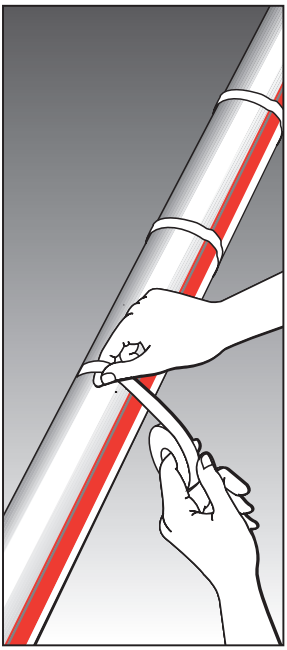
Raychem

Installation and Maintenance Manual



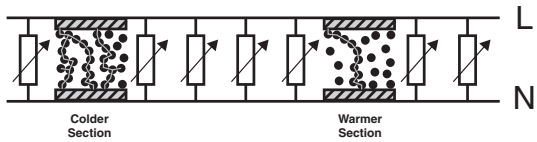
Self-Regulating and Power Limiting Heating Cable Systems

1 General information

Use of the manual

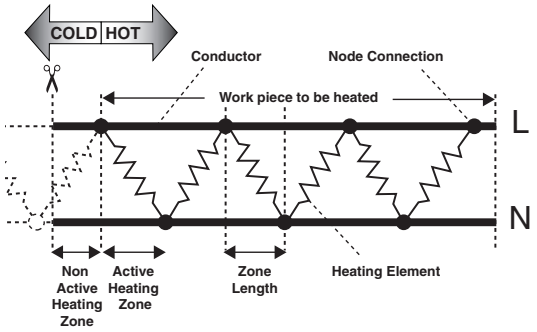
The Installation and Maintenance manual is for Raychem self-regulating and power limiting heating cable systems on thermally insulated pipes and vessels only.
For information regarding other applications contact your Tyco Thermal Controls representative.

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 Raychem 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	**Coding**
BTV: BAS98ATEX2338X	Ⓔx II 2 G EEx e II T6
QTVR: BAS98ATEX2337X	Ⓔx II 2 G EEx e II T6
KTV: BAS98ATEX2335X	Ⓔx II 2 G EEx e II 226°C(T2)
XTV: BAS98ATEX2336X	Ⓔx II 2 G EEx e II T3 and 240°C(T2)
VPL: BAS00ATEX2163X	Ⓔx II 2 G Ex es II T* *By design
PTB	
Certificate No	**Code**
BTV: PTB 98 ATEX 1102 X	Ⓔx II 2 G EEx e(m) II T6
QTVR: PTB 98 ATEX 1103 X	Ⓔx II 2 G EEx e(m) II T4
KTV: PTB 98 ATEX 1104 X	Ⓔx II 2 G EEx e(m) II T4/T3/226°C(T2)
XTV: PTB 98 ATEX 1105 X	Ⓔx II 2 G EEx e(m) II T4/T3/250°C(T2)

Rated Voltage

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

	BTV	QTVR	XTV-T3	XTV-T2	KTV	VPL
Minimum Bending Radius at Minimum Installation Temperature	35 mm	35 mm	50.8 mm	50.8 mm	50.8 mm	19 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)	–	–	–	–	–	250°C
Self-limiting Temperature in accordance with EN50 019, F.1.2	T6	T4	T3	T2	T2	–
Power Limiting Temperature (*By design)	–	–	–	–	–	T*

VPL 1 & VPL 2 Specifications

Cable	110V	Cable	230V	254V
5VPL1-CT	235°C	5VPL2-CT	230°C	225°C
10VPL1-CT	215°C	10VPL2-CT	210°C	200°C
15VPL1-CT	190°C	15VPL2-CT	180°C	145°C
20VPL1-CT	150°C	20VPL2-CT	150°C	Not allowed

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 Raychem 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 Raychem product literature, design guides 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 Raychem 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:

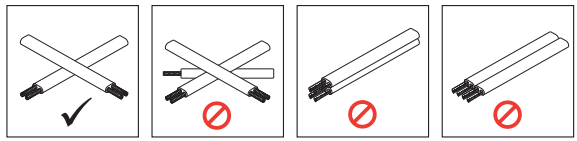
- Use a reel holder that pays out smoothly with little tension.
- Keep heating cable strung loosely but close to the pipe being traced to avoid interference with supports and equipment.

- 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 Raychem 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, Raychem 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:



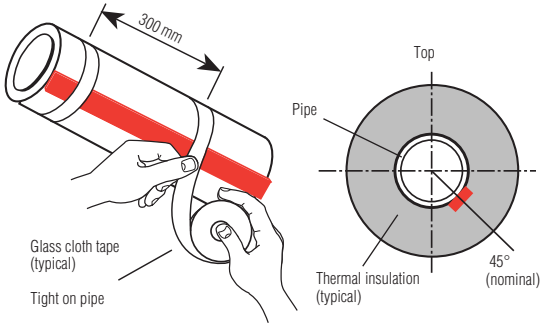
- Fix in place with a minimum of two wraps the appropriate self-adhesive glass cloth tape (see figure 1) or plastic cable ties at 300 mm intervals and additionally where necessary.
- Plastic cable ties must have a temperature rating that matches the system exposure temperature.
- The heating cable's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

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

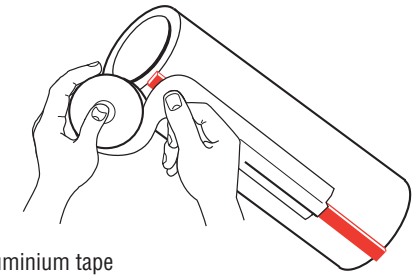


Raychem attachment tapes:

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.

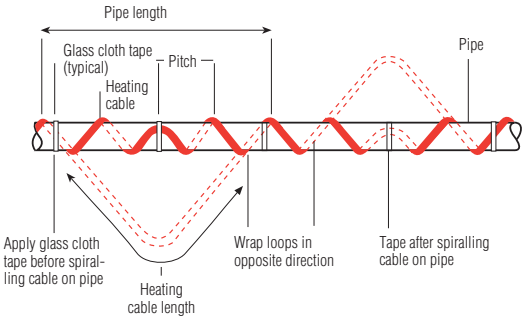
  Ensure that the active heating zones are located where heat is required i.e. on the pipe.

Spiral Pich Table (mm).

NB	NPS	**Spiral Ratio** - Metres of cable per metre of pipe				
(mm)	(inches)	**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



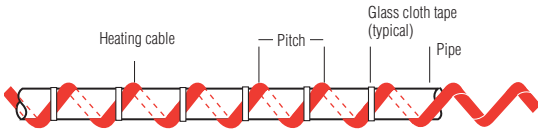
Heating cable length = pipe length x spiral ratio
Refer to design specification for spiral ratio

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

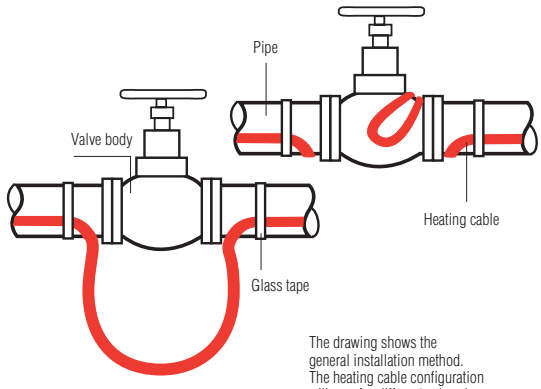
- Typical installation details for fixing heating cable to pipe fittings are shown hereafter.

General notes:

- Trace pipe fittings as shown to allow easy maintenance.
- Consult the design specification or Raychem 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

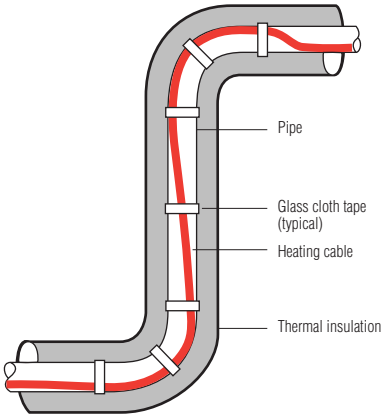
Figure 3



- 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

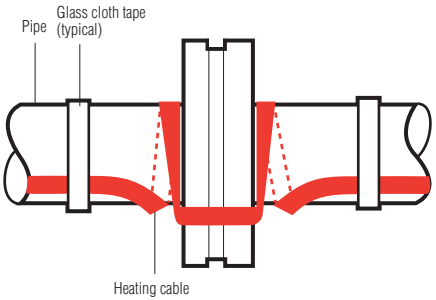
Figure 4



- 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

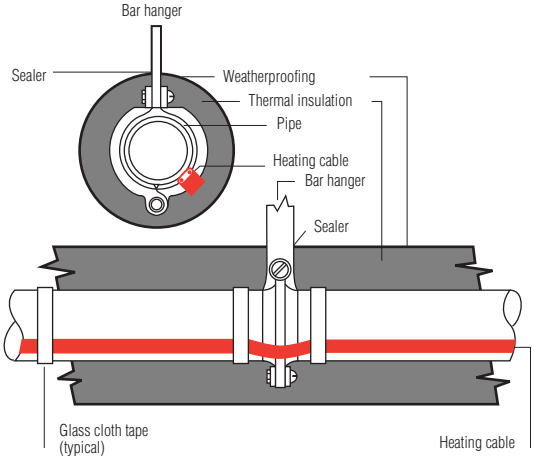
Figure 5



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

3.6.4 Pipe bar hanger

Figure 6

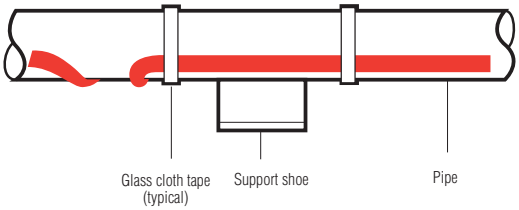


- **Do not** clamp heating cable with support. Heating cable must be over the support
- No additional heating cable is required for bar or rod pipe hangers unless called for in the design specification, then use loop length specified
- Fix with self-adhesive glass cloth tape
- Thermally insulate and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

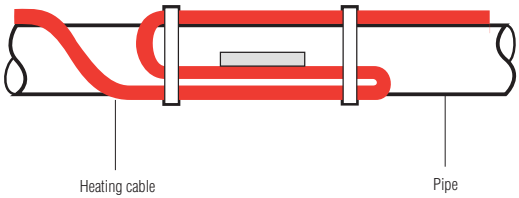
3.6.5 Pipe support shoe

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:

Use the Design Specification or the Component Selection Guide to select required components.

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

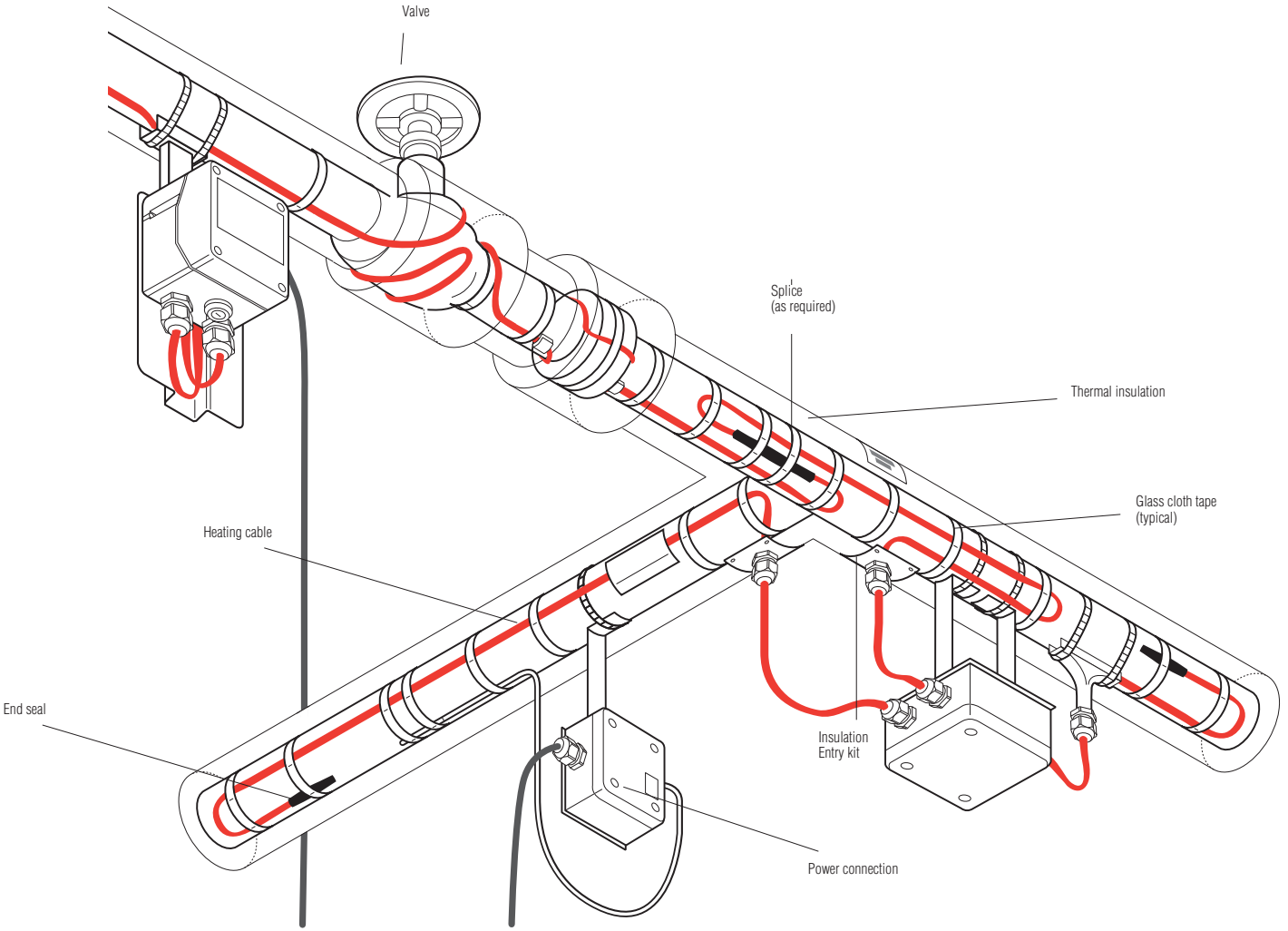
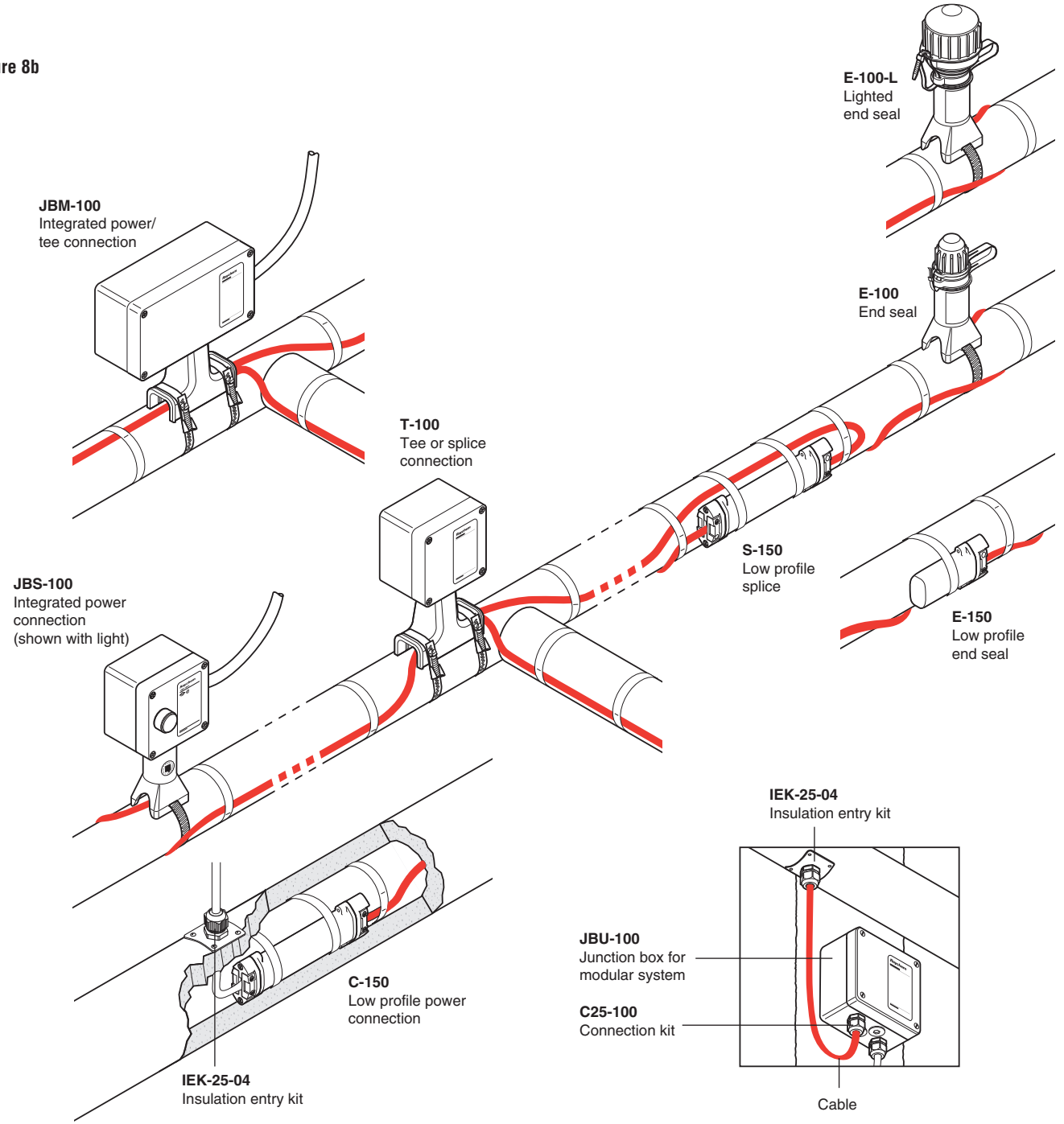


Figure 8b


E-100-L
Lighted
end seal
JBM-100
Integrated power/
tee connection
E-100
End seal
T-100
Tee or splice
connection
S-150
Low profile
splice
JBS-100
Integrated power
connection
(shown with light)
E-150
Low profile
end seal
IEK-25-04
Insulation entry kit
JBU-100
Junction box for
modular system
C25-100
Connection kit
C-150
Low profile power
connection
IEK-25-04
Insulation entry kit
Cable

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 Raychem 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, has 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

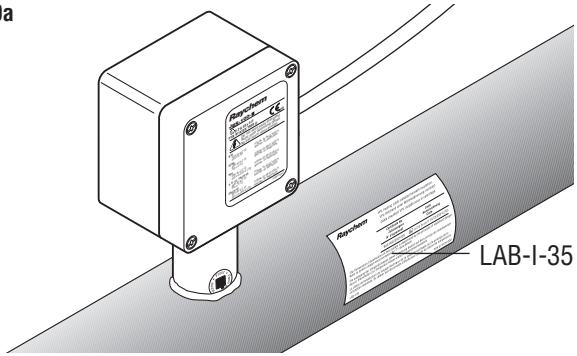
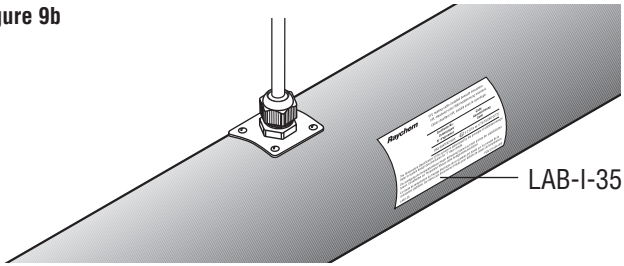


Figure 9b



- 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 Raychem product literature (see Raychem design guide). If devices other than those specifically identified are used, consult the Tyco Thermal Controls representative for the appropriate sizing information.

7.2 Residual current (earth fault) protection

Raychem 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.

8 Heating cable testing

8.1 Recommendations

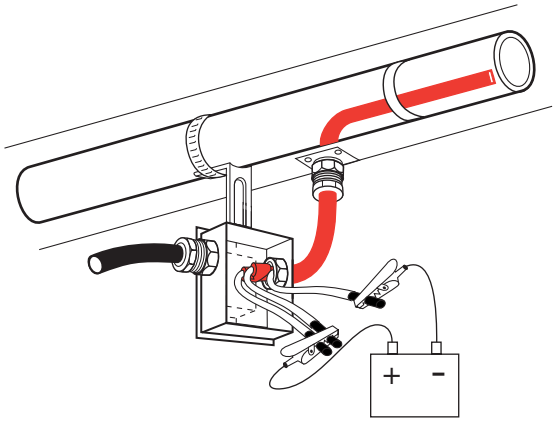
Raychem recommends insulation resistance test
before installing heating cable;
before installing thermal insulation;
prior to initial start-up; and
as part of the periodic maintenance. (see Section 9.2).

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 Raychem 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 occured.
- 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 30-33.
If the problem persists after following the guide procedures, contact your Raychem 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 completed and sealed	Initial								
	Date								
Locations of low profile components are marked on the cladding.	Initial								
	Date								

REMARKS & COMMENTS:

INSPECTION AND MAINTENANCE RECORD SHEET

		CIRCUIT NO.							
MAINTENANCE CHECKS FOR:					MONTH			YR.	
No signs of overheating, moisture, or corrosion, etc.	Initial								
	Date								
In connection systems	Initial								
Heating cable and cable glands tight Connection terminals tight Earth connection tight Insulation in good condition	Date								
Thermostats set properly and capillaries are protected	Initial								
	Date								
Megger test (bypass thermostat if applicable)	Reading								
	Initial								
	Date								
Circuit voltage	Panel								
	Connection terminals								
All boxes and thermostats have been firmly closed	Initial								
	Date								
Locations of under insulation components are marked on the insulation lagging	Initial								
	Date								

REMARKS & COMMENTS

Troubleshooting guide

A **Symptom:** Overcurrent protection trips or blows.

	Probable Causes		Corrective Actions
1	Electrical fault at: **a** damaged heating cable **b** faulty splices or tees **c** end seal **d** connection	**1**	Investigate and remedy (see note 1):
2	Circuit oversized	**2**	Resize or redesign within Electrical Protection Bulletin Guidelines. (If larger protection is required, ensure supply cables are compatible).
3	Start-up below design temperature	**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	Defective electrical protection	**4**	Replace.

B **Symptom:** RCD trips.

	Probable Causes		Corrective Actions
1	Earth fault at: **a** damaged heating cable **b** faulty splices or tees **c** end seal **d** connection	**1**	Investigate and remedy (see note 1):
2	Excessive moisture in: **a** junction boxes **b** splices and tees **c** end seals	**2**	Dry out and reseal or remake immediately. Perform insulation resistance test. (10 M Ω minimum)
3	High leakage currents due to a combination of excessive lengths of power cable and heating cable.	**3**	Redesign
4	Mains borne disturbances	**4**	Redesign distribution, guidance is available from Raychem.
5	Defective RCD	**5**	Replace.

C **Symptom:** No power output.

Probable Causes	Corrective Actions
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	**1** Restore supply voltage **a** following **A** and **B** (page 31) **b** re-tighten terminals NB: If excessive heating has occured due to high resistance, replace terminals or crimps **c** locate damage and repair
2 Control thermostat is connected in the normally open position	**2** Reconnect to normally closed position
3 High resistance connection at: **a** junction box terminals **b** splices and tees	**3** Locate and remedy by: **a** retighten **b** repair NB: If excessive heating has occured due to high resistance, replace terminals or crimps

D **Symptom:** Low pipe temperature.

Probable Causes	Corrective Actions
1 Wet thermal insulation	**1** Remove and replace with dry insulation of correct specification and ensure complete weatherproofing
2 Design error	**2** **a** check with competent authority for design conditions **b** modify to meet Raychem recommendations
3 Incorrect setting or operation of controls e.g., thermostats.	**3** Repair or reset to correct level of operation
4 Heating cable has been exposed to excessive temperature beyond rating.	**4** Replace

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.
4 If after 1, 2 and 3 above the fault has not been located, then either:
a) Consult Raychem for futher 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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