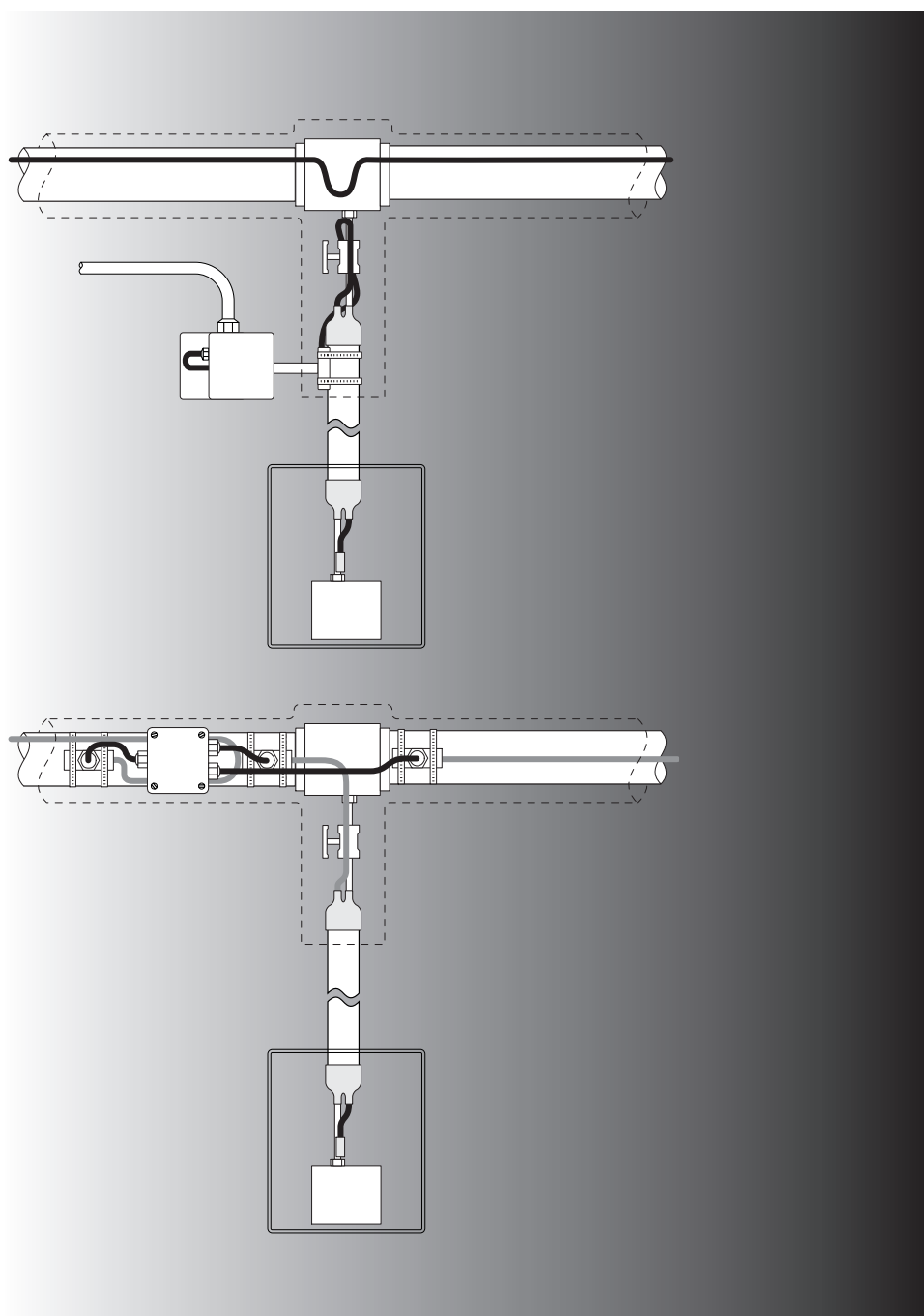


### Tubing Bundles

Heating solutions for instrument  
and small-diameter process lines



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## ***Safety Guidelines***

The safety and reliability of any heat-tracing system depends on both the quality of the products selected and the manner in which they are designed, installed, and maintained. Incorrect handling, installation, or maintenance of any of the system components can cause underheating or overheating of the pipe or damage to the heating cable system and may result in system failure, electric shock, or fire. The information, warnings, and instructions contained in this guide are important. Read and follow them carefully to minimise these risks and to insure that the system performs reliably.

Throughout the guide the following symbol:



identifies particularly important safety warnings that must be followed to ensure proper operation and reduce the risk of fire.

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### ***Important:***

For European systems, the following Raychem documents are required in order to complete the design and installation of Raychem Tubing Bundle systems:

- *Installation and Maintenance Manual (DOC-071)*
- *Components Selection Guide (DOC-050)*
- *Electrical Protection Bulletin (DOC-057)*
- *Thermal Design Guide (DOC-056)*

For North American systems, the following Raychem documents are required in order to complete the design and installation of Raychem Tubing Bundle systems:

- *Installation and Maintenance Guide (H54484)*
- *Design Guide for Insulated Pipes and Tubing (H51149)*

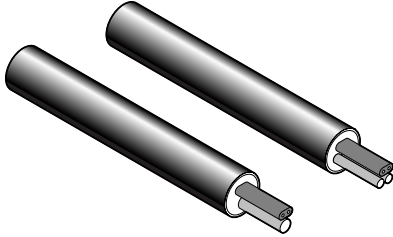
These documents are available from your Raychem representative.



# 1. Products

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## 1.1 Product line

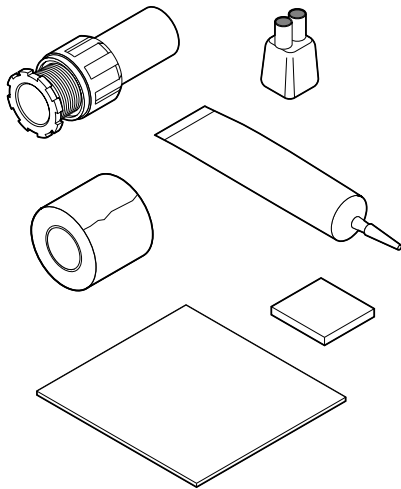


### Tubing bundles

Raychem tubing bundles are available in a wide range of tubing and heater options (see bundle ordering options on page 4).

### Trace-heating components

Raychem tubing bundles use the full range of standard XTV and BTV power connection and end seal kits.



### Bundle accessories

Raychem bundle accessories include heat-shrinkable boots for sealing bundle ends, heat-shrinkable cable entry seals, a jacket patch kit for sealing around thermostat sensor entries, and a high-temperature silicone sealant for sealing bundle ends.

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## 1.2 Approvals

Raychem BTV-CT and XTV-CT heating cables have agency approvals for use in both ordinary and hazardous plant locations. These agencies - including BASEEFA, CSA, FM, and PTB - issue approvals for the heating cable and components, and are based on testing and qualification of Raychem supplied components only. Substitution of components other than Raychem supplied components invalidates both the approval and the Raychem warranty. For specific approval information, contact your Raychem Representative.

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### 1.3 Bundle options

Raychem tubing bundles are offered in a variety of configurations, including the options shown below. For other configurations, including steam traced bundles, contact your Raychem representative.

#### RTB - X - XXX X - XXX - XXX

##### Heating cable

5B1	=	5BTV1-CT
5B2	=	5BTV2-CT
8B1	=	8BTV1-CT
8B2	=	8BTV2-CT
5X1	=	5XTV1-CT-T3
10X1	=	10XTV1-CT-T3
4X2	=	4XTV2-CT-T3
8X2	=	8XTV2-CT-T3
12X2	=	12XTV2-CT-T3
LTS	=	Low-temp. steam
HTS	=	High-temp. steam

##### Process tube wall thickness

035	=	.035 in
049	=	.049 in
10	=	1.0 mm
15	=	1.5 mm

##### Process tube material

S	=	Seamless 316 SS
W	=	Welded 316 SS
P	=	PFA
M	=	Monel
C	=	Copper

##### Process tubing size

6	=	6 mm
8	=	8 mm
10	=	10 mm
12	=	12 mm
1/4	=	1/4 in
3/8	=	3/8 in
1/2	=	1/2 in

##### Number of process tubes

1	=	Single tube
2	=	Dual tube

## 2. Product Selection

### 2.1 Select the heater type and temperature range

Table 1 shows the minimum and maximum temperatures that can be reached by the process tube over an ambient temperature range of -30°C to 38°C (-20°F to 100°F).

- In Table 1, find the column for the desired process tube size. Within the column, find the heater(s) that maintains a minimum temperature at or above the desired maintain temperature.
- If more than one heating cable will maintain the temperature, choose the one with the lowest maximum temperature. Make sure that:
  - The T-rating of the heating cable is adequate
  - Only XTV is used if the maximum system excursion temperature is above 85°C (185°F)
  - A thermostat will be used if the maximum temperature in the table is too high

**Table 1. Process tube temperature ranges for ambient range of -30°C to 38°C (-20°F to 100°F)**

Heating cable	Min.–max. tube temperature by tube size										
	6 mm			8 mm			10 mm		12 mm		
	(1/4 in)			(3/8 in)					(1/2 in)		
	°C	(°F)		°C	(°F)		°C	(°F)		°C	(°F)
Single tube											
5BTV(1 or 2)	19-52	(66-126)		18-52	(64-125)		16-51	(61-124)		15-51	(58-122)
8BTV(1 or 2)	32-58	(90-136)		31-57	(88-135)		29-57	(85-134)		28-56	(83-134)
5XTV1	31-92	(87-197)		28-89	(83-193)		26-87	(78-189)		23-86	(74-186)
10XTV1	63-109	(145-229)		59-107	(131-225)		56-105	(133-221)		53-103	(128-217)
4XTV2	18-78	(64-172)		16-76	(61-169)		14-74	(57-165)		12-73	(54-163)
8XTV2	43-90	(109-194)		40-88	(105-191)		38-86	(100-187)		36-85	(96-185)
12XTV2	60-99	(140-210)		57-97	(135-207)		54-96	(130-204)		52-94	(126-201)
Dual tube											
5BTV(1 or 2)	18-52	(64-125)		16-51	(61-124)		14-50	(58-122)		13-49	(56-121)
8BTV(1 or 2)	32-58	(89-136)		30-57	(86-135)		28-56	(82-133)		26-56	(79-132)
5XTV1	29-91	(85-195)		26-88	(78-190)		22-84	(71-184)		19-82	(66-180)
10XTV1	61-108	(142-227)		56-105	(134-221)		52-101	(125-214)		48-98	(119-209)
4XTV2	17-76	(62-169)		14-74	(57-165)		11-72	(51-161)		9-70	(48-158)
8XTV2	42-89	(107-192)		38-86	(101-188)		34-84	(94-183)		31-82	(89-180)
12XTV2	58-98	(137-208)		54-95	(130-204)		51-93	(123-199)		47-91	(117-195)

Maximum exposure temperatures: BTV = 85°C (185°F)  
 XTV = 215°C (420°F)

T-Ratings: BTV = T6  
 XTV = T3

Contact your Raychem representative for design assistance for the following applications:

- The desired maintain temperature range or process tube size does not appear in Table 1
- The ambient temperature range is different than  $-30^{\circ}\text{C}$  to  $38^{\circ}\text{C}$  ( $-20^{\circ}\text{F}$  to  $100^{\circ}\text{F}$ )
- Supply voltages other than 120Vac, 230Vac, or 240Vac are used
- Critical temperature applications
- Steam heating is required

## 2.2 Electrical sizing and run length

Tables 2 and 3 show the maximum bundle length that may be powered from different sized circuit breakers. Use Table 2 for European circuit breakers. Use Table 3 for North American circuit breakers. Note that ground-fault equipment protection (residual current device) is required on each heating cable branch circuit. To reduce the risk of fire caused by damage or improper installation, circuit breakers with a 30-mA trip level should be used. Alternative designs providing comparable levels of ground-fault protection may also be acceptable. Contact your Raychem representative for assistance if you need to size circuit breakers for use under different start-up conditions.

**Table 2. Maximum lengths using European circuit breakers<sup>1</sup>  
(meters at  $-10^{\circ}\text{C}$  start-up)**

Amps	5BTV2	8BTV2	4XTV2	8XTV2	12XTV2
6	50	30	55	35	25
10	80	50	90	60	45
13	105	65	120	75	55
16	130	80	145	95	70
20	160	100	185	115	85
25	165	120	230	145	105
32	—	—	250	180	135

<sup>1</sup> Type C: EN 60 898 circuit breakers

**Table 3. Maximum lengths using North American circuit breakers<sup>2</sup>  
(feet at  $0^{\circ}\text{F}$  start-up)**

Amps	5BTV1	8BTV1	5XTV1	10XTV1	5BTV2	8BTV2	4XTV2	8XTV2	12XTV2
15	140	100	160	95	280	200	360	220	150
20	185	130	215	130	375	265	480	295	200
30	270	200	325	195	540	400	720	440	300
40	270	210	380	265	540	420	765	540	400

<sup>2</sup> Square D type QOB-EPD, or Cuttler-Hammer (Westinghouse) type GFEP

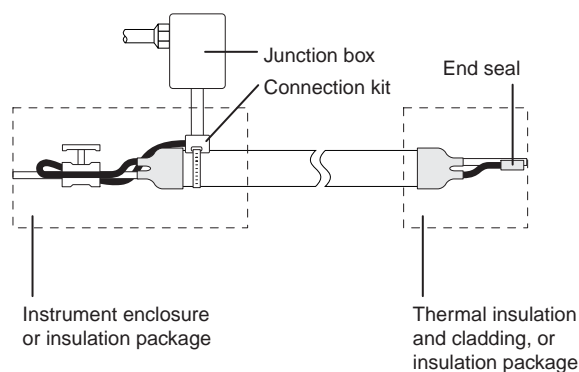


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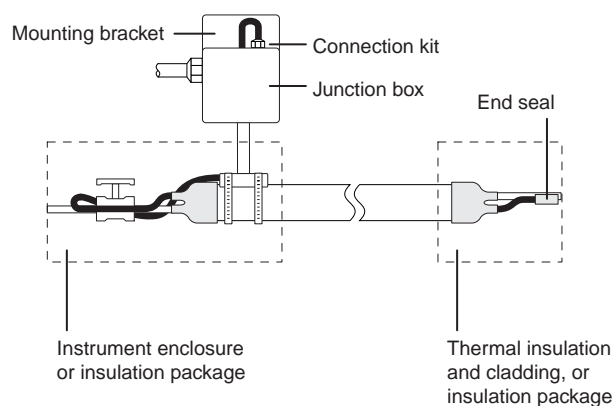
## 2.3 Select Components

The heating cable on Raychem Tubing bundles must be connected with XTV and BTV power connection and end seal kits. Typical North American and European component systems are shown below. Consult the appropriate guide for specific component selection information.

- Use Raychem Design Guide (H51149) for North American components selection
- Use Components Selection Guide (Doc-050) for European components selection

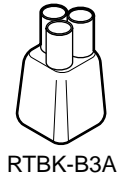
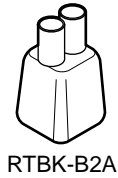


Typical North American power connection and end seal



Typical European power connection and end seal

## 2.4 Select bundle accessories

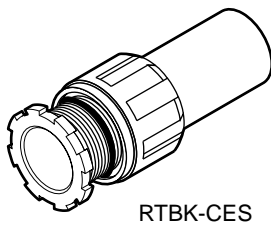


**Heat-shrinkable boots** (RTBK-B) are used for sealing bundle ends. The boots are designed to provide a weatherproof seal at the end of the tubing bundles. These boots may be used on all electric-traced bundles. For steam-traced bundles, use silicone sealant (TPK-SK-10).

Use RTBK-B2A for single tube bundles

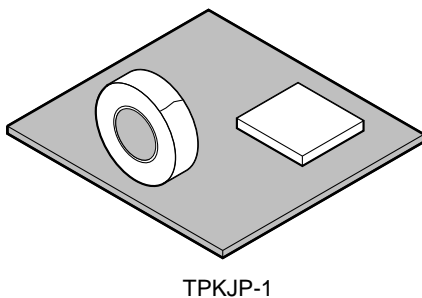
Use RTBK-B3A for dual tube bundles

**Important:** Although Raychem tubing bundles use a non-hygroscopic, thermal insulation, all bundle ends and jacket penetrations must be sealed to keep the insulation from getting wet.

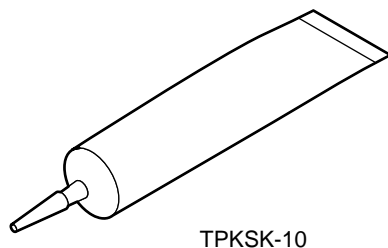


**Heat-shrinkable entry seals** (RTBK-CES) may be used to provide a water-proof fitting where the bundle enters an enclosure or penetrates a bulkhead. The thermally stabilized modified polyolefin entry seal includes an O-ring assembly that seals at the enclosure, and a heat-shrinkable nose that seals to the bundle.

Tubing size in mm (inches)	Single-tube bundle	Dual-tube bundle
6–10 mm (1/4–3/8")	RTBK-CES4	RTBK-CES4
12 mm (1/2")	RTBK-CES4	RTBK-CES5




**Jacket patch kits** (TPKJP-1) must be used for sealing around line-sensing thermostat entries. The kit contains thermal insulation, fiberglass tape to hold the insulation in place, and a black, self-sealing rubber patch for weatherproofing the bundle.



**Silicone sealant** (TPKSK-10) is a black silicone RTV sealant, used for sealing the ends of the tubing bundle from moisture. Cure time is approximately 24 hours at 25°C (77°F). The 280 gm (10 ounce) tube will seal approximately 10 bundle ends. Silicone sealant can be used for either electric- or steam-traced bundles.

## 3. Installation

---

 **WARNING:** Fire and shock hazard. Raychem tubing bundles must be installed correctly to ensure proper operation and to prevent shock and fire. Read these important warnings and carefully follow all the installation instructions.

- To minimise the danger of fire from sustained electrical arcing if the heating cable system is damaged or improperly installed, residual current devices (ground-fault equipment protection) must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit breakers.
- Use only approved connection kits and follow the installation instructions supplied with them. Do not use other kits or substitute parts. Do not use vinyl electrical tape.
- Damaged heating cable or components can cause electrical shock, arcing and fire. Do not attempt to repair or energise damaged cable. Remove damaged sections at once and replace.
- The black heating cable core and fibers are electrically conductive and can short. They must be properly insulated and kept dry.
- Damaged bus wires can overheat or short. Do not break bus wire strands when stripping the heating cable.

---

### 3.1 Description

Raychem tubing bundles are designed to be used as heated instrument lines or small-diameter process lines. The bundles are designed for single-use, fixed installation applications.

The minimum installation temperature for Raychem Tubing Bundles is  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ).

**Do not use Raychem tubing bundles in the following applications:**

- Applications that flex in normal use.
- Applications where the bundle is moved and re-used.

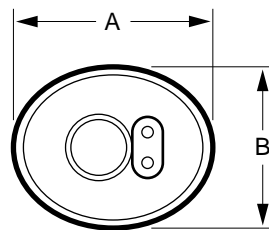
Electrically heated Raychem tubing bundles must be installed with standard BTV or XTV power connection and end seal kits.

All bundle ends must be temporarily sealed during installation. Tape a plastic bag in place to seal the end of the bundle.

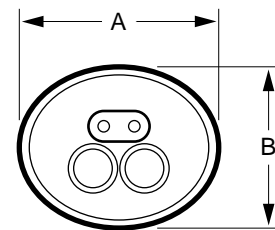
### 3.2 Weights and Dimensions

The following tables show nominal weights and outside dimensions for a variety of bundle configurations.

Electric bundle		Nominal wt kg/m (lb/ft)	Nominal dimensions mm (in)	
Type	Size		A	B
Single tube	6 mm (1/4)	.45 (0.3)	28 (1.1)	25 (1.0)
Single tube	8 mm (3/8)	.60 (0.4)	33 (1.3)	25 (1.0)
Single tube	10,12 mm (1/2)	.75 (0.5)	36 (1.4)	28 (1.1)
Dual tube	6 mm (1/4)	.60 (0.4)	33 (1.3)	28 (1.1)
Dual tube	8 mm (3/8)	.90 (0.6)	38 (1.5)	30 (1.2)
Dual tube	10,12 mm (1/2)	1.20 (0.8)	43 (1.7)	36 (1.4)



Electric single tube



Electric dual tube

---

### 3.3 Storage

When storing the bundle, take the following precautions:

- All bundle ends must be sealed at all times.
- Protect the bundle from the weather.
- Protect the bundle from mechanical damage.
- Store at temperatures between  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ) and  $60^{\circ}\text{C}$  ( $140^{\circ}\text{F}$ ).

---

### 3.4 Positioning and support

#### Positioning

Follow these six suggestions/steps to position the tubing bundle:

1. Position along existing structures, such as beams and columns, for support.
2. Avoid areas where the ambient temperature may exceed  $38^{\circ}\text{C}$  ( $100^{\circ}\text{F}$ ).
3. Maintain a 12 mm (1/2-in) clearance between bundles.
4. Allow 300–450 mm (12–18 in) of straight tubing bundle before connecting to fittings.
5. Add enough length to the bundle to connect to the heating cable power supply. (See Section 3.6). Include the length from the process connection location to the power junction box plus 150 mm (6") inside the junction box.

Minimum bending diameter: 400 mm (16 in)

Maximum support centers: Horizontal = 2 m (6 ft), Vertical = 4 m (12 ft)

#### Supports

Supports and hangers must have a large surface area (Fig A) and be designed so they cannot be overtightened and crush the tubing bundle. Do not use u-bolts as supports.

An angle iron may be used as a support (Fig. B). Place the bundle in an angle sized 12 mm (1/2 in) larger than the largest dimension of the bundle. Secure the bundle with metal or plastic straps. Do not use wire ties.

Cable trays may also be used as supports. Maintain a minimum of 12 mm (1/2 in) between bundles.

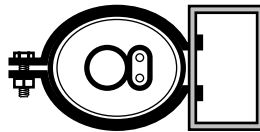


Fig. A

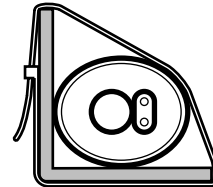


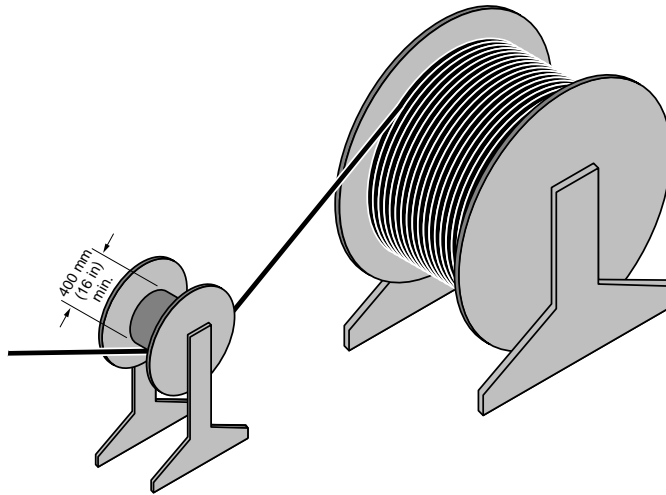
Fig. B

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### 3.5 Uncoiling and bending

Method 1: Roll the bundle off the shipping reel onto the floor or other flat surface. This will leave a slight bow that can be taken out by hand.

Method 2: Use a second smaller spool to straighten the product as it is taken off the larger shipping spool.



**Do not bend tighter than the minimum bending diameter of 400 mm (16 in).**

- The bundle jacket will wrinkle when the bundle is bent. This is a normal condition, and does not affect the performance or life of the bundle.
- When bending the bundle, use a mandrel with the minimum bending radius, such as a small spool or a pipe bender shoe.
- For dual-tube bundles, bend on the small dimension; the bundle will tend to twist and then bend on this dimension naturally.
- To bend on the larger dimension, grasp the bundle firmly and twist it 90 degrees. Then make the bend. This technique may also be used to position the tubing for process connections.

---

### 3.6 Trace-Heating Connections

Figures 1-4 show typical tubing bundle power connection and end seal installations. The tubing bundle heating cables are shown powered from a separate power feed, and from a tee connection.

Figure 1 - Power connection and end termination (Europe)

Figure 2 - Typical heating cable powered from a tee connection (Europe)

Figure 3 - Power connection and end termination (North America)

Figure 4 - Heating cable powered from a tee connection (North America)

#### Important Installation Notes:

- Use only approved BTV and XTV components for power connections and end terminations.
- Make sure that all pipes and tubes are thermally insulated.
- Do not power the tubing bundle heating cable from a tee connection if a line sensing thermostat is used on the main line - flow in the main line will shut down the tubing bundle heating cable.

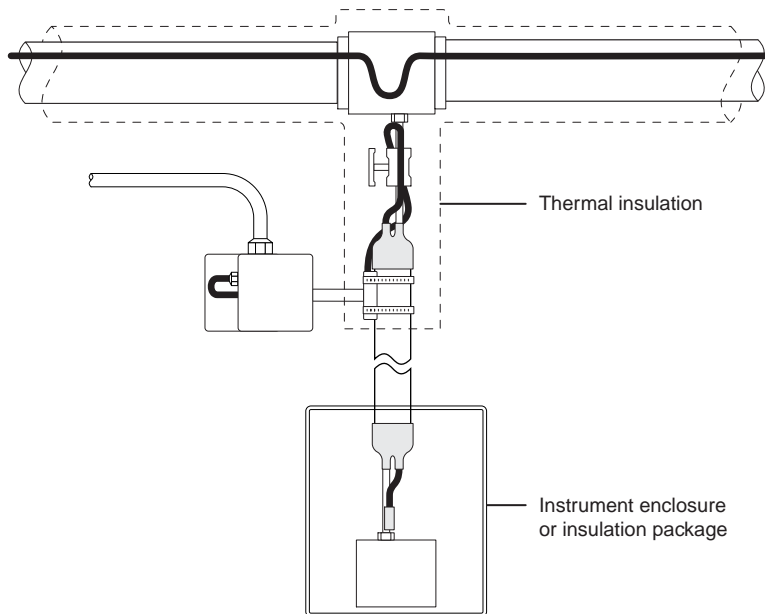


Figure 1 - Typical power connection and end termination (Europe)

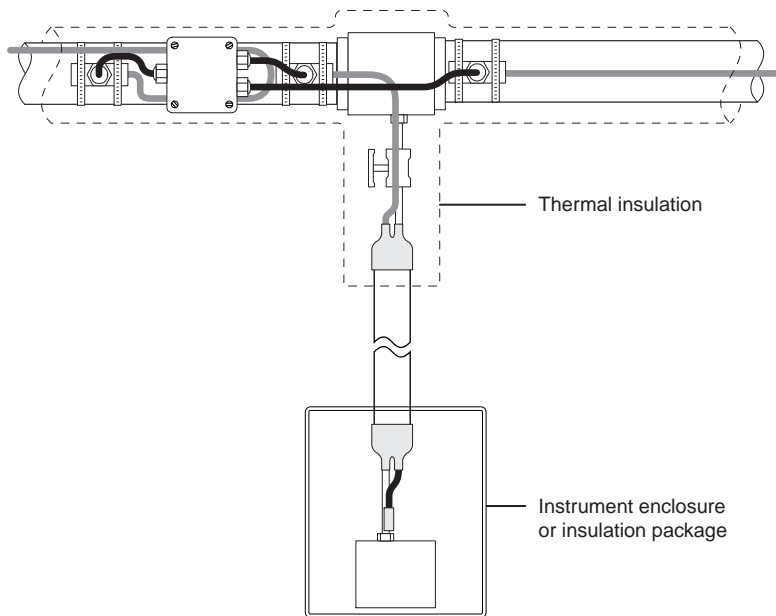


Figure 2 - Typical heating cable powered from a tee connection (Europe)

Note: Do not power the bundle heating cable from a tee connection if a line sensing thermostat is used on the main line.

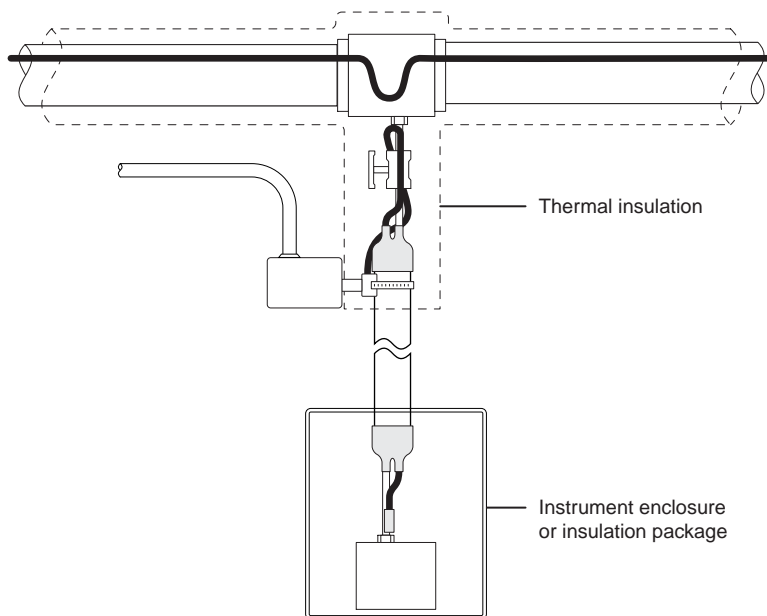


Figure 3 - Typical power connection and end termination (North America)



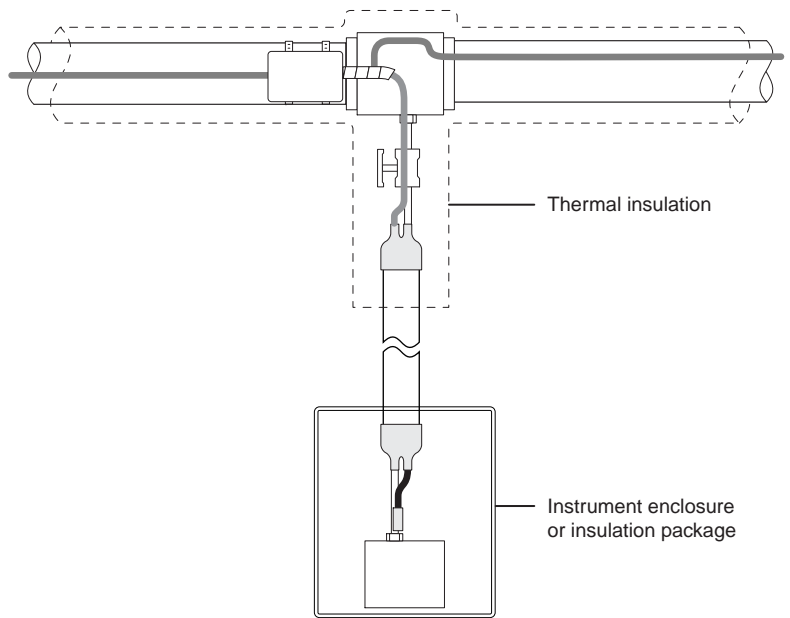


Figure 4 - Typical heating cable powered from a tee connection (North America)

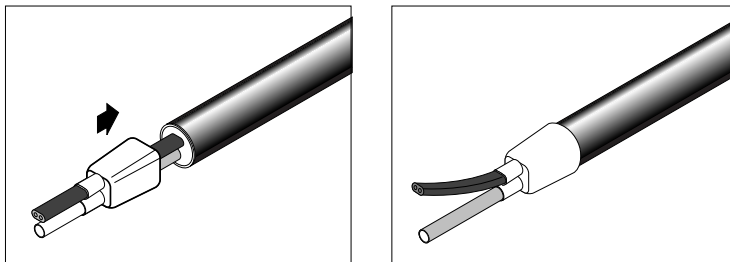
Note: Do not power the bundle heating cable from a tee connection if a line sensing thermostat is used on the main line.

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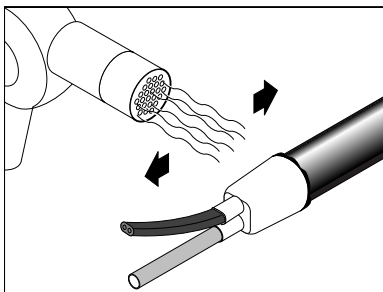
### 3.7 Bundle sealing

#### Heat-shrinkable boot installation

- Cut back the bundle, leaving the desired length of tubing and cable exposed.
- Use a tubing bender to bend the process tube(s) to the correct instrumentation centers before installing the boot. This will result in a more compact installation.
- Slip the boot over the end of the bundle with one tube or cable in each leg until the bundle seats at the bottom of the boot.

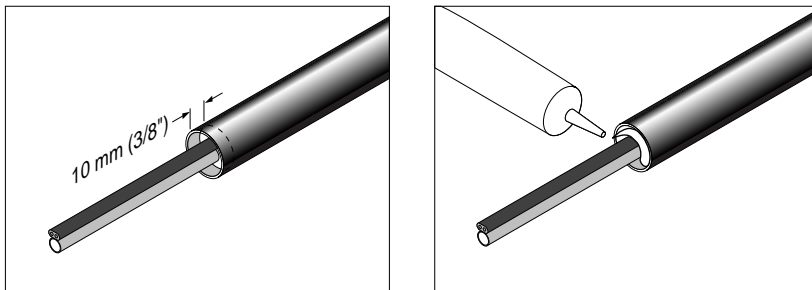


- Use a heat gun to shrink the boot over the bundle, tube(s) and heating cable. Applying heat evenly, move the heat source back and forth over the boot. Once the boot has assumed the shape of the bundle and tubes and an adhesive bead is visible, stop applying heat; further heating will not make the boot shrink more tightly.



#### RTV Sealant

- To seal the bundle with RTV sealant, cut the thermal insulation back under the jacket about 10 mm (3/8 in). It is important to cut the insulation out rather than push it back. Fill the end with sealant, making sure that all exposed insulation is protected.

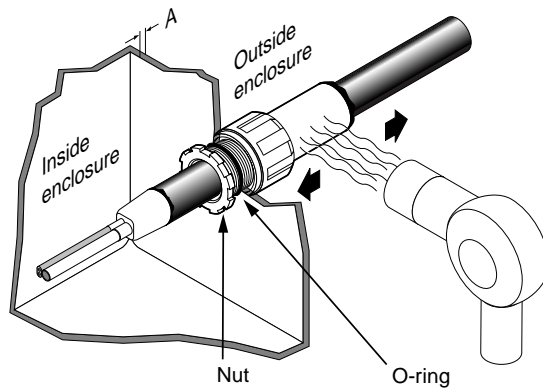


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### 3.8 Entry seals

- Place the rigid, externally threaded nut through the enclosure hole so that the flanged end is on the inside of the enclosure.
- Place the O-ring over the threaded end position against the outside of the enclosure.
- Using appropriate spanner wrenches, screw the shrinkable internally threaded nose on to the rigid nut and tighten.
- Shrink the expanded nose by applying heat with a heat gun. Applying the heat evenly, move the heat source back and forth over the nose. Once the boot has assumed the shape of the bundle and the tubes and an adhesive bead is visible, stop applying heat; further heating will not make the nose shrink more tightly.

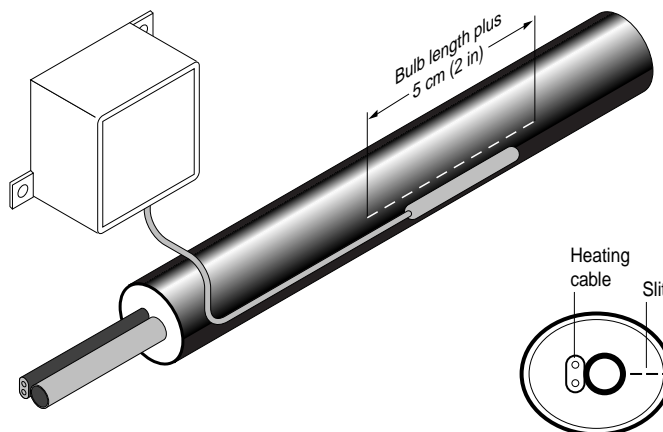
<b>Model number</b>	<b>Panel (A) maximum thickness</b>	<b>Nose I.D. Minimum expanded I.D.</b>	<b>Maximum recovered I.D.</b>	<b>Mounting hole diameter</b>
RTB-CES4	10 mm (0.38 in)	40 mm (1.60 in)	20 mm (0.75 in)	50 mm (2.00 in)
RTB-CES5	20 mm (0.75 in)	70 mm (2.75 in)	35 mm (1.43 in)	75 mm (3.00 in)



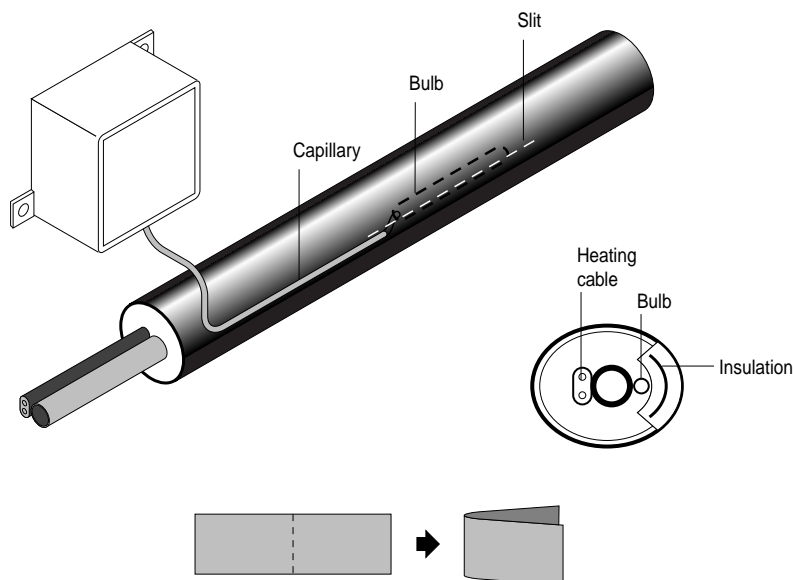
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### 3.9 Thermostat jacket patch

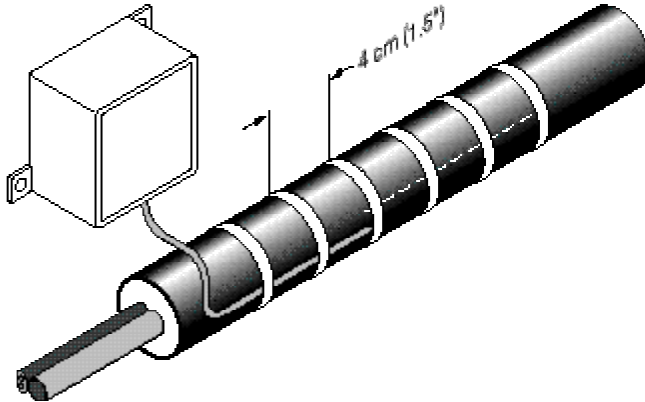
- Locate a suitable mounting location for the thermostat housing. Route the capillary along the bundle, away from heat sources other than the heating cable in the bundle.



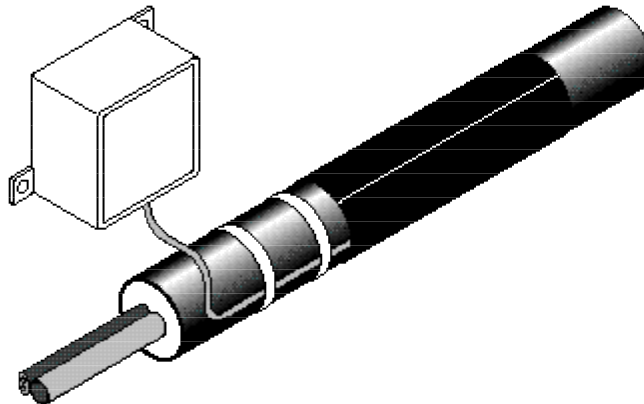
- Locate the heating cable in the bundle. The heating cable can usually be felt through the bundle and thermal insulation. Make a slit lengthwise along the bundle opposite the heating cable, where the capillary bulb will be placed. The slit should be about 50 mm (2 in) longer than the length of the bulb. The slit must go through the thermal insulation and Mylar film.
- Insert the bulb into the bundle in direct contact with the tube. Cut the 50-mm-wide (2-in-wide) thermal insulation into three pieces, each about 25 mm (1 in.) shorter than the length of the slit. For each piece, fold the tape along the cut length to make a double layer 25 mm (1 in) wide. Work each of the three pieces into the slit, positioning them on top of the capillary bulb, and under the outer jacket.



- Use the fiberglass tape to wrap the bundle at the slit area. Space the tape wrap every 40 mm (1.5 in). Secure the capillary to the bundle with the tape, for a distance of at least 50 mm (2 in) from the end of the slit. Apply a liberal bead of silicone sealant along each side of the capillary



- Use the black rubber patch supplied with the jacket patch kit to wrap the bundle at the slit. Cut the patch so that it extends 50 mm (2 in) past the slit in both directions. Remove the protective backing and wrap the patch around the slit area, overlapping the edge. Press into place.



- Use a heat gun to shrink the boot over the bundle tube and tracer. Applying heat evenly, move the heat source back and forth over the boot. Once the boot has assumed the shape of the bundle and tubes, stop applying heat; further heating will not make the boot shrink more tightly. Cut the tubing and cable to the length required for instrument and cable connections.

### **3.10 Bundle materials**

#### **Bundle jacket**

- Thermoplastic polyether urethane elastomer
- Halogen-free
- Abrasion resistant
- UV-resistant
- Low-temperature flexibility

#### **Thermal insulation**

- Fibrous glass
- Water-soluble chlorides less than 100 ppm
- Non-hygroscopic

#### **Tubing**

- Welded stainless steel tubing complies with ASTM A-269.
- Seamless stainless steel tubing complies with ASTM A-269 and A213-EAW.
- Metric tubing sizes provided with inspection certificate per EN10204.



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