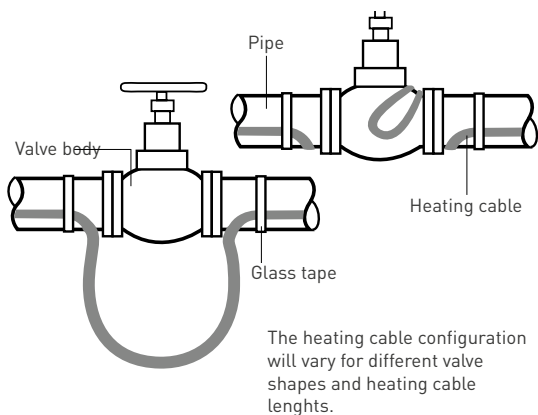
- ▶ Typical installation details for fixing heating cable to pipe fittings are shown hereafter.

General notes:

- ▶ Trace pipe fittings as shown to allow easy maintenance.
- ▶ Consult the design specification or Pentair Thermal Management product literature or TraceCalc software for the tracing requirements for fittings and supports.
- ▶ Follow the recommendations for cutting and stripping heating cables; they are included in the component installation instructions.

3.6.1 Valve

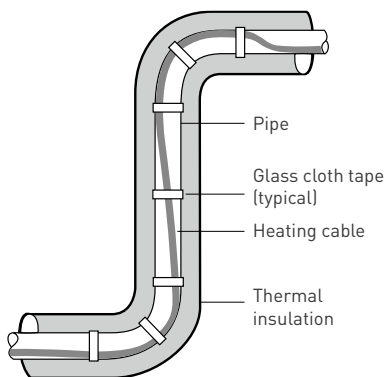
Figure 3



- Refer to design specification for additional heating cable length.
- Fix with self-adhesive glass cloth tape.
- Thermally insulate and weatherproof to specification (including valve stem).

3.6.2 Elbow

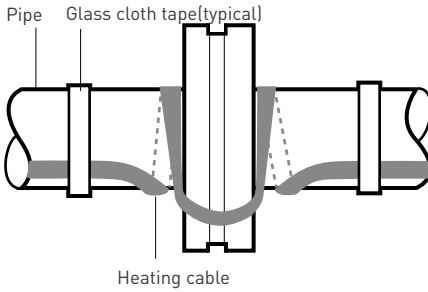
Figure 4



- Fix heating cable to outside (long) radius of elbow
- Fix with self-adhesive glass cloth tape
- Thermally insulate and weatherproof to specification

3.6.3 Flange

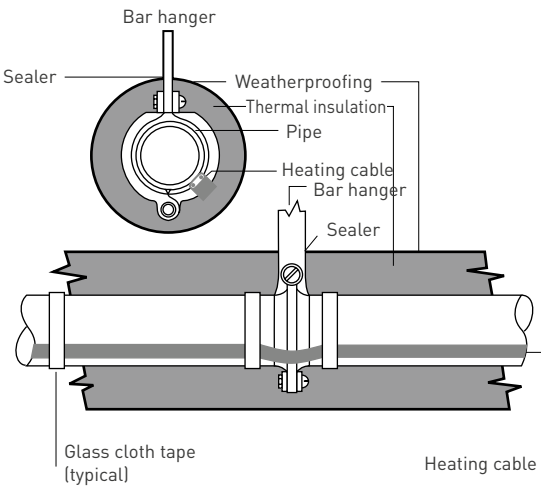
Figure 5



- Additional heating cable is 2-3 times diameter of pipe (typical)
- Fix with self-adhesive glass cloth pipe
- Thermally insulate and weatherproof to specification

3.6.4 Pipe bar hanger

Figure 6

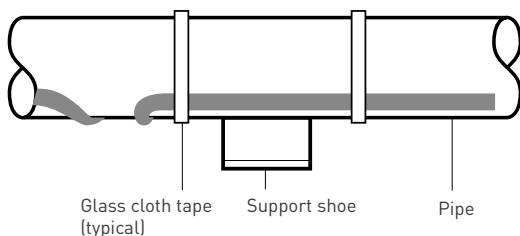


- ◻ **Do not** clamp heating cable with support. Heating cable must be over the support
- No additional heating cable is required for bar or rod pipe hangers unless called for in the design specification, then use loop length specified
- Fix with self-adhesive glass cloth tape
- Thermally insulate and weatherproof to specification

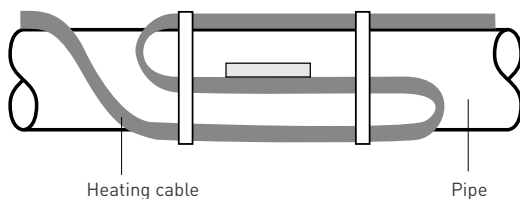
3.6.5 Pipe support shoe

Figure 7

Side view



View from under



- Refer to design specification for additional heating cable length
- Fix with self-adhesive glass cloth tape
- Thermally insulate and weatherproof to specification

4 COMPONENTS INSTALLATION

General notes:

Select the required components from Pentair Thermal Management product literature or use the TraceCalc software.

Raychem component kits (including power connections, splices and end seals) must be used to satisfy Standards and Approval Body requirements.

Installation instructions included in the kit must be followed, including those for preparation of the heating cable conductors for connections. Before assembly, use the guide given in the instructions to ensure that the kit is correct for the heating cable and environment.

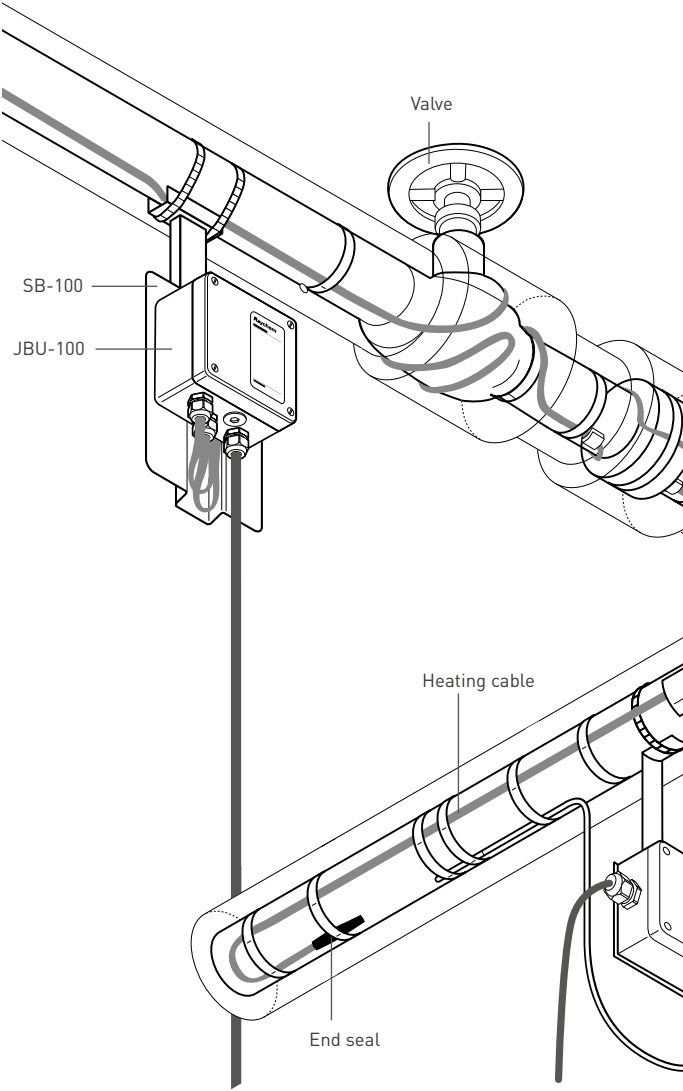
➤ Raychem self-regulating and power limiting heating cables are parallel circuit design. Do not twist the conductors together as this will result in a short circuit.

4.1 Components required

- For the installation of all components refer to the relevant component installation instructions.
- Required for each heating cable run:
Power connection and insulation entry kit
End seal.
- As required: Splice
Tee-splice: junction box, three connection kits and three insulation entry kits. Accessories (pipe straps, fixing tape, support brackets, labels, etc)

4.2 Typical systems

Figure 8a

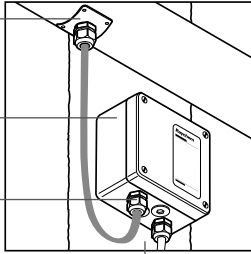


Wallmounted

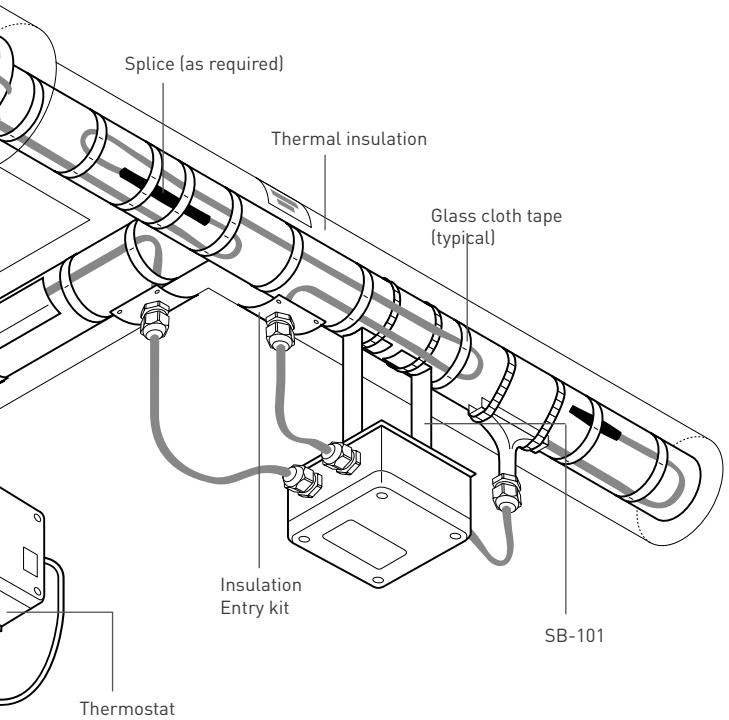
IEK-25-04
Insulation entry kit

JBU-100
Junction box for
modular system

C25-100
Connection kit



Heating cable



Splice (as required)

Thermal insulation

Glass cloth tape
(typical)

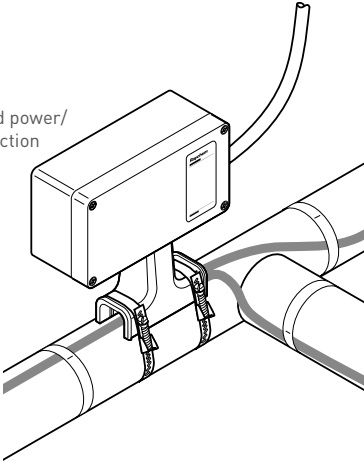
Insulation
Entry kit

SB-101

Thermostat

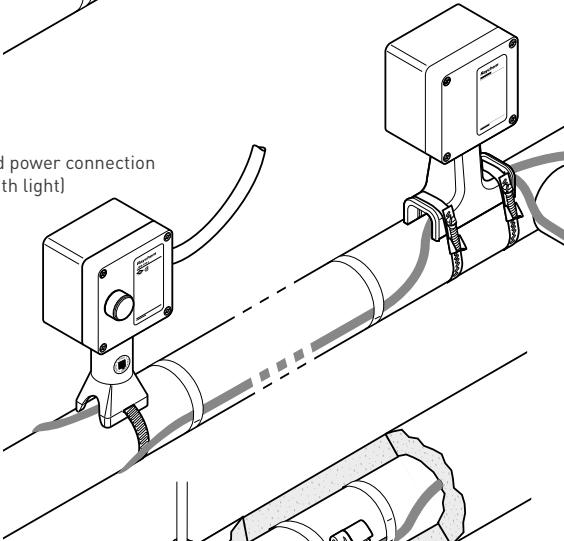
Figure 8b

JBM-100
Integrated power/
tee connection



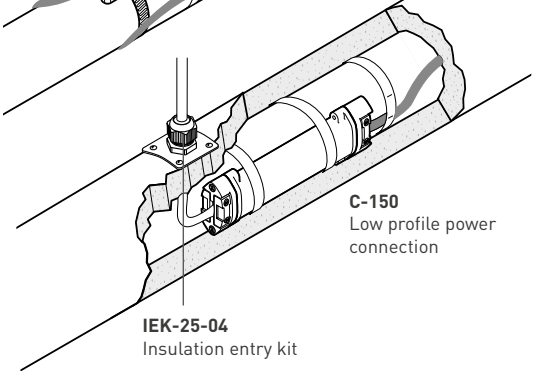
T-100
Tee or splice
connection

JBS-100
Integrated power connection
(shown with light)

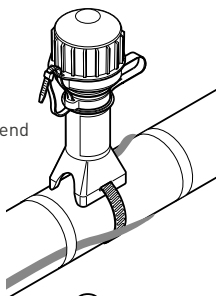


C-150
Low profile power
connection

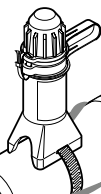
IEK-25-04
Insulation entry kit



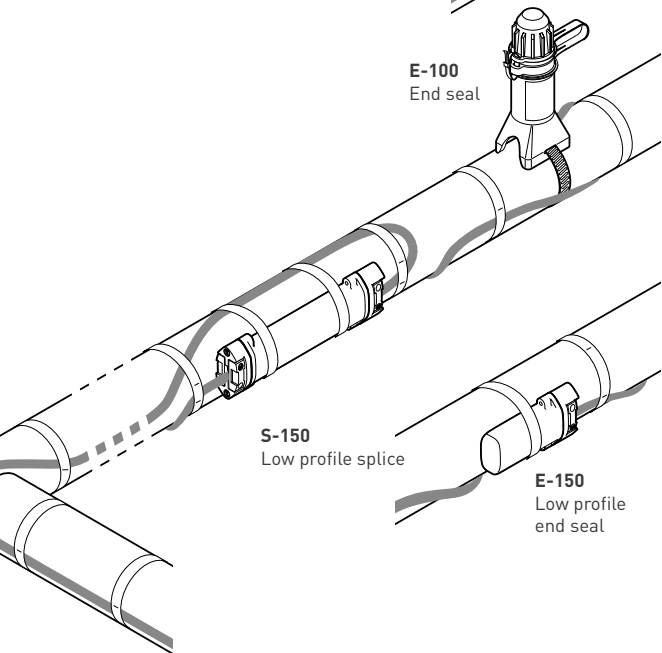
E-100-L
Lighted end
seal



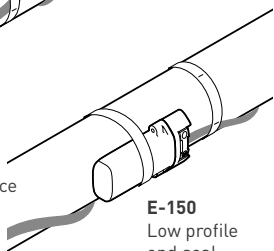
E-100
End seal



S-150
Low profile splice



E-150
Low profile
end seal



4.3 Component installation hints

- ▶ On horizontal pipes locate junction boxes below pipe wherever possible.
- ▶ Locate junction boxes for easy access but not exposed to mechanical abuse.
- ▶ Position junction boxes so that power cable and heating cable entries do not point upwards.
- ▶ Fix lids in place where access not required.
- ▶ Confirm junction box stopping plugs are correct for application and fixed firmly in place.
- ▶ Route heating cable from junction box to insulation entry so as to avoid possible mechanical damage.
- ◁ Do not strain heating cable as it exits/enters junction boxes and insulation entries.
- ▶ Ensure heating cable is fixed above pipe straps such as used for junction box support brackets.
- ▶ Fix all low profile components (e.g. heatshrink end seals) in place with self-adhesive glass cloth tape.

5 THERMOSTATS

- ▶ In temperature-sensitive applications, thermostatic control may be necessary. If maximum temperature is a concern, consult your Pentair Thermal Management representative for design assistance.
- ▶ Follow the installation instructions supplied with the thermostat. Use the proper wiring diagram for the heating cable layout and control method desired.

6 THERMAL INSULATION AND MARKING

6.1 Pre-insulation checks

- Visually inspect the heating cable and components for correct installation and damage. (See Section 10 if damaged.)
- Insulation resistance (Megger) testing (as per Section 8) is recommended prior to covering the pipe with thermal insulation.

6.2 Insulation installation hints

- Correct temperature maintenance requires properly installed and dry thermal insulation.
- Thermally insulate and weatherproof to design specification.
- Check insulation type and thickness against the design specification.
- To minimize potential heating cable damage, insulate as soon as possible after tracing.
- Check that all pipework, including fittings, wall penetrations and other areas, have been completely insulated.
- Ensure that heating cable is not damaged during installation of cladding for example by drills, self tapping screws and sharp edges of cladding.
- Check that all insulation entry kits are fitted correctly and sealed.
- Ensure that all places where valve stems, support brackets, thermostat capillaries, etc exit the cladding are sealed.

6.3 Marking

- For power limiting heating cable install label: LAB-I-35 as shown (typical) in figures 9a & 9b

Figure 9a

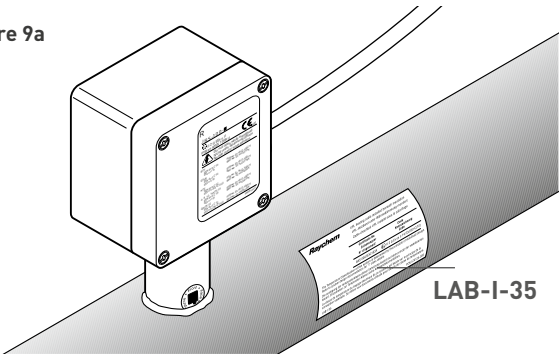
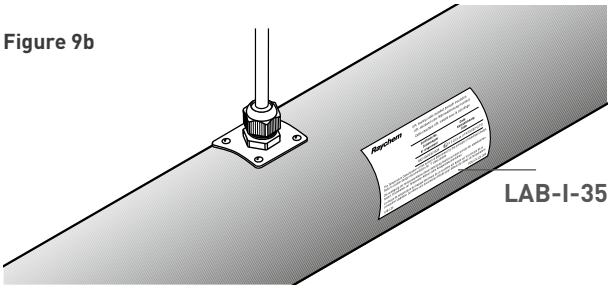


Figure 9b



- Install "Electric Traced" signs along piping at suitable intervals (3 m intervals recommended) on alternate sides as a warning.
- Mark on outside of insulation the location of heating cable components.

7 POWER SUPPLY AND ELECTRICAL PROTECTION

7.1 Electrical loading

Size overcurrent protective devices according to the design specification or applicable Pentair Thermal Management product literature. If devices other than those specifically identified are used, consult the Pentair Thermal Management representative for the appropriate sizing information.

7.2 Residual current (earth fault) protection

Pentair Thermal Management insists on the use of a 30 mA residual current device to provide maximum safety and protection. However, where there is a marked increase in nuisance tripping, a maximum 300 mA residual current device may be used. For heating cables installed in a hazardous area, the use of residual current devices is normally a condition of their approval.

HEATING CABLE TESTING

8.1 Recommendations

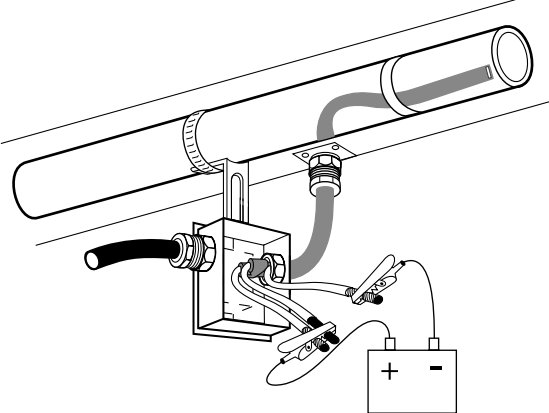
Pentair Thermal Management recommends insulation resistance test before installing heating cable; before installing thermal insulation; prior to initial start-up; and as part of the periodic maintenance. (see Section 9.2).

8.2 Test method

After completing heating cable installation, the insulation resistance between the conductors and the braid should be checked (see Figure 10) using a 2.500 VDC megger. Minimum readings should be 10 Megohms regardless of the heating cable length. The installer should record the original values for each circuit on the installation record sheet (see page 26).

Figure 10

Test between heating cable and braid



9 OPERATION, MAINTENANCE AND PIPE REPAIRS

9.1 Heating cable operation

- ◻ **Temperature exposure must not exceed that specified in Pentair Thermal Management product literature. Exceeding those limitations will shorten the service life and may permanently damage the heating cable.**
- ▶ Pipe insulation must be complete and dry to maintain the correct temperature.

9.2 Inspection and maintenance

- ▶ Visual inspection: Exposed heating cable and pipe insulation should be checked periodically to make sure that no physical damage has occurred.
- ▶ Meggering: The system should be meggered regularly. When meggering the insulation resistance from the main supply panel, it is recommended that the test is performed between L/N (together) and PE. Freeze protection systems should be meggered before the winter months each year (see section 8). Temperature maintenance systems should be tested at least twice a year. Function testing of electrical protection and temperature control systems should be carried out at regular intervals.
- ▶ The Periodic Inspection Record on the following pages should be filled out during maintenance of each circuit in your system.

9.3 Piping systems repair and maintenance

- ▶ Isolate heating cable circuit.
- ▶ Protect the heating cable from mechanical or thermal damage during pipe repair work.
- ▶ Check heating cable installation after pipe repairs and restore thermal insulation following the recommendations in Section 6. Check correct functioning of electrical protection systems.

10 HEATING CABLE DAMAGE

- ▶ Do not repair damaged heating cable.
Remove entire damaged section and splice in a new length using the appropriate Raychem splice kits.
- ▶ Replace damaged heating cable at once.
Damage allowing moisture and contamination to enter the heating cable may result in arcing earth faults and potential fire hazards.
- ▶ Heating cable exposed to fire or flame may cause further fire damage if powered.
Remove from service at once and replace before re-use.

11 TROUBLESHOOTING GUIDE

- ▶ Refer to the Troubleshooting guide on pages 28-31.
If the problem persists after following the guide procedures, contact your Pentair Thermal Management representative immediately.

INSTALLATION RECORD SHEET

CIRCUIT NO.

INSTALLATION RECORDS FOR:																				
Circuit breaker number																				
Drawing reference number																				
Megger test on pipe before insulating (bypass thermostat if applicable)	Reading																			
	Initial																			
	Date																			
Megger test after insulating (bypass thermostat if applicable)	Reading																			
	Initial																			
	Date																			
Circuit voltage	Panel																			
	Connection terminals																			
Insulation complete and sealed	Initial																			
	Date																			
Locations of low profile components are marked on the cladding	Initial																			
	Date																			

REMARKS & COMMENTS:

Troubleshooting guide

A Symptom: Overcurrent protection trips or blows **Probable Causes**

- 1 Electrical fault at
 - a damaged heating cable
 - b faulty splices or tees
 - c end seal
 - d connection

- 2 Circuit oversized

- 3 Start-up below design temperature

- 4 Defective electrical protection

B Symptom: RCD trips **Probable Causes**

- 1 Earth fault at:
 - a damaged heating cable
 - b faulty splices or tees
 - c end seal
 - d connection

- 2 Excessive moisture in:
 - a junction boxes
 - b splices and tees
 - c end seals

- 3 High leakage currents due to a combination of excessive lengths of power cable and heating cable.

- 4 Mains borne disturbances

- 5 Defective RCD

Corrective Actions

- 1 Investigate and remedy (see note 1):
 - 2 Resize or redesign within Technical Databook Guidelines. (If larger protection is required, ensure supply cables are compatible).
 - 3
 - a redesign for lower start-up temperatures
 - b preheat pipe from alternative heat source to within exposure temperatures given in Product Data Sheets
 - c Energize part of circuit followed by remainder (e.g. in sequence)
 - 4 Replace
-

Corrective Actions

- 1 Investigate and remedy (see note 1):
 - 2 Dry out and reseal or remake immediately. Perform insulation resistance test. (10 M Ω minimum)
 - 3 Redesign
 - 4 Redesign distribution, guidance is available from Pentair Thermal Management
 - 5 Replace
-

**C Symptom: No power output.
Probable Causes**

- 1 Loss of supply voltage due to:
 - a overcurrent or residual current protection operating
 - b loose terminals in junction box
 - c loss of supply cable continuity (e.g., open circuited from damage)

 - 2 Control thermostat is connected in the normally open position

 - 3 High resistance connection at:
 - a junction box terminals
 - b splices and tees
-

**D Symptom: Low pipe temperature.
Probable Causes**

- 1 Wet thermal insulation

 - 2 Design error

 - 3 Incorrect setting or operation of controls e.g., thermostats.

 - 4 Heating cable has been exposed to excessive temperature beyond rating.
-

Note:

Locate faults by the following steps:

- 1 Visually inspect the power connections, splices and end seals for correct installation.
- 2 Look for signs of damage at:
 - a) Valves, pumps, flanges and supports.
 - b) Areas where repairs or maintenance work has been carried out.
- 3 Look for crushed or damaged insulation and cladding along the pipe.

Corrective Actions

- 1 Restore supply voltage
 - a following **A** and **B** (page 31)
 - b re-tighten terminals
NB: If excessive heating has occurred due to high resistance, replace terminals or crimps
 - c locate damage and repair
-

- 2 Reconnect to normally closed position
-

- 3 Locate and remedy by:
 - a re-tighten
 - b repair
NB: If excessive heating has occurred due to high resistance, replace terminals or crimps
-

Corrective Actions

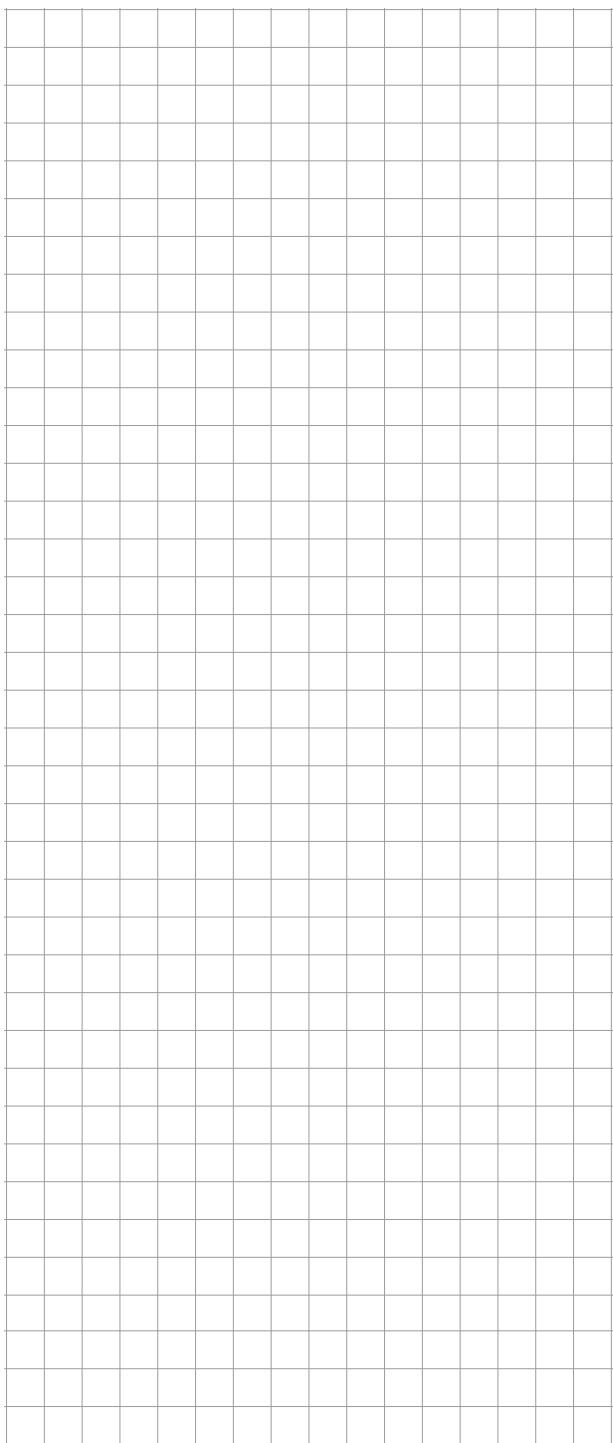
- 1 Remove and replace with dry insulation of correct specification and ensure complete weatherproofing
-

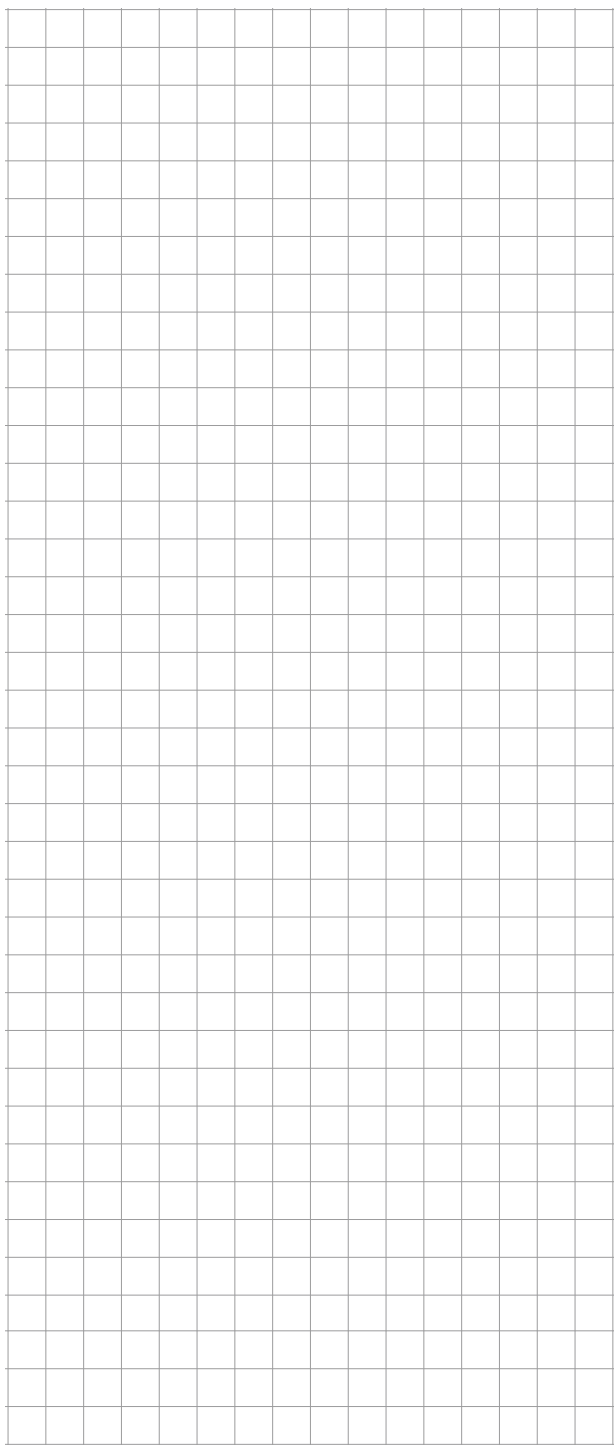
- 2
 - a check with competent authority for design conditions
 - b modify to meet Pentair Thermal Management recommendations
-

- 3 Repair or reset to correct level of operation
-

- 4 Replace
-

- 4 If after 1, 2 and 3 above the fault has not been located, then either:
 - a) Consult Pentair Thermal Management for further assistance.
 - b) Where local practices and conditions allow (e.g., non hazardous areas) isolate one section of heating cable from another by cutting in half and testing (e.g., Insulation Resistance) both halves until general area of damage is found. Remove insulation and expose fault.





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