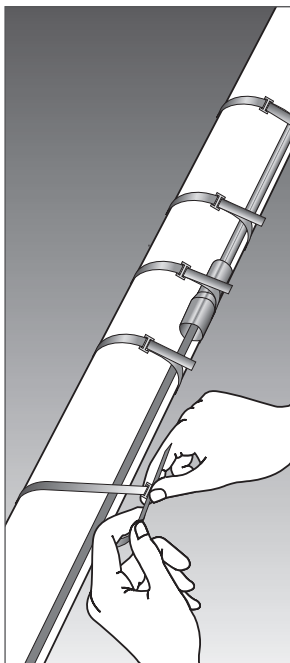


Raychem

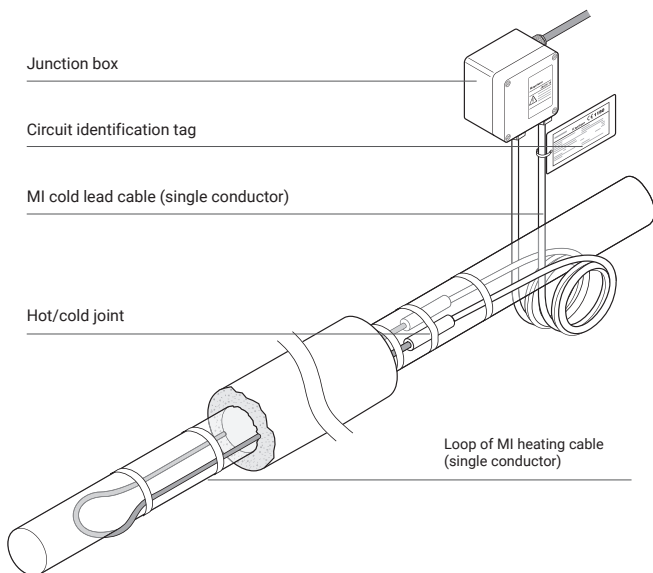
Mineral Insulated (MI) series heating systems

Installation, Maintenance and
Operation Manual

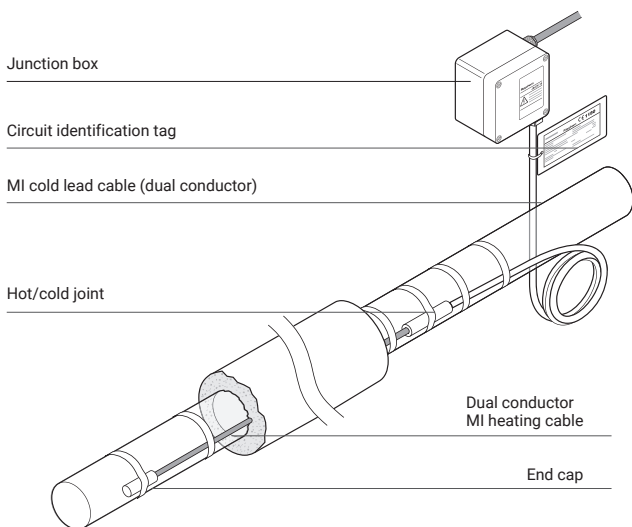


1.	General information	5
2.	Heating cable selection and storage	8
3.	Heating cable installation	10
4.	Components selection and installation	21
5.	Temperature control and limitation	22
6.	Thermal insulation and marking	23
7.	Power supply and electrical protection	26
8.	System testing and commissioning	26
9.	Documentation, operation, maintenance and repairs	27
10.	Trouble shooting	29
11.	Installation record sheet	30

Typical configuration for MI-heating cable system (single conductor)



Typical configuration for MI-heating cable system (dual conductor)



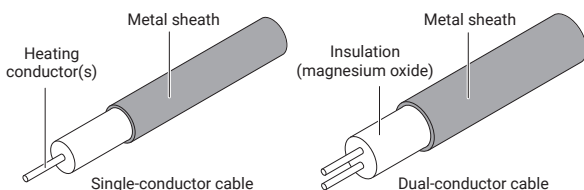
1. GENERAL INFORMATION

Use of the manual

This Installation and Maintenance manual applies to Raychem Mineral Insulated (MI) series resistance heating cable systems installed on thermally insulated pipes and vessels and associated equipment. In particular it refers to mineral insulated (MI) series heating systems, which feature a specific power output depending on various design parameters, in particular, cable length and voltage. This manual provides general information and shows an overview of the most common installations and applications on MI as well as typical examples. In any case the information provided for specific projects will take precedence over this manual. In case of conflicts, please contact your Chemelex representative.

Chemelex offers two different cable constructions for electrical heat-tracing purposes: single conductor cables, which are typically laid in loop configurations and dual conductor cables, which are typically laid in single runs.

Figure 1: Typical cable construction



Various types of the MI bulk heating cables are available:

HCC/HCH: Copper sheathed MI heating cables

HDF/HDC: Cupro-nickel sheathed MI heating cables

HSQ: Stainless steel sheathed MI heating cables

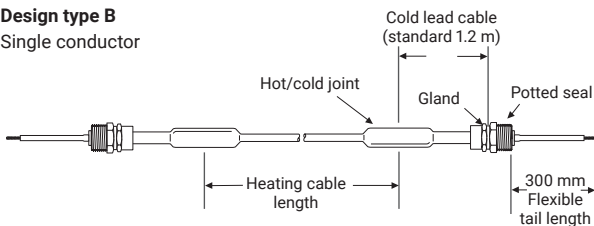
HAX: Alloy 825 sheathed MI heating cables

HIQ: Inconel sheathed MI heating cables

Figure 2: Typical heating unit designs

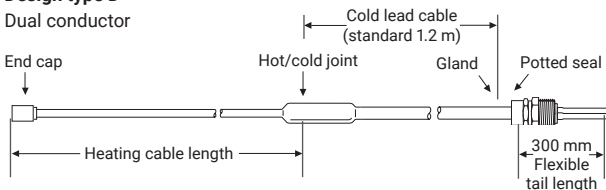
Design type B

Single conductor



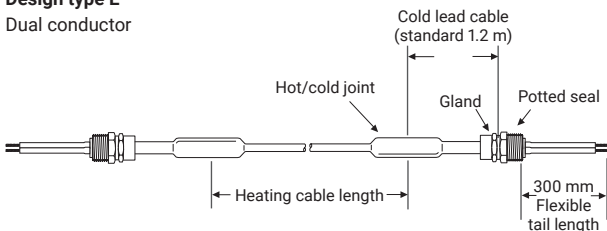
Design type D

Dual conductor



Design type E

Dual conductor



The joints can be either brazed or laser welded, refer to Raychem product literature for more detailed information.

Please note that this manual only covers the installation of pre-fabricated MI heating units. The complete termination process and repair of heating cable units is not covered by this manual and must be carried out by qualified and experienced personnel only. Keep ends of heating cables and kit components dry before and during installation.

For more information contact your Chemelex representative.

Important

For the Chemelex warranty to apply, the instructions of this manual must be followed. Design, installation, inspection, operation and maintenance must be in accordance with the standards IEC EN 60079-0, IEC EN 60079-30-1 and IEC EN 60079-31 (where applicable). Other local requirements and national electric codes applicable to electrical heat-tracing systems must be followed as well.

Personnel involved in the installation, testing and maintenance of electric heat-tracing systems must be suitably trained in all special techniques required, as well as in general electrical installation work. All work should be monitored by supervisors experienced in heat-tracing applications.

The presence of the heating cables shall be made evident by the posting of caution signs or markings at appropriate locations and/or at frequent intervals along the circuit

Area Classification – Ordinary

HCC/HCH/ HDC/HDF/HSQ/HAX/HIQ

Area Classification – Hazardous, Zone 1 or Zone 2 for gas / Zone 21 or Zone 22 for dust

Specific conditions of use in hazardous area:

1. The MI Cable Seal assembly is to be installed within a suitable enclosure to protect from light and impact
2. The MI Cable Seal Assembly has a service temperature range of -30°C to $+120^{\circ}\text{C}$ or -30°C to $+105^{\circ}\text{C}$ or -60°C to $+70^{\circ}\text{C}$. See the manufacturer's instructions for further information.
3. The maximum withstand temperatures & supply voltages are shown table 1 "Properties of MI heating units"
4. The minimum installation temperature is -60°C
5. The minimum cable spacing must not be less than 25 mm.
6. The minimum bending radius is 6 x cable diameter
7. Extreme care shall be used when handling and manipulating the Mineral Insulated Electric Heating cables. Repeated bending actions of the cable may weaken the mechanical strength of the cable which could lead to failure. For further information, consult the manufacturer.
8. Consideration shall be given during the selection of the heating cable sheath material for the environmental exposure. Certain environmental impurities may lead to failures such as stress corrosion cracking (SCC). Consult the manufacturer for further information.
9. When PVC sleeving is used the operating temperature must not exceed $+85^{\circ}\text{C}$.
10. When used in dust atmospheres the Compression Ring Type cable Gland shall be sealed in accordance with the manufacturer's instructions and applicable code of practice, and the enclosure to which the gland is attached shall be provided with a minimum ingress protection of IP6X.
11. The heating element supply circuit must include an electrical protection device in accordance with EN 60079-30-1

Certificate No.

Code Nos.

HCC/HCH/HDC/HDF/HSQ/HAX/HIQ (Heating units)

Baseefa 13ATEX0174X

Ex II 2 G Ex 60079-30-1 db eb IIC T* Gb

BAS21UKEX0519X

Ex II 2 D Ex 60079-30-1 tb IIIC T*°C Db IP6X
(for * see schedule)

IECEx BAS 13.0090X

Ex 60079-30-1 db eb IIC T* Gb
Ex 60079-30-1 tb IIIC T*°C Db IP6X
(for * see schedule)



№ EAЭC RU C-BE.МЮ62.В.00879/19
ООО «ПРОММАШ ТЕСТ»
1Ex e IIC T* Gb X
Ex tb IIIC T* Db X
Ambient temp range: $-60^{\circ}\text{C}...+70^{\circ}\text{C}$

HCC/HCH/ HDC/HDF/HSQ/HAX/HIQ (bulk cable)

Baseefa 13ATEX0173U

Ex II 2 G Ex 60079-30-1 IIC Gb

BAS21UKEX0517U

Ex II 2 D Ex 60079-30-1 IIIC Db

IECEx BAS 13.0091U

Ex 60079-30-1 IIC Gb
Ex 60079-30-1 IIIC Db



EAЭC RU C-BE.АД07.В.04188/22
ООО «Центр Сертификации ВЕЛЕС»
Ambient temp range: $-60^{\circ}\text{C}...+56^{\circ}\text{C}$
1Ex e IIC T* Gb X
Ex tb IIIC T* Db X
*: by design

Units made in Canada, Germany or Poland.

Bulk cable made in Canada or Italy

The order reference of MI heating units uses the following nomenclature

B	/HSQ1M1000	/43.0M	/1217	/230	/1.2M	/S33A	/X	/NPM25	/EX
									Area classification: EX, ORD
									Gland size NPM25 (Nickel plated brass), SSM25 (stainless steel) etc
									Hot/cold joint material type: X -stainless steel, Y - brass, LW - laser welded
									Cold lead rating and sheath type
									Cold lead length: M for unit in meters (standard is 1.2 m)
									Heating unit: Operating voltage
									Heating unit: total wattage in W
									Unit length: M for unit in meters
									Heating cable reference
									Heating cable unit type: Type B, D or E

When ordering, the complete order reference of the MI heating unit needs to be provided. For hazardous areas, information must also be provided about the T-rating and temperature data relevant to the application (max. sheath temperature data) to enable the correct representation of data on hazardous area tags attached to the completed heating unit in the factory. Before installation, check the suitability of the heating units supplied. Changes to any of the parameters may require a re-design and must be confirmed before installation.

2. HEATING CABLE SELECTION AND STORAGE

The selection of the proper heating cable and components, best suited for the application must be checked against the relevant product literature, the most important product properties are summarized in following table:

Table 1: Properties of MI heating units

Please check against individual datasheet or contact

MI Heating Cable Type	HCC/ HCH	HDC/ HDF	HSQ
Number of conductors	1	1	1
Maximum voltage (U0/U)	300 / 500 V		
Maximum withstand temp.(1)			
Brazed heating unit	200°C	400°C	550°C
Laser welded heating unit	-	-	680°C
Temperatureclassification	T6 – T3	T6 – T2	T6 – T1
Minimum cable spacing	25 mm		
Minimum installation temp.	-60°C		
Minimum bending radius	6 x Cable Diameter		
Chemical resistance	Low	Medium	Medium

MI Heating Cable Type	HAX1N	HAX2N	HAX2M	HIQ
Number of conductors	1	2	2	1
Maximum voltage (U0/U)	600/600 V		300/300 V	300/500 V
Maximum withstand temp.(1)				
Brazed heating unit	550°C	550°C	550°C	550°C
Laser welded heating unit	680°C	680°C	680°C	680°C
Temperature classification	T6 – T1	T6 – T1	T6 – T1	T6 – T1
Minimum cable spacing	25 mm			
Minimum installation temp.	-60°C			
Minimum bending radius	6 x Cable Diameter			
Chemical resistance	High	High	High	High

Contact Chemelex for further details

(1) The hot-cold junction used in a heating unit may lead to temperature limits below the limit of the heating cable. Contact Chemelex if the exposure temperature exceed values given in the tables above for more detailed instructions how the unit can be installed under those circumstances.

The maximum cable power output is directly dependant on the application and control method used. The actual limits of MI heating cables in a specific application are given in Raychem Engineering Software us (e.g. TraceCalc Pro design software). For more details, please contact us.

Ensure that the heating cable voltage and temperature rating is suitable for the application.

Changing design parameters such as voltage or cable length will result in a different power output and maximum sheath temperature. This may require a redesign of the entire system.

To prevent fire or explosion in hazardous areas, verify that the maximum sheath temperature of the heating cable is below T-class or auto-ignition temperature of the gases present in those areas. For further information, see design documentation (e.g. TraceCalc Pro reports).

For the evaluation of the chemical resistance of MI heating cables (for corrosion aspects), refer to our product datasheets or contact Chemelex for assistance. Check the design specification to make sure the correct heating cable is installed on each pipe or vessel.

Refer to Raychem product literature to select an appropriate heating cable for each thermal, chemical, electrical and mechanical environment.

Storage and transportation

- Store and transport MI heating units in a clean, dry place or container.
- Protect the heating cable from moisture and mechanical damage.
- Storage below 10°C may result in surface condensation, potentially causing low insulation resistance.
- After extended storage, it is strongly recommended to measure the insulation resistance of MI heating units prior to installation, also refer to section 8.

3. HEATING CABLE INSTALLATION

WARNING: As with any electrical equipment or wiring installation that operates at line voltages, damage to heating cable and components, or incorrect installation that allows the penetration of moisture or contamination can lead to electrical tracking, arcing and potential fire hazard. In case of damage and later repair on site any unconnected heating cable end, exposed to the environment, must be sealed appropriately.

The purchaser should make the manufacturer aware of any external effects or aggressive substances that the equipment may be exposed to.

3.1 Pre-installation checks

Check design recommendations:

- Verify that you have all required engineering documents supporting the installation
- Check for any special instructions in engineering documentation (e.g. cover with aluminium foil, use of metal mesh, fixation etc...).
- Verify that hazardous area information given in engineering documentation is compatible with the area classification the material will be installed in.

Check materials received:

- Inspect heating cable and components for in-transit damage.
- Review the heating cable design and compare the list of designed materials to the catalogue numbers of heating cables and electrical components received to confirm that proper materials have been received on site. The heating cable type and hazardous area marking (if applicable) is printed on a tag label supplied with each heating element.
- Measure and note down the electrical resistance and the insulation resistance of the cable. Compare these values to those in the design documents (see section 8).

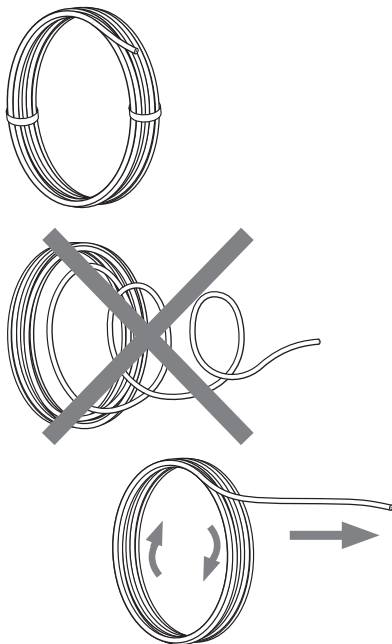
Check equipment to be traced:

- Check identification, length and diameter of pipework/vessel against the design documents. Also verify, that actual temperatures and insulation properties are in alignment with the design documentation.
- Ensure all pressure testing of pipework/ vessel is complete and final paint and pipe coatings are dry to touch.
- Walk the system and plan the routing of the heating cable on the pipe, including tracing of heat sinks. e.g. valves, flanges, supports, drains etc.
- Inspect piping for burrs, rough surfaces, sharp edges etc. which could damage the heating cable. Smooth off or cover with layers of aluminium foil. At elevated sheath temperatures consider the use of stainless steel foil. (e.g. HSQ; HIQ or HAX).
- Surface areas where heat-tracing is to be installed must be reasonably clean. Remove dirt, rust and scale with a wire brush and oil and grease films with a suitable solvent.

3.2 Heating cable pulling and laying and general installation guidelines

Heating cable pulling tips:

Figure 3: Importance of cable pulling direction



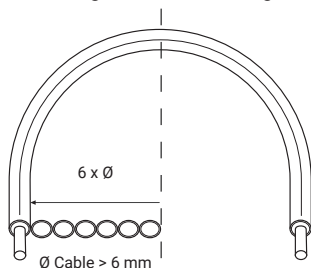
Avoid distortion of the cable and kinking.

When pulling the heating cable, avoid:

- Sharp edges
- Excessive pulling force
- Kinking and crushing
- Running over it with equipment.
- Pulling into a spiral
- Avoid pulling the cable by the flexible pig tail wires of the cold lead(s).

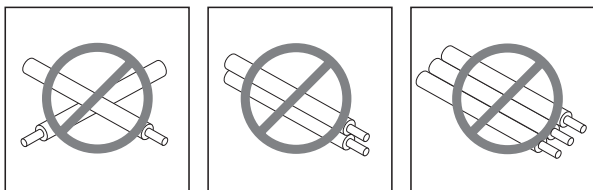
The minimum bending radius of the heating cable must be respected.

Figure 4: Minimum bending radius of MI heating cables



- Do not repeatedly bend and straighten the cable.
- Keep heating cable strung loosely but close to the pipe being traced, to avoid interference with supports and other equipment.
- Add additional heating cable to trace the fittings and supports as required by the design specification or engineering documents.
- Leave the appropriate amount of heating cable at all power connection, splice and tee locations.
- Do not bend the cable within 150 mm of the hot to cold junction or remote terminations.
- Do not bend the cold lead within 150 mm of the termination pot seal.
- Avoid crushing and excessive bending or pulling of cold leads during installation, testing and commissioning
- To maintain the integrity of the epoxy seal termination, avoid the application of excessive heat to the epoxy during installation, commissioning and operation of the heating units
- Keep gland back nut and olive assembled to the body to reduce chance of impact damage during installation.
- To prevent galling of threads when using stainless glands, a thread lubricant should be applied to the male thread mating with the female backnut.
- When installing MI and other constant wattage heating cables, ensure that they do not overlap or cross. Doing so may lead to local over-heating and hazard of fire.

Figure 5: Minimal spacing must be respected



Minimum cable spacing: 25 mm (lower spacings may be possible but require special attention and must be properly documented in the engineering documentation).

For installation in hazardous areas, the standard minimum spacing is 50 mm. This must be respected, unless lower spacings are specifically allowed in the engineering documentation.

Heating cable allowances

All parts of a heat traced system which increase the surface area of the normally insulated pipe/vessel (e.g. valves or flanges) or metallic fins that protrude out of the insulation (e.g. supports), will increase the overall heat loss. These areas of increased heat loss require compensation,

either by using higher overall design safety factors or by the addition of extra cable length. The heating cable allowances are specified in design software and documentation.

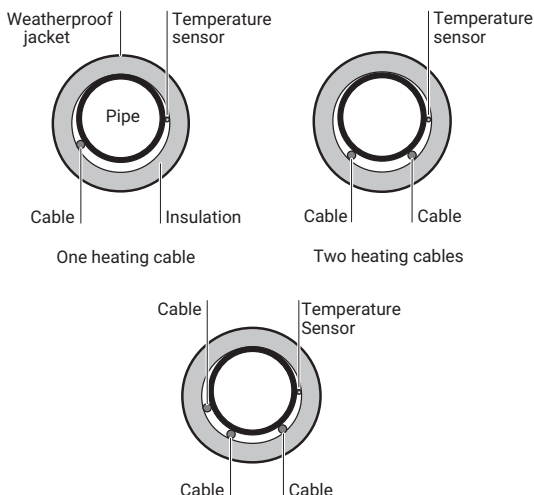
For some applications, it may be physically impossible to install all of the recommended heating cable directly on the fitting or support. In this case, install the excess heating cable on the pipe, on either side of the fitting or support, or distribute the additional heater length along the entire circuit length if a lower local temperature is acceptable.

This constraint may be difficult for small pipes and/or multiple cable runs. If required, contact Chemelex for assistance.

3.3 Heating cable attachment

- Fix in place with metal bandings, tie wire or wire cloth band at a typical interval of 300 mm and additionally where necessary.
- The use of tie wire with softer sheath MI heating cables (like copper HC and cupro-nickel HD) should be avoided, as the tie wire can damage the heating cable surface over time. Do not overtighten tie wire, use wire cloth band wherever possible.
- The hot to cold junction should be secured with metal bands at a typical distance of 150 mm on either side of the joints.
- Cable must be installed and fixed such that movement of cable during its heating up cycles is permitted, but not to allow cable to move freely under its own weight. Other attachments (like aluminium tape or glass tape) may be used, if specified in the design documentation.
- The heating cables may be installed in straight, multiple runs as required by the design specification.
- On horizontal pipes fix on lower quadrant as shown below and not on bottom of pipe.

Figure 6: Cable orientation on pipe



- On vertical pipe sections fix the heating cables equally distributed around the pipe circumference.
- Read the design documents, in particular concerning the need for cable allowances and regard the location of junction boxes/ controllers before permanently attaching the cable to the pipe.

- Verify if the design documentation requires that the heating cables have to be covered by aluminium or stainless steel foil before the insulation is applied.
- Installation on tanks typically requires additional fixing devices as pre-punched steel strips as shown below:

Figure 7: Typical cable layout on large surfaces like tank walls

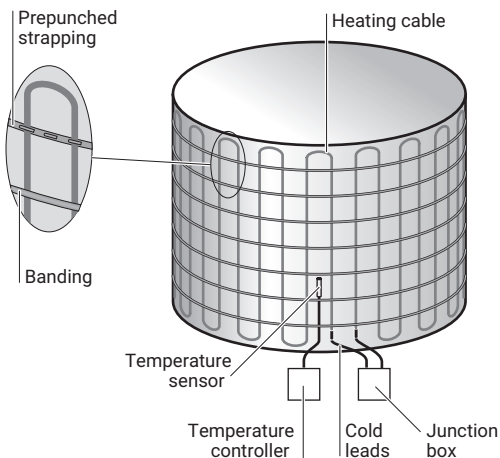
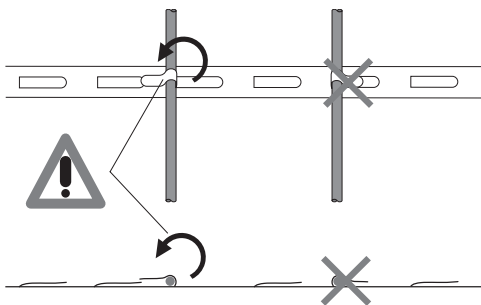


Figure 8: Fixing device: pre-punched metal strap



- Avoid sharp edges and properly seal penetration of MI cold lead cables through the insulation cladding.

3.4 Attachment materials

- Stainless steel pipe straps for different pipe dimensions up to 36" (e.g. PB 300).
- Stainless steel banding (30 m roll) together with stainless steel buckles (one per fixing) (e.g. SNLS + SNLK).
- Tie wire (e.g. RMI-TW) is especially suitable for the fixation on irregular shapes like pumps, valves etc.. The use of tie wire with softer sheath MI heating cables (like copper HC and cupro-nickel HD) should be avoided where possible, as the tie wire can damage the heating cable surface over time, use wire cloth band wherever possible. For the installation of MI heating cables on metal meshes, tie wire may be used, but must not be overtightened and should allow for free movement of MI heating cable during expansion and contraction.

- Pre-punched metal banding allowing fixed heater spacing, where multiple runs of cable are applied (e.g. HARD-SPACER-SS-25MM-25M).
- Various types of metal meshes are available for installation on tanks, valves, pumps (e.g. mesh types FT-19 and FT-20)

3.5 Typical installation details

The following details show some principles of MI cable installation, using dual conductor cables. Single conductor cables follow the same principles, but typically form a loop. Attention must be given, for single conductor configurations, where both ends need to be terminated in the same power supply box.

- **Where feasible, uncoil the heating cable and lay it alongside the pipe section to be traced.** For shorter single conductor cable, to be installed in the form of a “hairpin”, it may be advantageous to unroll the heating cable, loop it, and then lay it alongside the pipe section so that both runs of cable can be installed simultaneously.

Figure 9: Uncoiling heating cable

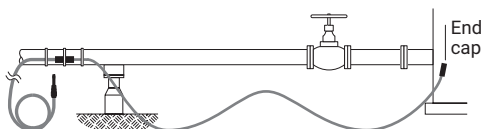
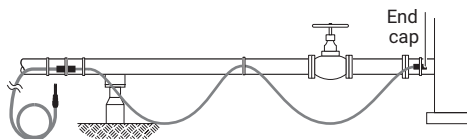
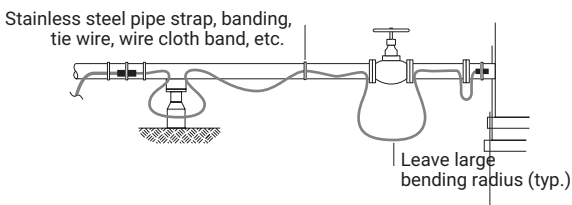


Figure 10: Attaching hot-cold joint and end cap



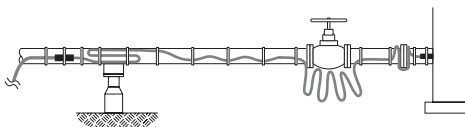
- Attach hot-cold joint to end of pipe nearest the power supply point, and the other end of heating cable to the other end of the pipe. Support hot-cold joint by attaching cable with pipe straps/banding at a distance of 6 inches (150 mm) on either side of joint. Secure joint itself to pipe with a pipe strap/band as shown in Figure 10.
- Fasten middle of heating cable to the halfway point of pipe leaving equal slack on either side.
- Attach heating cables to pipe with pipe straps/banding, tie wire or wire cloth band at 12-18 inches (300-450 mm) intervals. Tie wire should be snug, but should not cut or indent the sheath.
The use of tie wire with softer sheath MI heating cables (like copper HC and cupro-nickel HD) should be avoided, as the tie wire can damage the heating cable surface over time, use wire cloth band wherever possible.

Figure 11: Allowances for valves, flanges, and pipe supports



- Use tie wire or wire cloth band to hold cable to irregularly shaped objects such as valves or pipe supports.

Figure 12: Installing cable on valves and pipe supports



- Allow cable to wave along pipe as per Figure 14 and Figure 15. This allows for expansion and contraction of the heating cable as it heats up and cools down. The recommended field variance to allow for a wave is about 2% of the total length. Use up excess cable by waving along pipe and increasing amount used at each pipe support.
- **Note:** Do not use up excess cable at one location. Distribute equally along pipe.

Figure 13: Completed MI heating cable installation

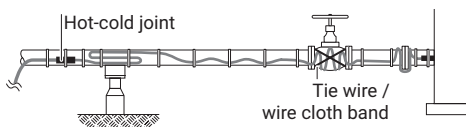


Figure 14: Pipe strap spacing

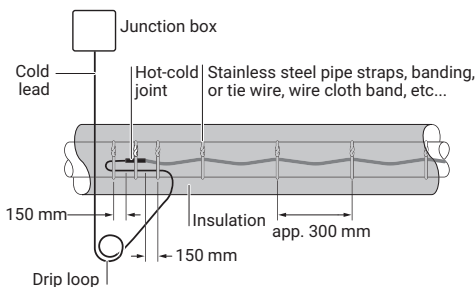
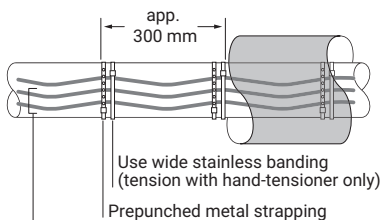


Figure 15: Fastening several runs of cable



Wave cables with a minimum spacing of 25 mm to 50 mm along pipe, unless design documentation clearly states other values.

- **Note:** Where several heating cables are required, a pre-punched metal strapping may aid the installation and consistent spacing of heating cables.

Figure 16a: Valves

For valve sizes 3½" (90 mm) or smaller

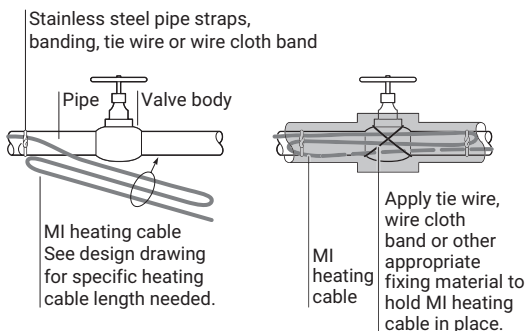
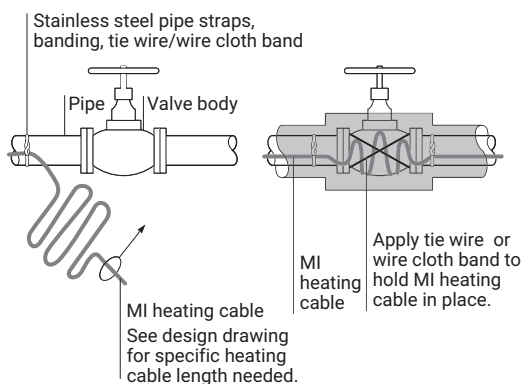


Figure 16b: Valves

For valve sizes larger than 3½" (90 mm)



- The minimum spacing must be respected, unless design documentation clearly states other values, also refer to page 12, Figure 5.

Figure 17: Installation at 90° elbow

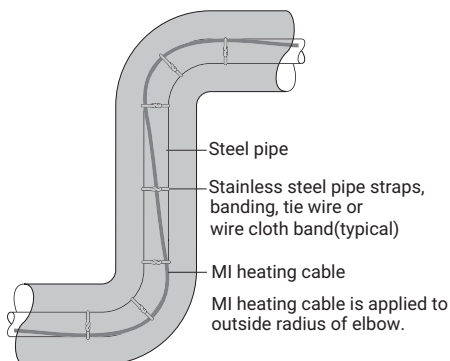


Figure 18: Flanges

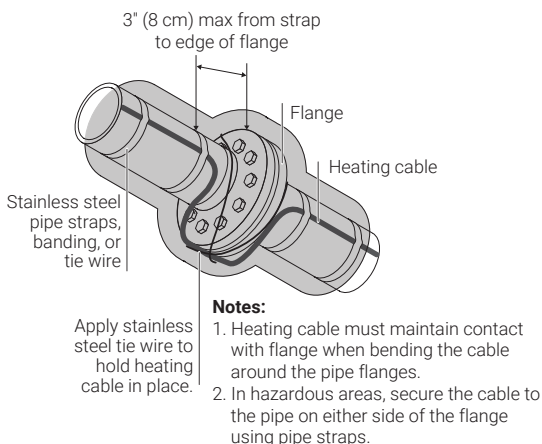
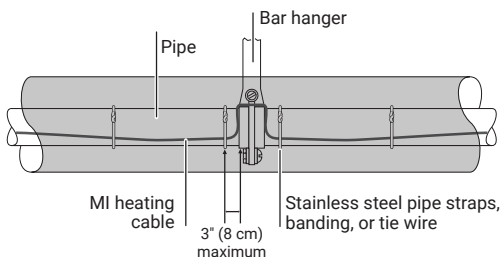
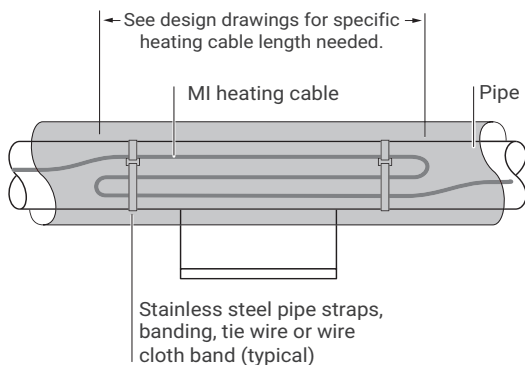


Figure 19: Cable layout over clamps and straps



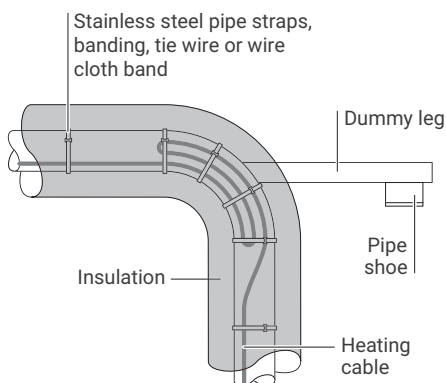
Notes: In hazardous areas, secure the cable to the pipe on either side of the pipe support using pipe straps

Figure 20: Shoe and sleeve type support



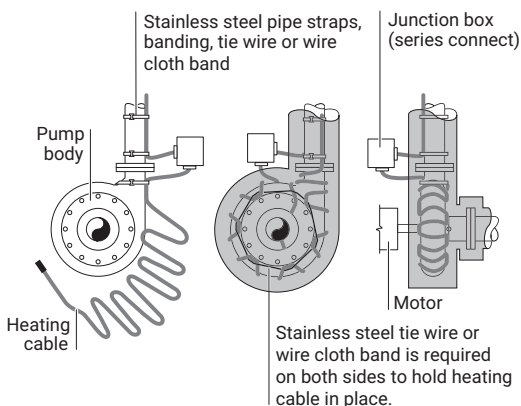
- The minimum spacing must be respected, unless design documentation clearly states other values, also refer to page 12, Figure 5

Figure 21: Dummy supports



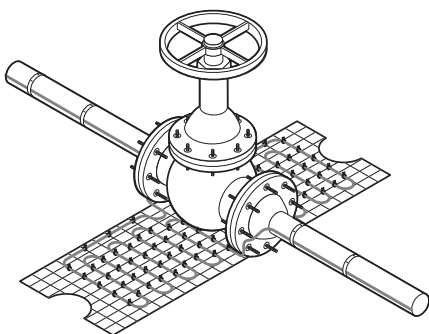
- The minimum spacing must be respected, unless design documentation clearly states other values, also refer to page 12, Figure 5.
- Check drawings for dummy leg insulation.
- Pumps should have their own heating cable, separate from the connection box.

Figure 22: Pumps



- The minimum spacing must be respected, unless design documentation clearly states other values, also refer to page 12, Figure 5.
- Cover the heating cable with metal foil or equivalent before applying insulation to ensure the cables do not become trapped in the insulation.
- **General note:** Trace pipe fittings as shown to allow easy maintenance. An alternative is the use of metal wire mesh cages.

Figure 23: Cable applied on metal wire mesh



- Consult the design specification for the heat-tracing requirements of fittings and supports.
- The heating cable's minimum bend radius must be respected (refer to Table 1).
- The minimum spacing must be respected, unless design documentation clearly states other values, also refer to page 12, Figure 5.
- After installing the cable onto the mesh, push the mesh firmly against the valve body to optimize contact between cable and valve body.

3.6 Heating cable allowances

All parts of a heat traced system that increase the surface area of the insulated pipe/vessel or metallic fins that protrude out of the insulation (e.g. supports), will increase the overall heat loss. These areas of increased heat loss require compensation, either by using higher overall design safety factors or by the addition of extra cable length. In such cases sufficient cable should be added to at least enable removal of instruments, valves etc ("maintenance loop").

For further details on individual allowances please refer to Raychem design specification (e.g. TraceCalc Pro reports).

4. COMPONENTS SELECTION AND INSTALLATION

4.1 General notes

Use the Design Specification to select required components. Raychem components must be used to satisfy Standards and Approval Body requirements and the Chemelex warranty to apply.

4.2 Component installation hints

- On horizontal pipes locate junction boxes below pipe where ever possible.
- Locate junction boxes for easy access, but not exposed to mechanical abuse.
- Try to position junction boxes such, that power cable and heating cable entries point downwards to avoid water ingress in the insulation.
- Confirm junction box glands and stopping plugs are appropriate for application and fixed firmly in place. Ensure that sealing washer is installed if needed to meet installation requirements.
- Route heating cable between junction box and the place where it enters the insulation cladding such, that the risk of mechanical damage is minimized.
- Do not strain cold lead cable as it exits/enters junction boxes and insulation entries.
- Ensure heating cable is fixed over pipe straps such as used for junction box support brackets so as to avoid potential mechanical damage.
- Cable joints (splices) should be located only in places, where cable is not bent or mechanically stressed.
- Do not bend the cold lead within 150 mm of the termination pot seal.
- Perform visual inspection of glands for scratches or damage, including threads
- Ensure surface of cable where gland will seal to sheath is clean
- If gland is contaminated: disassemble, clean, and visually inspect contaminated parts
- In Ex d hazardous applications glands must have a minimum of 5 threads engaged.
- Perform visual inspection of gland after tightening back nut and check for cracks, deformation / out-of-round.
- Tighten back nut to approximately 25 ft-lb (34 N-m)
- Lock nut applied to gland threads inside enclosure to be tightened wrench tight
- Enclosures with unthreaded gland entries should have openings in accordance with IEC 60079-31
- Optional Chemelex fibre or PTFE sealing washers may be used with metric threaded gland bodies to obtain an IP66 rating

 **Important:** The compression nut must be tightened to the torque setting indicated on the tag attached to the gland connector. This ensures that the cable sheath is properly grounded and prevents moisture from entering the junction box.

5. TEMPERATURE CONTROL AND LIMITATION

5.1 General rules

Raychem MI series heating cables are constant power output heaters and as such typically require temperature control, unless otherwise explicitly specified.

Good practice and local regulations may require additionally independent temperature limitation devices; The selection of such devices also depends on environmental conditions (non-haz or haz area).

- For applications in hazardous areas either a stabilized design or a thermostat control with temperature limiter complying with the requirements of IEC 62086 and IEC/EN 60079-30-1 can be used to limit the surface temperature of the heating cable.
- In cases where stabilized design is not applicable, a control thermostat must ensure that the heating system under normal conditions will be switched off, as soon as maintain temperature is reached.
- An additional, independent temperature limiter ensures that the surface temperature of the heating cable will not exceed the maximum allowed temperature of hazardous area if the control thermostat fails.
- A lockout function ensures that the heating cable remains switched off, until failure has been eliminated and normal conditions are restored.
- The lockout function is manually re-armed. Reset requires a tool (e.g. a key to open a panel or a password for software).
- Value of setpoint has to be secured against unintended change.
- Limiter must permanently switch off in case of sensor malfunction.
- Optionally the limiters could be assessed to other standards
- Follow the installation instructions supplied with the thermostat and/or the limiter.
- Use a proper wiring diagram for the heating cable layout and control method desired.
- The limiter must be set to ensure that the maximum temperature of the surface of the cable does not exceed either T-class or maximum working temperature of the heater for a given output under worse case conditions.
- **Warning:** As with any temperature measurement equipment, possible falsification of true temperatures due to increased heat loss caused by the sensor itself might lead to inaccurate temperature readings or unsafe tripping of safety limiters. The setpoint might need to be adjusted accordingly.
Contact Chemelex or the supplier of the limitation device in order to obtain detailed information concerning offsetting of limitation devices.

5.2 Sensor placement: Temperature control device

The choice of the right location for the controller sensor depends on, but is not limited to following aspects:

- Flow direction of the fluid, best location: downstream.
- Impact of heat sinks such as supports etc, best location: close to heat sink.
- Chimney effect on large size vertical pipes, best location: on the bottom.
- Accessibility for maintenance purposes, best location: at ground level.
- Impact of other heat sources, sun etc., best location: at cold side.

For details please refer to the engineering documentation.

5.3 Sensor placement: Temperature limiter device

Typically the sensor is being placed on a length of cable, that is separated from the pipe by means of insulating material, in order to create an “artificial hotspot”. The choice of the right location for the limiter sensor depends on, but is not limited to following aspects:

- Flow direction of the fluid, best location: upstream in case of warmer intruding fluid.
- Impact of heat sinks such as supports etc, best location: away from heat sinks.
- Accessibility for maintenance purposes, best location: at ground level.
- Chimney effect on large size vertical pipes, best location: at the top.
- Impact of other heat sources, sun etc., best location: at hot side of pipe.
- It is the responsibility of the installer to ensure that these conditions are met in the most appropriate way.

For more details please refer to the engineering documentation.

6. THERMAL INSULATION AND MARKING

6.1 Pre-insulation checks

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

6.2 Insulation related requirements

- Correct temperature maintenance requires properly installed and dry thermal insulation.
- The sheath temperature of an MI heating cable can be substantially above the temperature of the pipe/equipment to be traced. Verify that the max. sheath temperature of the heating cable is compatible with the insulations materials to be used. Contact your Chemelex representative if you have any questions.
- Check that all pipes, including fittings, wall penetrations and other areas are completely insulated.
- Thermally insulate and weatherproof to design specification.
- Ensure that heating cable is not damaged during installation of cladding by drills, self tapping screws and sharp edges of cladding etc.
- In all stabilized design cases, the characteristics of the installed thermal insulation (material and thickness) must comply with the design requirements and be verified and confirmed in the documentation, to ensure compliance with approvals requirements.
- Make sure, that under no circumstances any insulation material is being placed between heated surface and cable, thus disabling intended heat flow to the substrate, which may result in possible overheating of the cable.
- Good practice requires wrapping of the installed heating system with an appropriate metal foil prior to installation of the thermal insulation. This is especially so at places where intimate contact between heat-tracing cable and heated surface is not possible, such as valves or flanges where a suitable heat sink of temperature rated metal foil and wire cloth band may be used to improve heat-transfer. Also refer to design documentation, which may specify this requirement as well as material type, thickness etc... Further details may also be described in local insulation standards.

- Check that all HC or HD cables are mechanically protected and properly sealed at all places where they penetrate the insulation cladding.
- Ensure that all places are sealed where thermostat capillaries, sensor cables or support brackets etc. exit the cladding.

6.3 Marking

- Install “Electric Traced” signs on the insulation cladding along piping at suitable intervals (3-5 m intervals recommended) on alternate sides as a warning.
- Mark on outside of insulation the location of any heating cable components like connection points, splices etc.

MI-Heating unit identification:

- Each MI heating unit is supplied with an identification tag with important details about the type and operation conditions of the unit.
- In hazardous areas, the cable tag is mandatory.
- The tag contains the area classification in addition to other relevant design information.

**Figure 24: Typical MI identification tag
(for use in hazardous areas)**

 Raychem					 0598					
CATALOGUE NO: DESIGN / CABLE REF. / LENGTH / WATTS / VOLTS / C.L.LENGTH / C.L.CODE / JOINT / GLAND / AREA. B / HSQ1M1000 / 43M / 1187 / 230 / 2M / S33A / X / NPM25 / EX										
ORDER NO:		P 179883		CUSTOMER ORDER NO:		1789556				
SERIAL NO:		1539 6983 7894		CIRCUIT ID:		YYZX4 5				
OUTPUT POWER		@ 230 V: 1187 W		MAINTAIN TEMP OF:		50°C				
MAX. SHEATH TEMP:		331°C		SHEATH REF. TEMP.:		200°C				
DESIGN METHOD:		STABILIZED		ZONE / T* (CLASS) / AIT:		Z1 / T1				
<table border="0"> <tr> <td>HAZARDOUS LOCATIONS</td> <td> IECEX BAS 13.0090X Basseea13ATEX0174X UKEX BAS21UKEX0519X </td> <td> Ex 60079-30-1 db eb IIC T* Gb Ex 60079-30-1 tb IIIC T* C Db IP6X Tmin = -60°C II 2 G Ex 60079-30-1 db eb IIC T* Gb II 2 D Ex 60079-30-1 tb IIIC T* C Db IP6X Tmin = -60°C </td> <td>(T*: See above)</td> </tr> </table>							HAZARDOUS LOCATIONS	IECEX BAS 13.0090X Basseea13ATEX0174X UKEX BAS21UKEX0519X	Ex 60079-30-1 db eb IIC T* Gb Ex 60079-30-1 tb IIIC T* C Db IP6X Tmin = -60°C II 2 G Ex 60079-30-1 db eb IIC T* Gb II 2 D Ex 60079-30-1 tb IIIC T* C Db IP6X Tmin = -60°C	(T*: See above)
HAZARDOUS LOCATIONS	IECEX BAS 13.0090X Basseea13ATEX0174X UKEX BAS21UKEX0519X	Ex 60079-30-1 db eb IIC T* Gb Ex 60079-30-1 tb IIIC T* C Db IP6X Tmin = -60°C II 2 G Ex 60079-30-1 db eb IIC T* Gb II 2 D Ex 60079-30-1 tb IIIC T* C Db IP6X Tmin = -60°C	(T*: See above)							
RU C-BE .IM43.B.01571 1Ex e IIC T* Gb X Ex tb IIIC T* Db X Темп. окр. среды: -60°C до +56°C * : температурный класс(см. проектную документацию) При использовании во взрывоопасных зонах необходимо неукоснительно соблюдать инструкцию по монтажу! FOLLOW INSTALLATION AND OPERATION INSTRUCTIONS FOR SAFE USE IN HAZARDOUS AREA!										
Сделано в Канаде ТАБЛИЧКУ НЕ СНИМАТЬ! (SEE OTHER SIDE) THIS TAG MUST NOT BE REMOVED										

- **Catalogue No** is the order reference following the nomenclature of MI heating units (also see page 8)
- **Serial No**: unique number for complete factory traceability. The first 2 digits refer to the year of manufacture. (example: 18158634001 -> unit made in 2018)
- **Zone/T*(Class)/AIT** states the “T-class” or “Auto Ignition Temperature” including the “Zone” classification, which the unit is designed for
- **Design method** informs about the method of temperature control, which has been used for the design and must be installed to control the heating unit.

Examples:

1. "Stabilized" indicates that the design method used is "stabilised design". All parameters used in the design of the application must be respected in order to comply with the hazardous area requirements (e.g. pipe diameters, insulation thickness, process, ambient conditions ...). The reference temperature for the sheath temperature calculations is either the calculated "max. uncontrolled temperature" or the "max. process temperature", whichever is higher.
 2. "Control limited" indicates that the design method used is "control limited design". The reference temperature for the sheath temperature calculations is the control limited set point and must be assured by the use of an alarm capable control unit making sure the heating element is switched off, when the pipe/equipment exceed this temperature. The use of a wrong control device or a change of the temperature setting will invalidate the design calculation.
 3. "Limiter-Lockout" indicates that the design method used assumes the installation of an approved limiter (typically a safety temperature limiter which sensor is installed on the heating cable surface using an "artificial hotspot"). The set point of the limiter must be below the T-class of the area and may require an additional down-adjustment for potential falsifying of the measured temperature, refer to the instructions given by the manufacturer of the limiter.
- **Max. Sheath Temperature** is the max. sheath temperature of the MI heating cable based on the application design data
 - **Sheath Reference Temperature** is the reference temperature, which the "max. sheath temperature" calculated in the design of the system is based upon, (also see "Design Method")
 - **Output power** refers to the expected power of the heating unit at the specified voltage/configuration. It is based on the desired maintain temperature and may be significantly lower than during start-up phase, in particular for heating cables using conductors with a high temperature coefficient (e.g. copper conductor). Refer to the design information for proper sizing of the circuit breaker and power supply.

The design calculation must always be in compliance with the application design and the ambient parameters.

Note : If the output power is achieved by power modulation with an SSR control at high frequency (e.g. Raychem NGC-40 controller), it is indicated on the tag by adding 'PWRCTL' after the design method.

For example : Design method : Stabilized-PWRCTL

This indicates that the output power and all resulting temperatures are only valid when the MI heating units are used in conjunction with the specified controller and specified programming parameters.

Failure to configure and program as specified can invalidate the sheath temperature calculations and cause the T-class to be exceeded.

7. POWER SUPPLY AND ELECTRICAL PROTECTION

- Do not energize cable when it is coiled or on the reel.
- De-energize circuits before installation or servicing.

7.1 Earth connection

- Bond the metal sheath of the heating cable to a suitable earth terminal through an integral earth plate in the junction box.
- Optional earth lugs are available to facilitate earthing of the metal cable sheath and must be used when utilizing enclosures without an integral earth plate

7.2 Electrical loading

Size overcurrent protective devices according to the design specification and/or local standard practices.

7.3 Residual current (earth fault) protection

Chemelex requires the use of a 30 mA residual current device to provide maximum safety and protection from fire. Where design results in higher leakage current, the preferred trip level for adjustable devices is 30 mA above any inherent capacitive leakage characteristic of the heater as specified by the heating cable supplier or alternatively, the next common available trip level for non adjustable devices, with a maximum of 100 mA or 300 mA (Depending on area classification). All safety aspects need to be proven. Also refer to local standards.

Special regard should be given to electrical safety in IT power networks where use of RCD is restricted. For any heating cables installed in a hazardous area, the use of residual current devices is mandatory by the electrical codes and standards.

Earth fault equipment protection is required for each circuit.

7.4 Isolation from power supply

For any heating circuits installed in hazardous areas a means of isolation from the supply is mandatory.

7.5 Circuit marking

Make sure for all hazardous area installations, that system is properly marked with a heating cable tag.

8. SYSTEM TESTING AND COMMISSIONING

WARNING: Fire hazard in hazardous locations. Megger tests can produce sparks. Be sure there are no flammable vapors in the area before performing this test (hot work permit).

8.1 Testing of insulation resistance and conductor resistance

We recommend insulation resistance test

- Before installing heating cable, while the cable is still on the reel
- Before installing thermal insulation
- Prior to initial start-up/after completion of thermal insulation
- As part of the periodic maintenance (see Section 9.2).

The heating circuit electrical resistance needs to be measured and compared to the design documentation before initial startup.

8.2 Test method for insulation resistance testing

After completing heating cable installation, the insulation resistance between the conductor and the outer sheath has to be tested.

All mineral insulated heating cables:

Use a minimum testing voltage of 500 V and not more than 1000 V DC (between conductor and metal sheath).

For hazardous areas a testing voltage of 1000 V DC is recommended.

Minimum readings should be $\geq 20 \text{ M}\Omega$ for new heating units. The installer should record the values for each circuit on the installation record sheet.

8.3 Commissioning

- Verify all system documentation is complete as per "9.1 Documentation".
- Record and retain all installation & post insulation test values as per the Installation record sheet in this document.

9. DOCUMENTATION, OPERATION, MAINTENANCE AND REPAIRS

WARNING: Heating cables are capable of reaching high temperatures during operation and can cause burns when touched. Avoid contact when cables are powered. Thermally insulate the traced pipe or equipment before energizing the cable. Use only properly trained personnel.

Caution: Consult the trace heating system documentation prior to maintenance/repair/modification. After maintenance/repair/modification, test the operation of the earth-fault device of each affected circuit.

In the event of an earth fault or over current interruption, the device shall not be reset until the cause of the trip has been investigated by qualified personnel.

9.1 Documentation

The trace heating system documentation shall be retained for each trace heating circuit for as long as the system is in use. As a minimum, the trace heating system documentation shall include the following information:

- trace heating circuit identification
- heating cable type;
- operating voltage;
- length or dimensions of heating cable;

(this data is also indicated on the tag attached to the heat tracing circuit).

In case of stabilized design:

- temperature to be maintained or the maximum process / exposure temperature;
- maximum workpiece temperature;
- temperature class or maximum sheath/surface temperature as applicable;

(this design & temperature data are also indicated on the tag attached to the heat tracing circuit);

- maximum ambient temperature;
- trace ratio;
- pipe size or workpiece dimensions;
- thermal insulation type, size, and thickness;
- thermal insulation cladding specification, if applicable

(this data is usually part of the as-built documentation or the detailed calculation reports from design software such as TraceCalc Pro, TracerLynx,...).

In case of controlled design:

- temperature to be maintained or the maximum process / exposure temperature;
- temperature class or maximum sheath / surface temperature as applicable.

(this design & temperature data are also indicated on the tag attached to the heat tracing circuit);

- Trace Heating system design parameters
- maximum ambient temperature;
- trace ratio;
- temperature controller / limiter set point;
- location of the sensor of the temperature controller / limiter on the pipe / workpiece;
- details of the mounting of the sensor;
- details for any failure annunciation and monitoring (alarm or lim lock out)

(this data is usually part of the as-built documentation and/or the detailed calculation reports from design software such as TraceCalc Pro, TracerLynx,...).

9.2 Heating cable operation

- Temperature exposure to the cable must be within the range specified in the product literature. Exceeding the limitations will shorten the service life and may permanently damage the heating cable and/or connections.
- Pipe insulation must be complete and dry to maintain the required temperature.

9.3 Inspection and maintenance

- Visual inspection: heating cable exposed to ambient and pipe insulation should be checked periodically to make sure, that no mechanical damage has occurred.
- Insulation testing: The system should be tested regularly. Check in advance, whether hazardous area conditions allow insulation testing. A hot work permit might be required.
- When measuring the insulation resistance from the main supply panel, the dielectric test is performed between L (live) and PE (earth).
- Functionality test of electrical and protective earth protection: Circuit breaker and residual current device should be tested at least once a year or according to manufacturer's instructions.
- Verify that all junction boxes are appropriate for the area classification and correctly sealed with no moisture inside. Ensure that the cable gland connectors are tight and correctly fitted into junction boxes.
- Check for damage to cold lead and inspect glands for worn or galled threads. The use of a thread lubricant on threads between gland backnut and body is recommended with stainless steel glands.
- Functionality test of temperature control systems: Depending on how essential temperature control is regarding process requirements and how critical temperature limitation is for accordance with hazardous area requirements, test should be carried out at regular intervals.
- The Installation Record Sheet on the following pages should be completed during maintenance of each circuit in your system. Freeze protection systems should be measured before the winter months each year (see section 8).
- Temperature maintenance systems should be tested at least twice a year.
- When performing maintenance requiring removal of gland from enclosure, it is recommended that IP sealing washers be replaced

9.4 Piping systems repair and maintenance

- Isolate heating cable circuit and protect the heating cable from mechanical or thermal damage during pipe repair work.
- Check heating cable installation after pipe repairs and make sure, that thermal insulation is restored, following the recommendations in Section 8. Check correct functioning of all relevant electrical protection systems.

10. TROUBLESHOOTING

WARNING: Damage to cables or components can cause sustained electrical arcing or fire. Do not energize heating cables that have been damaged. Damaged heating cable or terminations must only be repaired or replaced by qualified personal. Contact Chemelex for assistance.

- It should be carefully evaluated, whether the severity of the damage allows on-site repair or whether the entire heating cable needs to be replaced.

Also refer to the Troubleshooting guide on the following pages. If the problem persists after following the guidelines, contact Chemelex.

11. INSTALLATION RECORD SHEET

Heating Cable Installation Record

Installation company :		Installer:	
Project / Site name:			
Area name:			

	Value/Remarks	Date	Initials
Heating circuit number:			
P & ID -number:			
Drawing number:			
Panel/Circuit breaker number:			
Heating cable type:			
Cable length (m):	loop 2 x: m, star 3 x: m		

	Required value	Actual value	Signature
1 Visual inspection			
Minimal allowed spacing	mm		
Minimal bending radius	mm		
Temperature sensor properly installed on the pipe and control temperature is set	yes		
Sensor of temperature limiter properly installed and set according to design specification	yes		
2 Before commencing of thermal insulation works			
Insulation resistance test voltage (V DC)	1000 V DC		
Insulation resistance test before thermal insulation (MΩ)	> 20 MΩ		
Loop resistance	ohms		
Average pipe temperature when measuring loop resistance:	°C		
Cable covered with metal foil at flanges, valves, metal wire mesh cages etc., as per requirements in design documentation	yes		

3 After finalization of thermal insulation works

Cables are sealed and protected at entries into insulation cladding	yes		
Thermal insulation material and thickness meet designed values	yes		
Warning labels installed on cladding every 5 m and at components	yes		
Insulation resistance test voltage V DC	1000 V DC		
Insulation resistance test after insulation	MΩ		

4 Prior to energizing of the cable

Circuit feeding box marked properly	yes		
Control temperature set to setpoint	°C		
Limiter set to trip value and protected against changes	°C		
Insulation resistance test voltage V DC	1000 V DC		
Insulation resistance test at commissioning	MΩ		
Circuit voltage at feeding box Ph-Ph, Ph-N for 3 phase	V		

Symptom and probable causes

A Symptom: Insulation resistance less than expected

Probable causes:

- | | |
|---|--|
| 1 | Rainy or high humidity |
| 2 | Nicks or cuts in heating cable sheath, with moisture present |
| 3 | Kinked or crushed heating cable. |
| 4 | Arcing created by damage to the heating cable. |
| 5 | Physical damage to heating cable is causing a direct short. |
| 6 | Presence of moisture in terminations or connections |
| 7 | Damaged termination |
| 8 | Moisture in junction boxes |

B Symptom: Circuit breaker trips

Probable causes:

- | | |
|---|---|
| 1 | Circuit breaker undersized |
| 2 | Defective circuit breaker |
| 3 | Short circuit in electrical connections |
| 4 | Excessive moisture in connection boxes |
| 5 | Nicks or cuts in heating cable sheath, moisture present |
| 6 | Kinked or crushed heating cable |
| 7 | Defective RCD |
| 8 | Excessive earth leakage current, RCD trips |

Corrective actions

- 1 Dry tails and face of seal
- 2 Visually inspect cable for damage, especially at elbows, flanges, and around valves. If damaged, repair or replace heating cable.
- 3 Inspect power connection box for moisture or signs of tracking.
- 4 Dry out connections and retest
- 5 Check for visual indications of damage around the valves, pump, and any area where there may have been maintenance work. Look for crushed or damaged insulation along the pipe. Replace damaged sections of heating cable.
- 6 Dry out cold lead and/or connections and replace termination if necessary.
- 7 Replace termination
- 8 Check and replace seals on junction boxes

Corrective actions

- 1 Recalculate circuit load current. Resize breaker as required
- 2 Repair or replace breaker
- 3 Eliminate short circuit. Thoroughly dry connections
- 4 Eliminate short circuit. Thoroughly dry connections
- 5 Repair damaged section or replace heating cable
- 6 Repair damaged section or replace heating cable
- 7 Replace RCD
- 8 Check insulation resistance. If within acceptable range, evaluate electrical design for compatibility with RCD used.

C Symptom: Power output appears correct but pipe temperature is below design

Probable causes:

-
- 1 Wet or missing insulation with proper weather-proofing
 - 2 Insufficient heating cable on valves, maintain temperature at flanges, supports, pumps, and other heat sinks
 - 3 Temperature controller set incorrectly
 - 4 Improper thermal design used
 - 5 Temperature sensor in wrong location
 - 6 Low fluid temperature entering pipe
-

D Symptom: Power output is zero or incorrect

Probable causes:

-
- 1 No input voltage
 - 2 Temperature controller wired in the normally open (N.O.) position
 - 3 Limiter has tripped
 - 4 Broken or damaged heating element, hot-cold joint, end cap, or broken tail
 - 5 Wrong cable used
 - 6 Improper voltage used
-

Locate faults by the following steps:

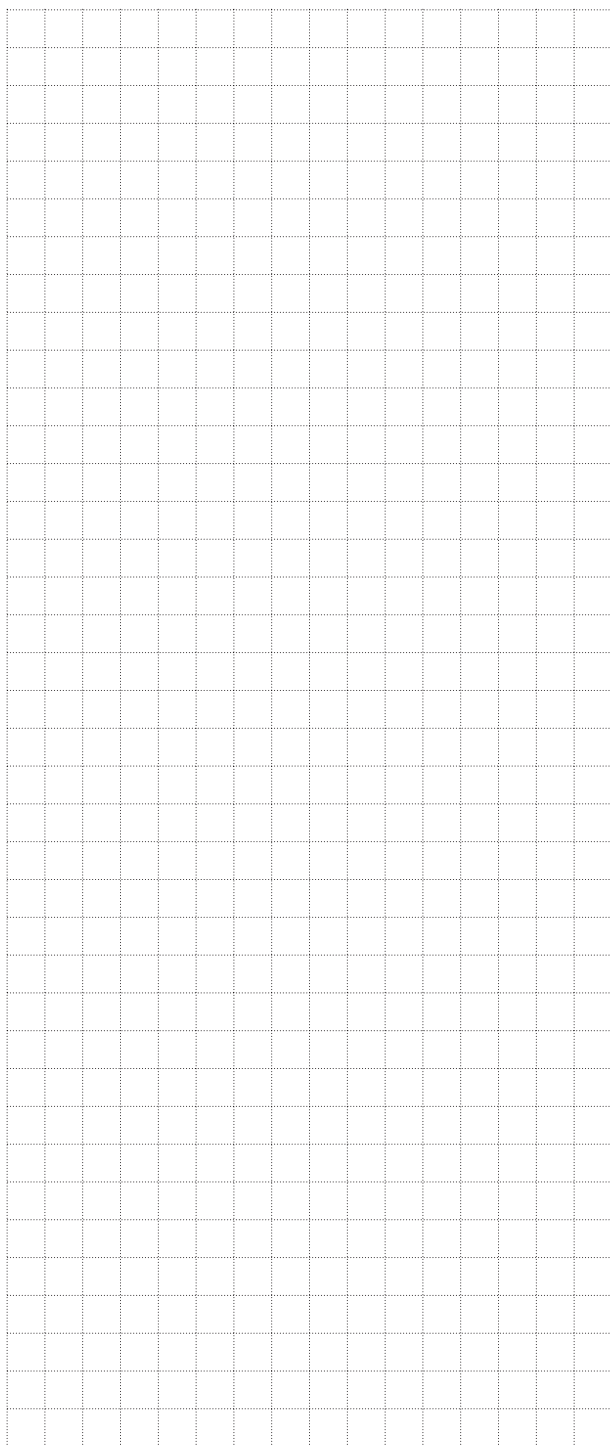
- 1 Visually inspect the power connections, splices and
- 2 Look for signs of damage at: end seals for correct installation
 - a) Valves, pumps, flanges and supports
 - b) Areas where repairs or maintenance work has been carried out recently
- 3 Look for crushed or damaged insulation and cladding along the pipe
- 4 If after 1, 2 and 3 above the fault has not been located, then consult Chemelex for further assistance

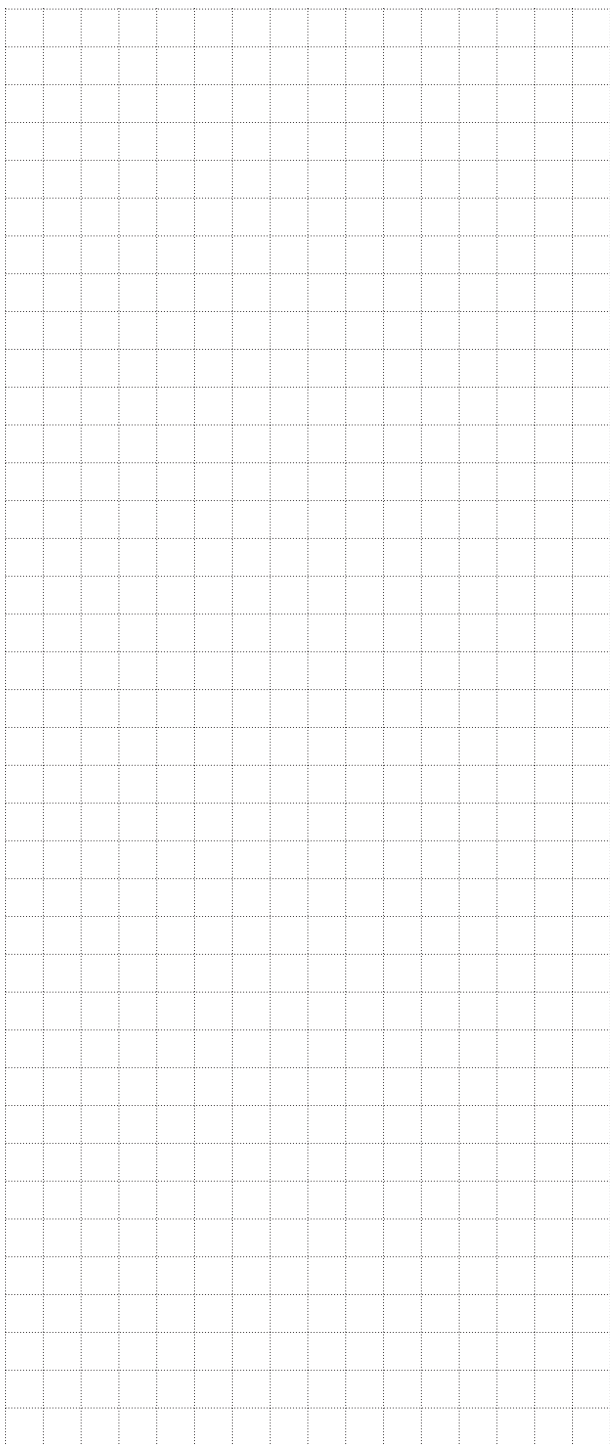
Corrective actions

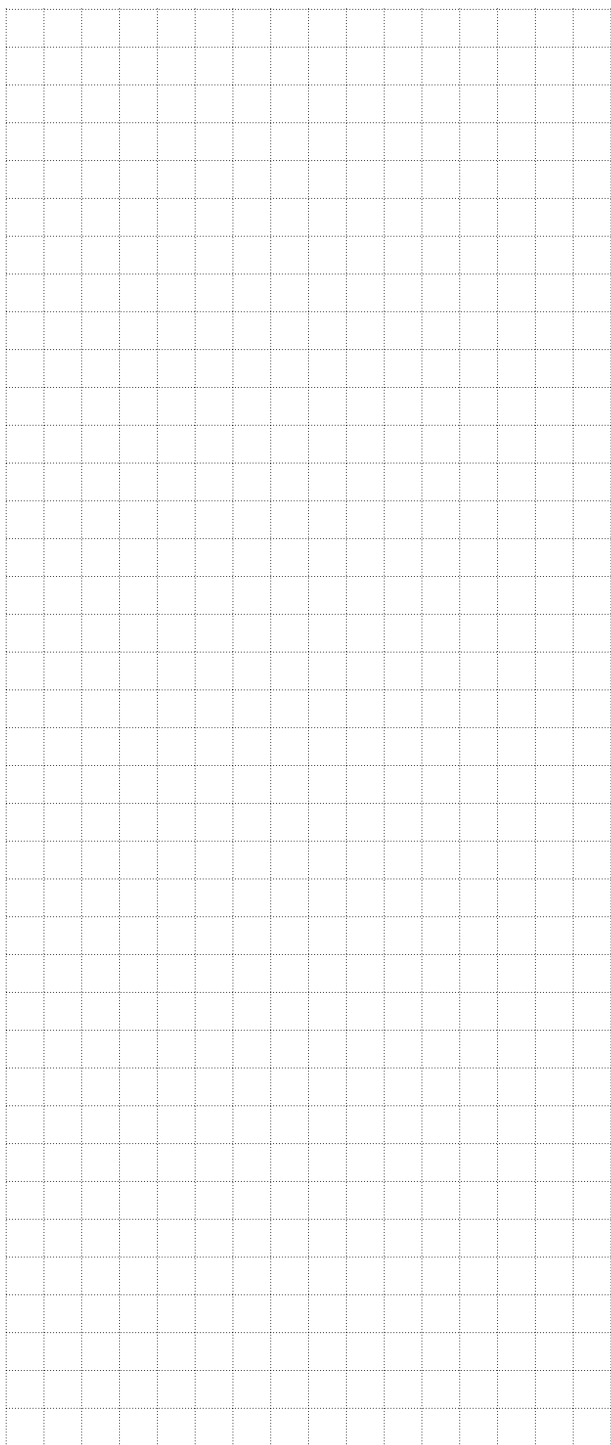
-
- 1 Remove wet insulation and replace with dry insulation and secure it
 - 2 Confirm compliance with system design. (If valve, flange, and pipe support types and quantities have changed, additional heating cable may be required.)
 - 3 Reset temperature controller
 - 4 Contact your Chemelex representative to confirm the design and modify as recommended
 - 5 Confirm that sensor is in the correct location
 - 6 Verify temperature of fluid entering pipe
-

Corrective actions

-
- 1 Repair electrical supply lines and equipment
 - 2 Confirm wiring using the normally closed (N.C.) terminals so that contacts close with falling temperature
 - 3 Check the reason for the limiter trip. Resolve problem and reset limiter.
 - 4 Repair or replace heating cable
 - 5 Verify installation as per design and replace cable if necessary
 - 6 Verify voltage and connect to proper voltage if necessary
-







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Raychem Tracer Pyrotenax Nuheat

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