



**KME ITALY SpA**

**MINERAL INSULATED HEATING  
CABLES**

**EN 62395 – 1: 2014-10**

---

**INSTRUCTION MANUAL**



# MINERAL INSULATED HEATING CABLES

## INSTRUCTION MANUAL

*Instruction edition: February 2018*

*Instruction review: 01*

*Translation from the original instruction*

Manufacturer:	KME ITALY SpA
Address:	Via della Repubblica, 257 55051 Fornaci di Barga (LU) ITALY
Phone:	(+39) 0583 701.413-412
Fax	(+39) 0583 701406
Web:	<a href="http://www.kme.com">www.kme.com</a>
Mail	<a href="mailto:mic@kme.com">mic@kme.com</a>

## **KME ITALY SpA – All rights reserved**

These instructions are assigned to users of MINERAL INSULATED HEATING CABLES, for the training of maintenance technicians and operators. Instructions, drawings, tables and anything else contained in this manual are of a technical reserved nature and may not be reproduced and/or published, neither completely nor in part, without specific written permission by the company KME ITALY SpA.

The company KME ITALY SpA cannot be held responsible or liable for any injury caused by incorrect use of this documentation. To avoid incorrect maneuvers which could cause hazards to persons it is important that you read and understand all the documentation supplied with the MINERAL INSULATED HEATING CABLES.

The Manufacturer reserves the right to modify some information or procedures contained in this manual at any time and without notice.

## INDEX

<b>1. Introduction .....</b>	<b>- 1 -</b>
1.1. TECHNICAL FEATURES.....	- 1 -
1.2. APPLICATION .....	- 2 -
1.3. PRODUCTIVE PROCESS.....	- 2 -
<b>2. Safety .....</b>	<b>- 13 -</b>
2.1 INTENDED USE.....	- 13 -
2.2 RESIDUAL RISKS.....	- 14 -
2.3 ATTENTIONS TO FOLLOW .....	- 14 -
2.4 INSTALLATION .....	- 15 -
2.5 UNINSTALLING AND DISPOSAL .....	- 15 -
<b>3. Dimensional and electric features .....</b>	<b>- 16 -</b>
3.1. RANGE OF PRODUCTS .....	- 16 -
3.2. TECHNICAL DATA .....	- 18 -
3.3. MINERAL INSULATION HEATING ELEMENTS.....	- 18 -
3.4. INSULATION FEATURES.....	- 19 -
<b>4. Installation .....</b>	<b>- 21 -</b>
4.1. TESTS .....	- 21 -
4.2. INSTALLATION .....	- 21 -
4.2.1 How unwind the coils.....	- 21 -
4.2.2 Cut the sections of cable .....	- 21 -
4.2.3 Bending radius .....	- 21 -
4.2.4 Bracket units .....	- 22 -
4.2.5 Dilations and vibrations .....	- 22 -
4.2.6 Buried cables .....	- 22 -
4.2.7 Installation in industrial application .....	- 24 -
4.3. EXAMPLES OF APPLICATIONS AND INSTALLATIONS AND SYSTEM DIMENSIONING .....	- 28 -
4.3.1 Outdoor Surfaces - Prevention of snow accumulation and ice formation..	- 28 -
Determining the power for the snow melting.....	- 28 -
Choose the heating elements.....	- 28 -
4.3.2 Roofs and gutters - Prevention of snow accumulation and formation of ice	- 30 -
-	-

Determining the power needed.....	- 30 -
<b>4.3.3 Industrial applications.....</b>	<b>- 32 -</b>
Thermal calculation .....	- 32 -
Choosing the heating cable.....	- 34 -
Verifying the choosen heating cable .....	- 34 -
Determination of the sheath temperature of the heating element .....	- 35 -
<b>4.3.4 Cooling cells – Floor frost protection .....</b>	<b>- 37 -</b>
Determination of the necessary power .....	- 37 -
Choosing the heating elements .....	- 37 -
<b>4.3.5 Underfloor buildings heating.....</b>	<b>- 39 -</b>
Heating system management .....	- 39 -
Determination of the necessary power .....	- 39 -
Choosing the heating elements .....	- 40 -
Installing suggestions .....	- 41 -
<b>Chapter 5 Execution of terminations and joints.....</b>	<b>- 42 -</b>
<b>5.1 TESTING.....</b>	<b>- 42 -</b>
<b>5.2 TEMPORARY SEALING OF THE ENDS OF THE CABLES .....</b>	<b>- 42 -</b>
<b>5.3 COLD JOINT EXECUTION.....</b>	<b>- 43 -</b>
<b>5.4 COLD JOINT TERMINATION.....</b>	<b>- 45 -</b>
<b>5.4.1 Gland .....</b>	<b>- 45 -</b>
Glands Type " RN " for electrical hermetic installations .....	- 45 -
Glands Type "RAD ISO " and “RAD GAS” .....	- 46 -
<b>5.4.2 Seal kits .....</b>	<b>- 49 -</b>
Brass cup -	49 -
Spacer -	50 -
Sealant -	50 -
Insulating sheaths .....	- 51 -
<b>5.5 TERMINATION EXECUTION .....</b>	<b>- 53 -</b>
<b>5.5.1 Preliminary test of the insulation resistance.....</b>	<b>- 53 -</b>
<b>5.5.2 Specific tools .....</b>	<b>- 53 -</b>
Stripper -	53 -
Crimping tool for cup/spacer .....	- 54 -
<b>5.5.3 Preparation of the ends of the cables.....</b>	<b>- 54 -</b>
<b>5.5.4 Seal mounting.....</b>	<b>- 55 -</b>
<b>5.5.5 Test of the insulation resistance before installation.....</b>	<b>- 56 -</b>

---

5.5.6	<i>Test of the insulation resistance after installation.....</i>	<i>- 56 -</i>
5.5.7	<i>Positioning the seal on cable with LSF sheath .....</i>	<i>- 57 -</i>
5.6	OTHER ACCESSORIES.....	- 58 -
5.6.1	Locknuts .....	- 58 -
6.1.1	Junction boxes.....	- 59 -
<b>Chapter 6 Annexes .....</b>		<b>- 61 -</b>
1.	MINERAL INSULATED HEATING CABLE – Facsimiles EU DECLARATION OF CONFORMITY delivered with the product	
2.	MINERAL INSULATED HEATING CABLE AND THEIR TERMINATIONS - Documentation delivered with products	



# 1.

## Introduction

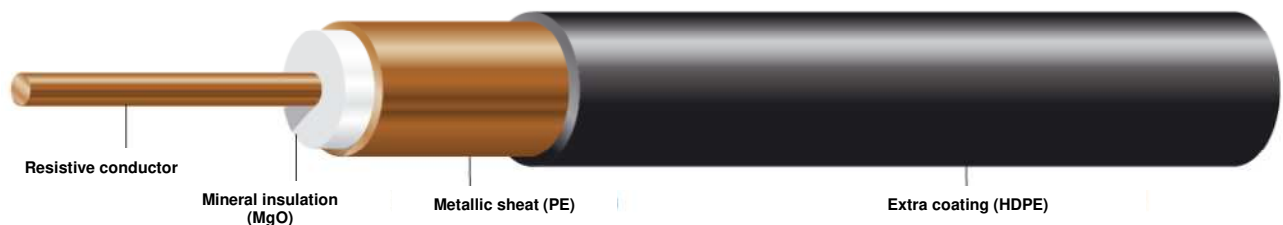
The quality of an electrical installation depends by the compliance with the regulations, by the technical capability of the designer and installer, but also by the behavior of the various electrical components in both normal situations and in critical conditions.

The task the legislator is to define the minimum conditions for which certain components have to operate; certification bodies verify that these conditions are satisfied in the actual production; to this general principle are to undergo both the components of a certain complexity that those with a simple structure which appear to be less critical.

The mineral insulated heating cable falls within the category of electric cables, a range of standardized products of common use; security issues invest heavily electrical conduits for their characteristic of crossing different environments, so then the search for innovative solutions is very important in this field too often overlooked, but vital for the whole operation of a series of safety devices required in special situations where reliability becomes critical and essential.

### 1.1. Technical features

The mineral insulated heating cable, completely made by KME Italy SpA in Fornaci di Barga (LU), consists of an isolated resistive conductor with magnesium oxide and a continuous, non-welded metal outer sheath.



To meet the different application requirements, the resistive conductor can be made of Copper or Kumanal while the outer sheath can be made of Copper, Cupronickel 70/30.

The mineral insulating cable follows a production process consisting of a series of threading operations alternating with annealing operations; threading operations on the outer sheath compresses the mineral insulator, which compresses the conductor to create a perfectly homogeneous body.

During this operation, the sheath / insulation and insulating / conductor deformations are proportional to each other without altering the properties of the Magnesium Oxide and the electrical and mechanical properties of the metal elements that make up the cable.

When the mineral insulation cable is installed in places where there are chemical or atmospheric agents that can cause corrosion of the outer sheath, this should be protected by a high density polyethylene (HDPE) extra coating; in this case, the maximum operating temperature must not exceed 105 ° C.

Mineral insulated heating cables are constructed in accordance with the IEC 800 standard and main features are:

- high performance: mineral insulation cables, made up of inorganic materials, can operate at very high temperatures and high power output;
- durability: the characteristics of the cable, determined by the inorganic components, do not degrade over time;

- mechanical resistance: mineral insulated heating cables can be bent, manipulated and installed with any shape without risk of damage to their structure and alteration of their characteristics;
- protection: the outer sheath, continuous and seamless, guarantees excellent mechanical protection and should be used as a protective conductor.

Mineral insulated heating cables are the simplest and most effective solution to the many heating problems that arise in industry and construction, and so on. And in some specific cases, it is extremely cheaper and longer lasting operation of self-regulating heating tapes.

## 1.2. Application

- Industry: There is a wide range of heating applications in this area: heated pipes, valves, tools and storage tanks to keep the fluidity of the products while machining.
- Refrigerating cells: frost protection of cold storage floor and heating of access door guides.
- Outdoor surfaces: for the prevention of snow accumulation or formation of ice on roads, viaducts, garage access ramps, parking lots, hospitals, etc.
- Gutter Channels: To keep gutters, rain goggles and end parts of ice or snow free roofs.
- Domestic heating: free from traditional systems with boiler, in combination with photovoltaic and accumulation systems (night delivery).

## 1.3. Productive process

It is interesting to briefly recall the construction method of the cable to give users the ability to more clearly appreciate the components of the material properties, which confer different characteristics compared to cables with traditional insulation.

Regarding the metal materials are used for the starting assembly of large diameter copper tubes, continuous, and without welds, and one or more of copper bars, which have between them the same relative proportions who have later in the finished cable.

The magnesium oxide powder, after a complex preliminary treatment, is compressed so as to form small cylinders, perforated longitudinally to allow insertion of the desired number of conductors.

This construction system ensures a high degree of accuracy and uniformity of the thickness of insulation between the conductors and the outer sheath and between the conductors themselves.

After the assembling of the above components, the pipe is drawn in stages with the necessary intermediate annealing to obtain the cable in the size designated by the standard construction.

After the winding of the cable in coil, the last operation is a annealing to normalize the internal stress and to ensure the most appropriate and uniform handling characteristics.

## 2. Safety

### 2.1 Intended use

Referring to the EU Declaration of Conformity, drafted in accordance with 2014/35/UE Directive – Low Voltage Directive (LDV), given with the product (see an example of declaration in Chapter 6), the intended use of the single product differ as specified below and with regard to the cable maximum operating voltage as indicated in the table:

- **Mineral Insulated Heating Cable CN Series** – Mineral Insulated Heating Cable with CuNi30Fe1Mn sheath (Alloy N. C71520) and Cu ETP Conductors (Alloy N. CW004A).
- **Mineral Insulated Heating Cable H/CN Series** – Mineral Insulated Heating Cable with CuNi30Fe1Mn sheath (Alloy N. C71520) and Cu ETP Conductors (Alloy N. CW004A).
- **Mineral Insulated Heating Cable KN Series** – Mineral Insulated Heating Cable with CuNi30Fe1Mn Sheath (Alloy N. C71520) and CuMn10Al2 Conductors.
- **Mineral Insulated Heating Cable CC Series** – Mineral Insulated Heating Cable with Cu DHP Sheath (Alloy N. CW024A) and Cu ETP Conductors (Alloy N. CW004A).
- **Mineral Insulated Heating Cable KC Series** – Mineral Insulated Heating Cable with Cu DHP Sheath (Alloy N. CW024A) and CuMn10Al2 Conductors.
- **Terminations for Mineral Insulated Heating Cable** – Seal and/or glands to perform termination of Mineral Insulated Heating Cable with RAD ISO, RAD GAS, RN glands, according to what marked on them.

Series/Cable Type	Maximum Operating Voltage
CC4, CC7, CC11, CC17	750 V
CC25, CC40, CC63	600 V
CC88	400 V
Series CN	600 v
Series H/CN	750 V
KC100, KC140, KC220, KC315, KC450, KC630, KC800, KC1600	600 V
KC1250, KC2000, KC2700	400 V
Series KN	600 V

*Note:* the cables belonging to the series CC/DHPE and KC/DHPE being the equivalent ones, with external covering in HDPE, of the CC and KC series have the same maximum operating voltages as the corresponding bare cables.

All Mineral Insulated Heating Cable can be used for the following types of **installations and applications**.

- Installations of **trace heating for surface heating** on pipes, vessels and associated equipment – applications include: freeze protection and temperature maintenance, hot water lines, oil and chemical lines, sprinkler system mains and supply piping.
- **Outdoor exposed area installations** of trace heating – applications include: roof de-icing, gutter and down-spout de-icing, catch basins and drains, rail heating.
- Installations with **embedded trace heating** – applications include: snow melting, frost heave protection, floor warming, energy storage systems, door frames.

## 2.2 Residual risks

Here is a list of residual risks in the event of incorrect transport, installation, use or maintenance of Mineral Insulated Heating Cable and their Terminations.

- **Electrocution** due to incorrect execution of the termination, putting one of the phases on the earth sheath.



- **Electrocution** or insulation loss due to incorrect handling or installation because of shock, crushing, perforations or excessive bending of the cable, that could damage the earth sheath.



- **Bump** due to the cable fall in case of faulty handling or installation.



- **Cutting / Shearing / Puncture / Burns** during manual operations required for the installation and the termination's execution.



- **Generic hazard** for transportation, installation, use or maintenance performed by unqualified and non trained or incorrectly equipped personnel.



- Contact with **chemicals**.



## 2.3 Attentions to follow

The following are the attentions to follow during transport, installation, operation and maintenance of Mineral Insulated Heating Cable and their Terminations.

- Always wear PPE required for transportation, installation and use (gloves, goggles, helmets, shoes).
- Designate for these operations only technical personnel trained on the correct procedures for the transport, installation, use and maintenance of Mineral Insulated Heating Cable and their Terminations.
- For a proper design and installation of the system, it is strictly necessary to refer to the table in the paragraph to this document "3.1 Range of products", where the fundamental relationship between Temperature, Power Resistance and Cable Length is reported to achieve the desired result.
- Earth-fault equipment protection is required for each circuit.
- De-energize all power circuits before installation or servicing.
- Keep ends of trace heaters and surface heaters and kit components dry before and during installation.
- Caution: only use in areas subject to low risk of mechanical damage.
- The additional mechanical covering shall not be removed and the trace heater or surface heater shall not be operated without the mechanical protection in place.
- The presence of the trace heating equipment shall be made evident by the posting of caution signs or marking at appropriate locations and/or at frequent intervals along the circuit.
- The presence of the trace heating equipment shall be made evident by the posting of caution signs or marking where clearly visible.
- Persons involved in the installation and testing of electrical trace heating systems shall be suitably trained in all special techniques required. Installations are intended to be carried out under the supervision of a qualified person.
- For use with sprinkler systems the system installation shall comply with the obstruction requirements of local codes and standards (e.g. NFPA 13 [3]) such the thermal insulation over the trace heating does not unacceptably obstruct the sprinkler or cover the wrench boss.
- Sprinkler systems provided with trace heating shall be properly grounded..
- For use with sprinkler systems the design and monitoring of trace heating systems shall be in accordance with IEC 62395-1 and IEC 62395-2.
- If the backup power is being provided for the building electrical systems, it shall also provide backup power supply for the trace heating system.
- For use with sprinkler systems the intended applications are for supply piping and branch lines including sprinkler heads.
- For use with sprinkler systems the minimum ambient rating is – 40 °C.
- During the execution of the termination connect immediately the earth sheath to a properly marked section of cable, before performing the remaining steps.



- 
- Pay attention to the weight to transport and handle, and certainly if more than 20 kg, do not carry it manually but use suitable lifting and transport equipment.
  - During installation and execution of terminations always mark in a visible and unequivocal way the cables at both ends
  - At the end of installation and execution of terminations make a visual check on the earth sheath, to check for any discontinuities, perforations, excessive crushing or bending.
  - At the end of installation and execution of terminations perform a strength test and an insulation resistance test before powering up the system.
  - Use only KME tools for installation and execution of terminations.
  - Use only KME terminations and accessories.
  - When you install at altitude, constrain the cables through the use of KME staples, using an adequate fixing distance.
  - Durante il trasporto, l'installazione e lo stoccaggio prestare attenzione in ogni momento al raggio di curvatura del cavo, che deve essere appropriato al diametro del cavo affinché lo stesso non venga danneggiato.
  - During transport, installation and storing avoid shocks, crushing or perforations that may make the cable unusable.
  - The mineral insulated cable is moisture sensitive, because the magnesium oxide, that acts as insulation, absorbs moisture if left exposed, causing the decrease of the insulation resistance value. If stored for a long time or if it's necessary to hold the cable exposed to humid environment, it is good practice to temporarily seal the ends by wrapping them with self agglomerating tape or by wrapping the ends of the cable with common insulating tape.
  - In case of storage, even temporarily, use covered areas, protected from weather and far from transit zones; also the plastic cover of the coated cables may harden and deteriorate if kept to sunlight for a long time.
  - In case of manipulation of chemical agents, follow the instructions of the related material safety data sheet (MSDS).
  - Before uninstall the cable, ensure that there is no voltage in the system

## 2.4 Installation

For the correct and complete installation procedure and execution of the terminations procedure carefully follow what quoted in this document at the specific paragraph, where are reported all KME accessories required and detailed procedures to fully execute transportation, installation and termination of Mineral Insulated Heating Cable, accompanied by technical data, tips and detailed illustrations about.

## 2.5 Uninstalling and disposal

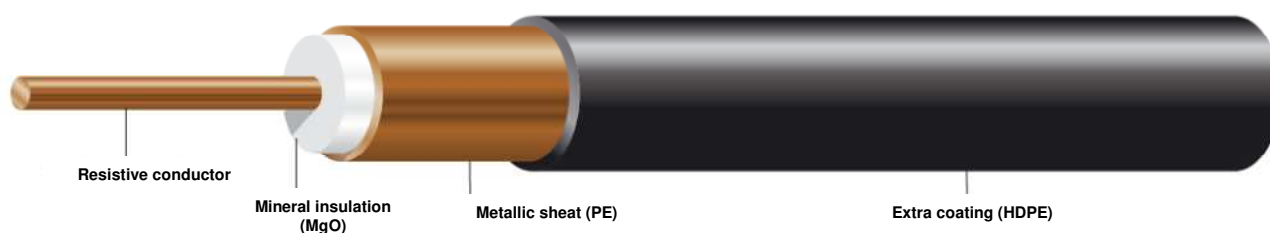
Before proceeding to final dismantling it is necessary to separate the various parts that could cause pollution, make a selection of materials in order to facilitate recycling, to earmark separate disposal.

## 3.

## Dimensional and electric features

### 3.1. Range of products

The mineral insulated heating cable, completely made by KME Italy SpA in Fornaci di Barga (LU), consists of an isolated resistive conductor with magnesium oxide and a continuous, non-welded metal outer sheath.



To meet the different application requirements, the resistive conductor can be made of Copper or Kumanal while the outer sheath can be made of Copper, Cupronickel 70/30.

The following tables show the various possible combinations between the conductor type and the outer sheath, highlighting for each of these the maximum operating temperatures and the electrical / dimensional characteristics. **For a proper design and installation of the system, it is strictly necessary to refer to the following tables, where the fundamental relationship between Temperature, Power Resistance and Cable Length is reported to achieve the desired result.**

CORE TYPE	SHEATH TYPE	MAX OPERATING TEMPERATURE (°C)	CABLE CODE
Copper (C)	Copper (C) + Polyethylene (HDPE)	110	CC/HDPE
Kumanal (K)	Copper (C) + Polyethylene (HDPE)	110	KC/HDPE
Copper (C)	Copper (C)	250	CC
Kumanal (K)	Copper (C)	250	KC
Copper (C)	Cupronickel (CN)	400	CN
Kumanal (K)	Cupronickel (CN)	400	KN

OUTER SHEATH IN COPPER			
Cable Type	Resistance $\Omega/\text{km}$ at 20°C	Ø Outer sheath mm	Ø Core mm
KC 2700	2700	2.7	0.44
KC 2000	2000	2.8	0.51
KC 1600	1600	3.5	0.57
KC 1250	1250	2.8	0.65
KC 800	800	3.5	0.81
KC 630	630	4.0	0.91
KC 450	450	4.0	1.08
KC 315	315	4.3	1.29
KC 220	220	4.5	1.54
KC 140	140	4.9	1.93
KC 100	100	5.2	2.28
CC 88	88	2.7	0.5
CC 63	63	3.2	0.59
CC 40	40	3.4	0.74
CC 25	25	3.7	0.94
CC 17	17	4.6	1.13
CC 11	11	4.9	1.38
CC 7	7	5.3	1.78
CC 4	4	5.9	2.26

OUTER SHEATH IN COPPER AND HDPE			
Cable Type	Resistance $\Omega/\text{km}$ at 20°C	Ø Outer sheath mm	Ø Core mm
KC 2700/HDPE	2700	4.3	0.44
KC 2000/HDPE	2000	4.4	0.51
KC 1600/HDPE	1600	5.1	0.57
KC 1250/HDPE	1250	4.4	0.65
KC 800/HDPE	800	5.1	0.81
KC 630/HDPE	630	5.6	0.91
KC 450/HDPE	450	5.6	1.08
KC 315/HDPE	315	5.9	1.29
KC 220/HDPE	220	6.1	1.54
KC 140/HDPE	140	6.5	1.93
KC 100/HDPE	100	6.8	2.28
CC 88/HDPE	88	4.3	0.5
CC 63/HDPE	63	4.8	0.59
CC 40/HDPE	40	5.0	0.74
CC 25/HDPE	25	5.3	0.94
CC 17/HDPE	17	6.2	1.13
CC 11/HDPE	11	6.5	1.38
CC 7/HDPE	7	6.9	1.78
CC 4/HDPE	4	7.5	2.26

OUTER SHEATH IN COPPER NICKEL AND CORE IN KUMANAL (K)			
Cable Type	Resistance $\Omega/\text{km}$ at 20°C	Ø Outer sheath mm	Ø Core mm
KN 1600	1600	3.2	0.57
KN 1000	1000	3.4	0.72
KN 630	630	3.7	0.91
KN 400	400	4.0	1.14
KN 250	250	4.4	1.45
KN 160	160	4.9	1.81

OUTER SHEATH IN COPPER NICKEL AND CORE IN COPPER (C)			
Cable Type	Resistance $\Omega/\text{km}$ at 20°C	Ø Outer sheath mm	Ø Core mm
CN 63	63	3.2	0.59
CN 40	40	3.4	0.74
CN 25	25	3.7	0.94
CN 17	17	4.6	1.13
CN 11	11	4.9	1.38
CN 7	7	5.3	1.78
CN 4	4	5.9	2.25

## 3.2. Technical data

The conductor resistance is dependent on the temperature according to the following relationship:

$$R_t = R_{20} \cdot [1 + \alpha \cdot (t - 20)]$$

where:

$R_t$  = resistance at temperature  $t$  ;

$R_{20}$  = resistance at temperature 20 °C;

$t$  = temperature under consideration;

$\alpha$  = temperature coefficient.

$\alpha$  and  $[1 + \alpha (t - 20)]$  values are shown in the following table.

Materials	Resisitivity at 20°C	$\alpha$
Copper (C)	1.72 $\mu\Omega \text{ cm}^2/\text{cm}$	0.004
Kumanal (K)	41.0 $\mu\Omega \text{ cm}^2/\text{cm}$	0
Nickel/Chrome 80/20 (T)	113 $\mu\Omega \text{ cm}^2/\text{cm}$	variable

Copper (C)	Temperature (°C)	20	40	60	80	100	150	250
	$[1 + \alpha(t-20)]$	1	1.08	1.16	1.24	1.32	1.52	1.92
Kumanal (K)	Temperature (°C)	From 20 to 350 °C						
	$[1 + \alpha(t-20)]$	1						
Nickel/Chrome 80/20 (T)	Temperature (°C)	20	100	200	400	600	800	
	$[1 + \alpha(t-20)]$	1	1.019	1.035	1.063	1.066	1.062	

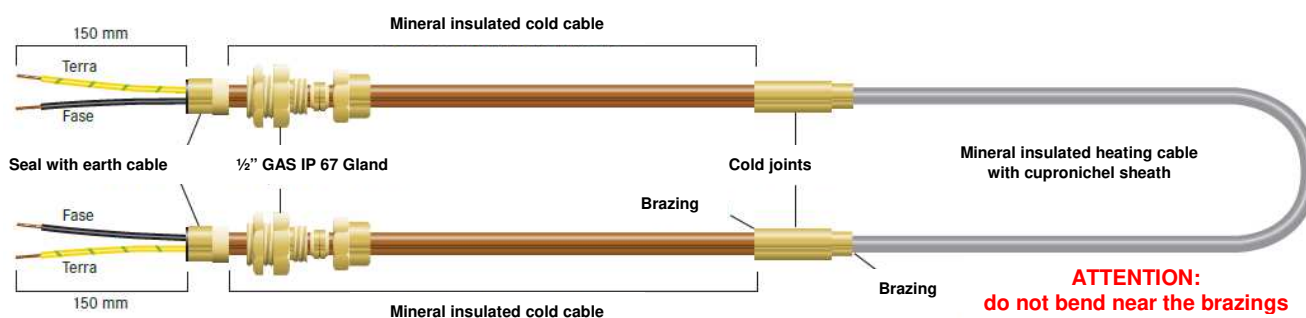
## 3.3. Mineral insulation heating elements

A heating element is a system:

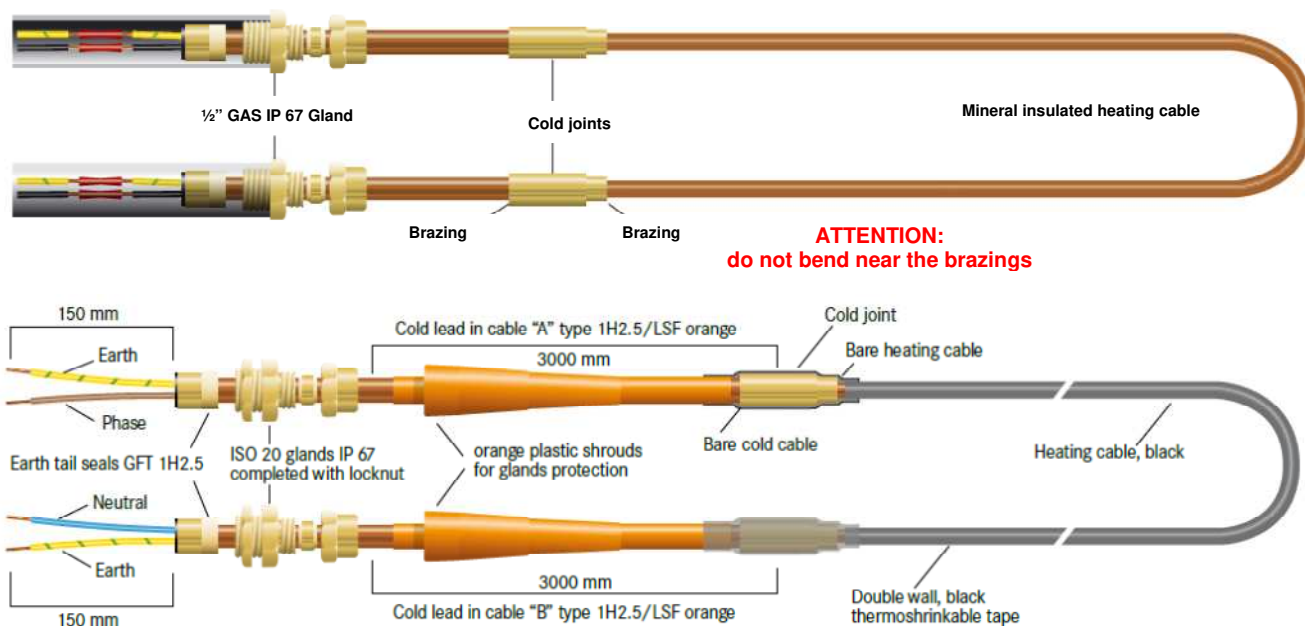
- designed by the KME Technical Service, in such a way as to provide the thermal power at the appropriate sheath temperature;
- already assembled in the factory and ready to be installed, to be directly powered by connection to the power supply box or control panel.

The mineral insulating element consists of an active heating section and two cold ends connected to the heating cable by means of two suitable cold joints.

The cold sections are made of heavy series (450/750 V) mineral isolation cable, unipolar or bipolar, with a copper conductor section that is considerably higher than that of the heating cable; They are normally fitted with a brass fuse of 1/2 "UNI EN 228 (ex UNI 338) gas with IP 67 degree of protection and a ground wire terminal.



If there is a need, which has already occurred during the design phase or after installation, to vary the length of the cold queues, special junctions between cold mineral quench and traditional cable can be adopted, as shown in the figure below. This mode of supply would ensure maximum installation flexibility for the installation company, leaving it in charge of choosing and supplying the type of traditional cable considered to be the most suitable on site.



### 3.4. Insulation features

#### *Thermal conductivity*

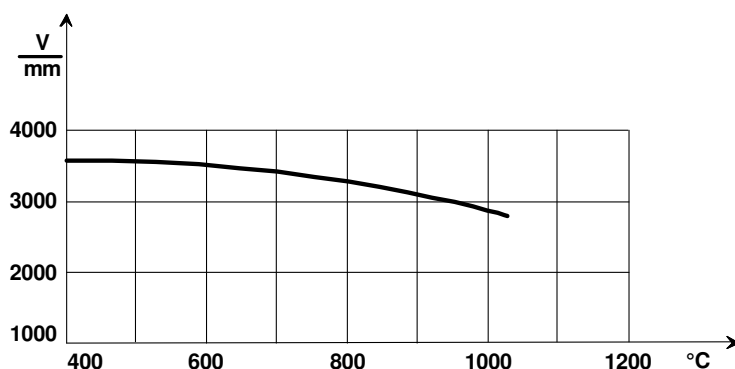
As is well known, an electrical insulator is also a thermal insulator; In ordinary cables, therefore, the electrical insulation prevents the diffusion of heat to the outside and the cable thus assumes, with the same current as transported, a higher temperature with respect to a cable with the mineral insulator.

In fact, magnesium oxide is an exception to this general rule: it is an excellent electrical insulator and a good thermal conductor; These two characteristics allow to electrically isolate conductors and easily transmit Joule-produced heat to the outside.

The thermal conductivity of magnesium oxide increases with its density, resulting from the degree of compression; The constructive process of KME ITALY results in a density of 2.0 g / cm<sup>3</sup> corresponding to a thermal conductivity of 2.36 W / m ° C.

#### *Dielectric strength*

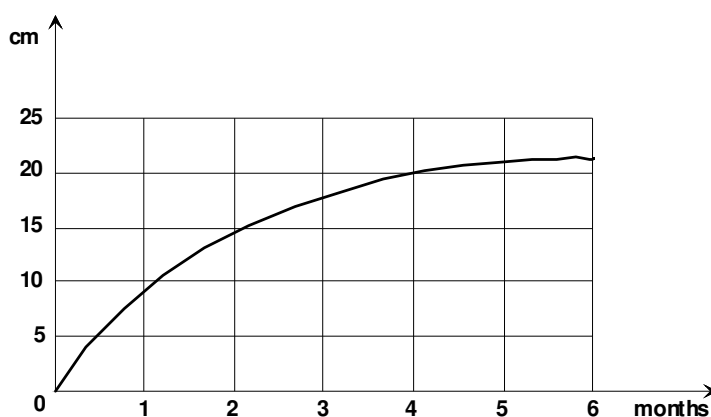
The dielectric strength of the insulator decreases with the increase in temperature as shown in the following diagram; This decrease is relatively negligible at temperatures below 1000 °C.



### *Resistance to humidity*

Magnesium oxide, used in the cable as an electrical insulator, is hygroscopic and the presence of moisture reduces the value of insulation resistance; This, measured with a megaohmmeter at 500 V must be greater than 100 MΩ.

In any case, if one end of the cable is left open, moisture penetrates inward only for a few centimeters; The following diagram shows the depth of moisture penetration as a function of the exposure time to the atmosphere of a non-sealed end cable.



Moisture can therefore easily be removed or by cutting about 0.1 m of cable from each end without heating or heating the cord with an industrial phon so as to push the moisture towards the free ends.

In order to avoid moisture absorption, both the cable shipped and those in the warehouse are temporarily sealed and the ends of each cable taken in operation must be protected by special terminals.

## 4.

# Installation

The purpose of this section is to provide a general guide to the installation of electrical energy cables with mineral insulation; installation systems, materials and plant components must comply with the applicable standards.

### 4.1. Tests

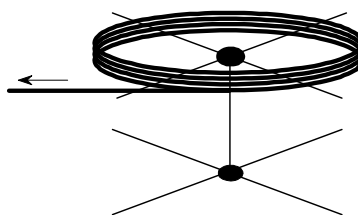
It is necessary, before installation, to check the insulation resistance, using a megohmmeter or megger with a set voltage of 500 V dc between the conductors and the outer copper sheath; in such conditions the insulation resistance must not be less than 100 M $\Omega$ ; when the installation is complete, every cable terminations must be again subjected to the insulation resistance test as described above.

### 4.2. Installation

#### 4.2.1 How unwind the coils

The mineral insulated cable is normally supplied in self-supporting coils having an internal diameter of 500, 1200 and 1450 mm depending on the outer diameter of the cable.

To unwind properly the coils is possible to construct a simple unwinder, using a metal profile or wooden boards such as that used for the support of common cables.

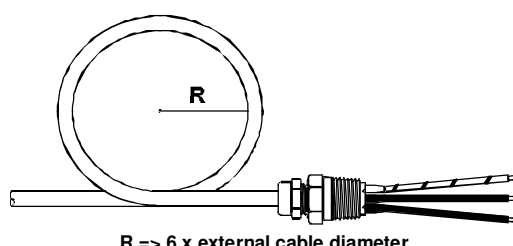


#### 4.2.2 Cut the sections of cable

When you have to cut the sections of cable from coil, the length of the sections can be roughly determined by multiplying the average internal diameter (length of a cable loop) of the coil for  $\pi$  and counting the number of turns necessary.

#### 4.2.3 Bending radius

The curves should generally be limited to a minimum radius of no less than six times the Diameter of the copper sheath of the cable, so as to allow to straighten the cable and perform any subsequent curves.

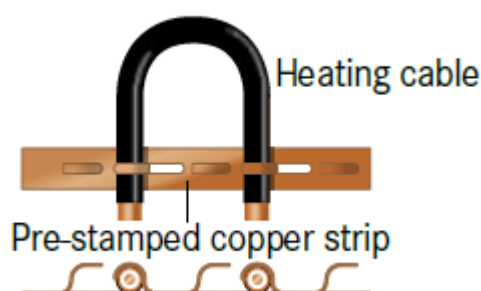


If it is necessary to perform more tight curves, the minimum radius of curvature must not be less than that indicated in the following Table; these curves should be permanent and any straightening, if unavoidable, must be carried out carefully to avoid damage to the copper sheath of the cable.

Cable external diameter (mm)	Minimum bending radius (mm)
$D < 12$	3 D
$12 < D < 15$	4 D
$15 < D < 25$	6 D
$D > 25$	12 D

#### 4.2.4 Bracket units

When there is no welded mesh to attach the heating cable, apply the pre-stamped copper strip (with expansion plugs or steel nails to the floor) (see figure below); The tapes will be applied at a distance of 1 to 2 meters and in any case in such a way as to ensure a sufficient fastening to maintain the geometry and the set pitch.



#### 4.2.5 Dilations and vibrations

When the cable passes through expansion joints of structures, or when connects equipment subjected to vibrations, is required the realization of expansion rings whose minimum radius must not be less than six times the outer Diameter of the cable.

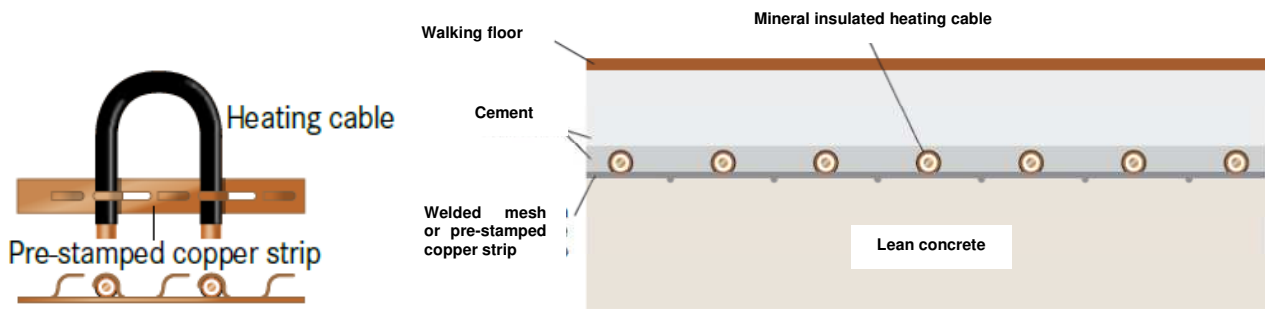
In the case of excessive and prolonged vibration it is advisable to carry out the termination of the cable MICO in a junction box adjacent to the user's power supply terminal; the connection between the terminal and the junction box can be performed with a flexible cable

#### 4.2.6 Buried cables

Before fixing the cable this must be straightened by hand or by using the straightener or pipe bend; The straightening can be done using a wooden block and a hammer, or with a rubber hammer; A metal hammer must never be used directly on the cable sheath in order not to compromise the mechanical and electrical characteristics of the sheath itself.

The heating elements lie at a depth of  $5 \div 7$  cm from the rolling or tread planes (asphalt, cement, etc.) with longitudinal forward and return passageways to the direction of travel; The finish coating will be made after the heating elements have been installed.

1 When there is no welded mesh to which the heating cable is attached, apply the pre-stamped copper strip (with the expansion plugs or steel nails to the floor) (see figure below); The tapes will be applied at a distance of 1 to 2 meters and in any case in such a way as to ensure a sufficient fastening to maintain the geometry and the set pitch.



2 Remove the heating element from the packaging and check the parameters indicated on the identification card (type, length, power, voltage, etc.); Carefully store this tag that must then be attached to the cold tail near the power supply box. On the back of the card, the installer's installation location must be affixed to the ramp, slider, etc ..

3 Check the insulation resistance using a Megaohmmeter or Megger with a voltage of 500 V between the resistive conductor (with black insulating sleeve) and ground conductor (with yellow / green insulating sheath); The value found must be equal to or greater than 100 MΩ.

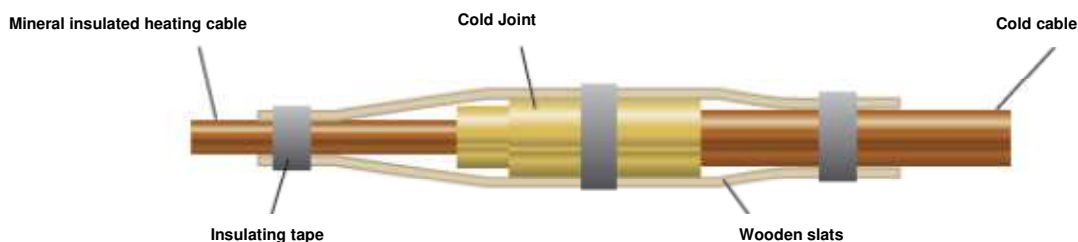
4 Determine the position of the power supply box, then place the cold joint of the heating element on the floor so that the cold wire reaches the power supply box while remaining immersed in the concrete slab.

5 Carefully unfold the heating element and fasten it to the pretreated copper strip with the geometry and the pitch provided; The minimum bending radius of the heating cable must not be less than 8 times the outer diameter of the cable.

6 If the surface S to be heated is slightly different from the ones shown in the previous table, the actual installation step P of the heating element (length L) will be determined with the following report:

$$P \text{ [cm]} = \frac{S \text{ [m}^2\text{]} \cdot 100}{L \text{ [m]}}$$

7 The junction between the hot and cold section, carried out by a joint, must be handled with care, avoiding bending in its vicinity. To prevent damage, the area could be reinforced with two wooden slats fixed with normal insulating tape.

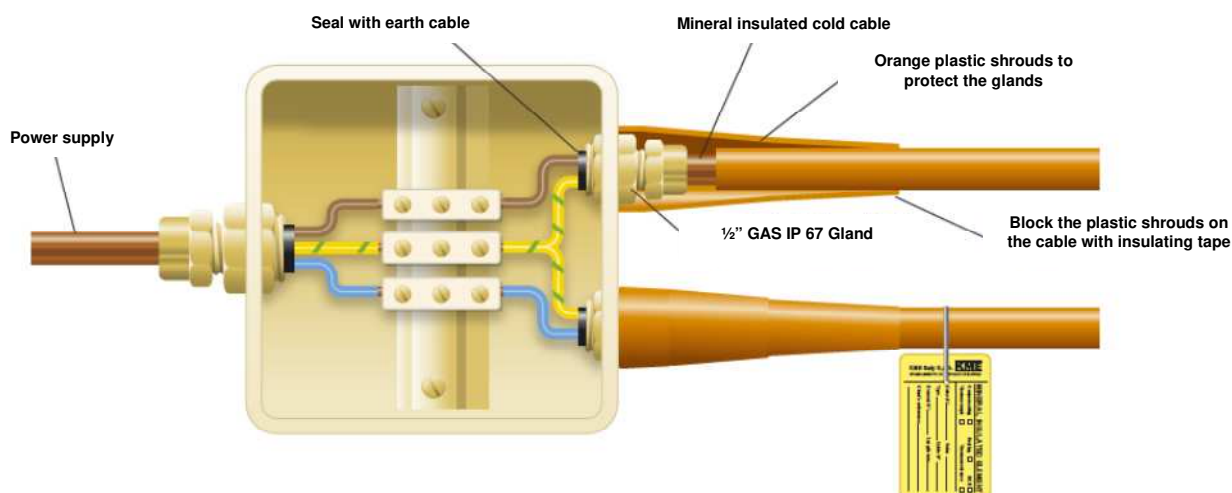


8 Before securing the last loop, connect the cold queue to the power supply box and complete the fastening until it runs out.

9 When finished, check the isolation resistance again before laying the slab in the manner described above.

10 Make a concrete cast of thickness of 2 cm; This operation is necessary to avoid mechanical damage (which may compromise its operation) to the heating cable during the next stage finishing of the ramp. During the throwing operation and its finish the heating element must not: be trampled down, hit by tool-tips or driven by means of transport such as wheelbarrows etc .; If you can not do without crossing the ramp during the throw you have to use wooden boards that will be resting on the heating element gently. Failure to do so may cause damage such as to delay the laying and cause the heating element to be replaced.

11 Again, check the insulating strength and electrical continuity of the heating element and perform the connections to the power cassette, as shown in the following figure.



**ATTENTION:**  
do not bend near the brazings. Cold joints must be  
put under cement

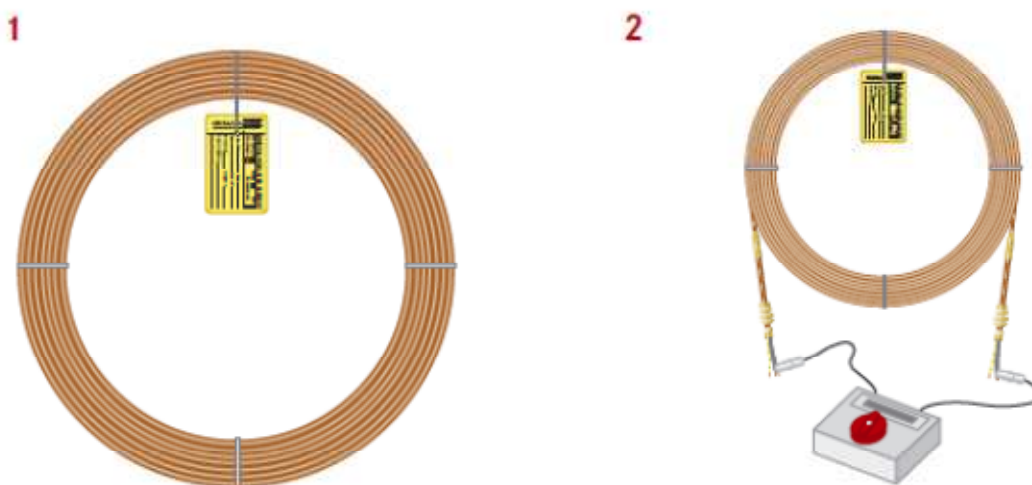
The presence of underground electric heating cables must be clearly indicated (CEI 11-17) and a copy of the installation geometry must be in the possession of the plant maintenance manager in order to avoid damaging the heating cables during any work on the ramp. Following the laying of the cable.

## 4.2.7 Installation in industrial application

Before fixing the cable this must be straightened by hand or by using the straightener or pipe bend; The straightening can be done using a wooden block and a hammer, or with a rubber hammer; A metal hammer must never be used directly on the cable sheath in order not to compromise the mechanical and electrical characteristics of the sheath itself.

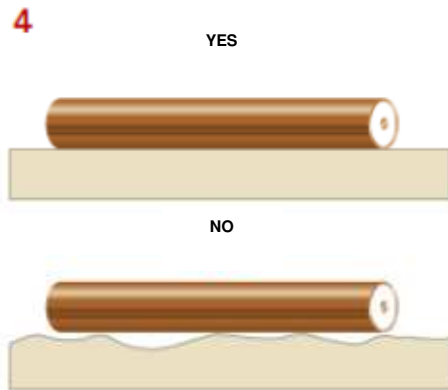
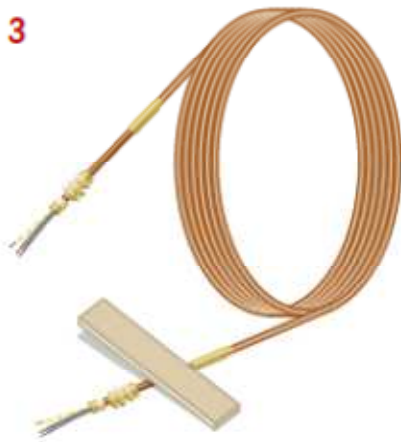
1 Remove the heating element from the packaging and check the parameters indicated on the identification card (type, length, power, voltage, etc.); Carefully store this tag that must then be attached to the cold tail near the power supply box. On the back of the board, the installer's installation location must be affixed to the pipeline, reservoir, etc. by the installer.

2 Check the electrical continuity and insulation resistance using a Megaohmmeter or Megger with a voltage of 500 V between the resistive conductor (with black insulating sleeve) and the earth conductor (with yellow / green insulating sheath); The value found must be equal to or greater than 100 MΩ.



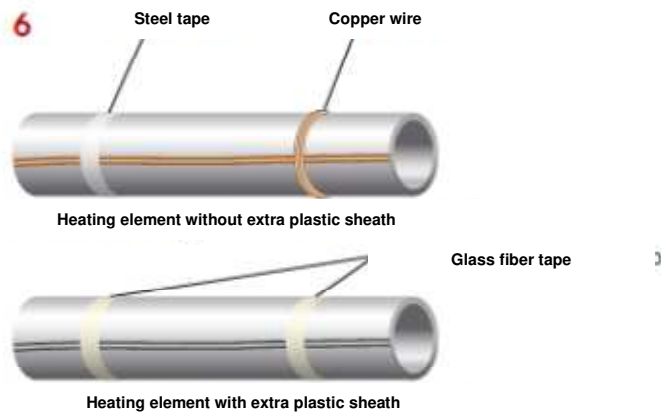
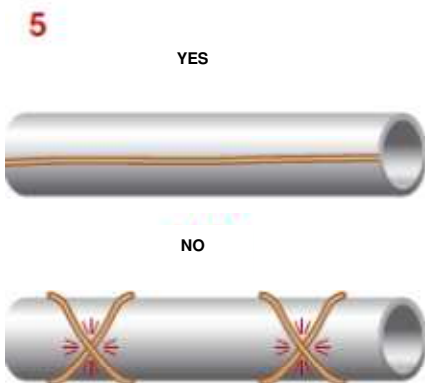
3 Carefully unscrew the heating element by careful not bending it near the blades on the cold joints; To this end a wooden tablet may be used;

4 Do not install the heating elements on rough surfaces or on sharp edges; In this way, interpose between any sharp edges (as in the case of valves or flanges as shown below) and the heating cable a metal sheet;



5 the heating cables must not be in contact or overlap;

6 for fixing the heating elements with a sheath without further plastic coating it is recommended to use metal clamps with rounded edges or copper wire; In this case, be careful not to distort the cable. In the case of heat-sealing elements with plastic coating, use a fiberglass adhesive tape;



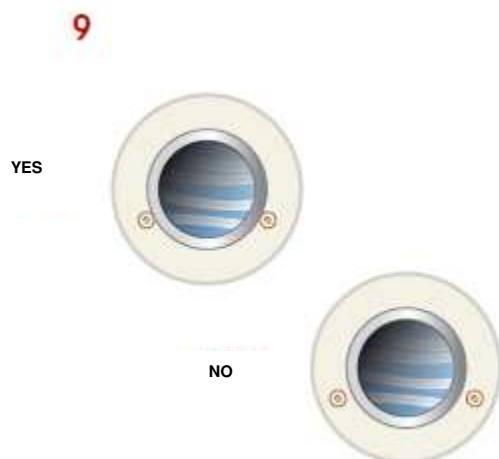
7 the minimum bending radius of the heating cable must not be less than  $6 \div 8$  times the outer diameter of the cable; The thermostat sensor must not be placed in direct contact or under the influence of the heating element. This is usually located at the point of the pipeline where it is presumed to have the lowest temperature;

8 depending on the diameter of the cable or the type of installation (longitudinal or spiralized) the distance between the fixing and the other varies from 500 to 750 mm;

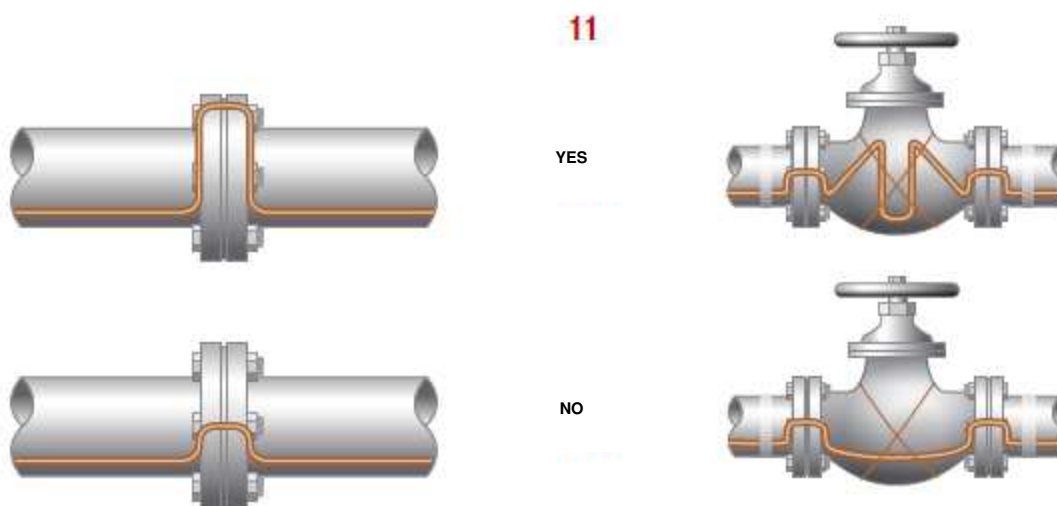


9 the heating element must be placed in close contact with the surface to be heated. In some situations it may be necessary to use thermal cement; In this case this should not contain corrosive substances for the heating element sheath;

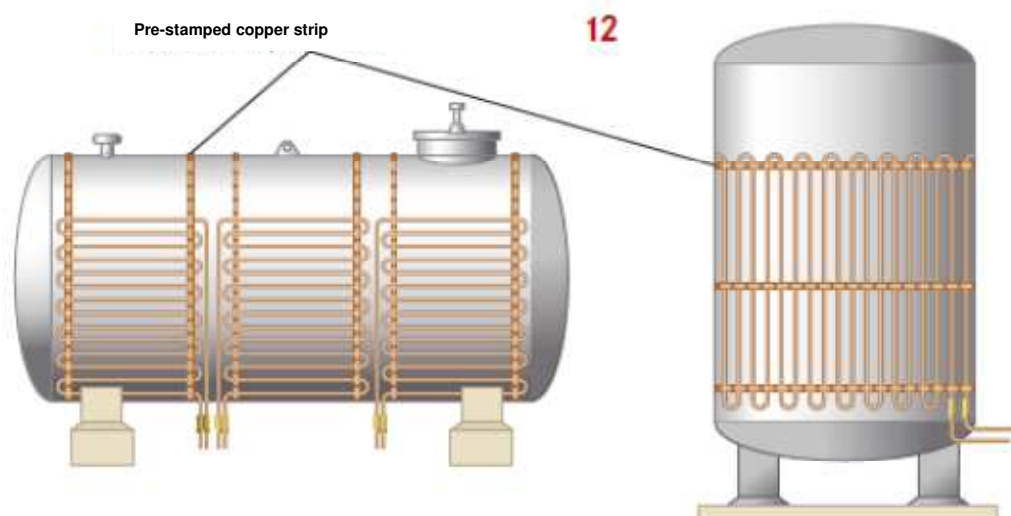
10 cold joints should not be in contact with the pipe (or the particular to be heated) but they must be placed outside the insole, where they can not be damaged;



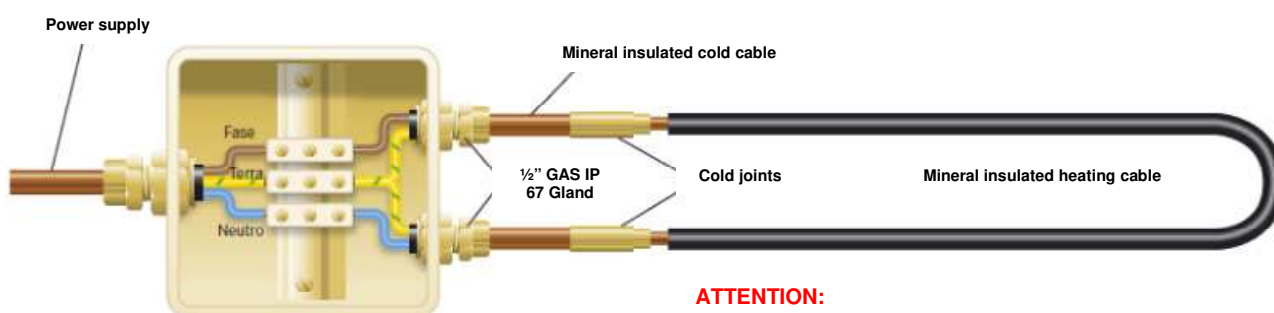
11 on the valves and flanges the heating elements must be installed in such a way as to allow the disassembly of the equipment and at the same time to effectively achieve heating;



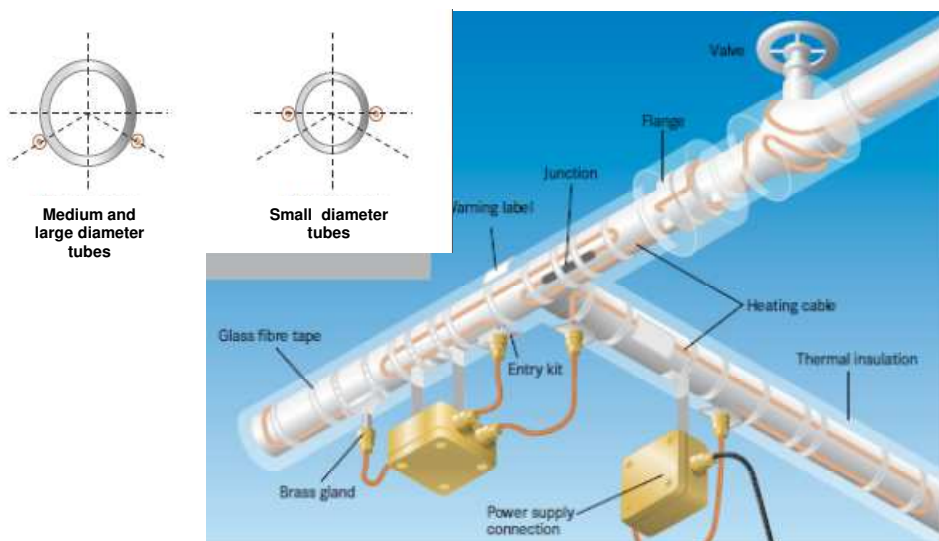
12 on the tanks the heating elements must be fixed by means of a normal metallic or pretreated metal band. The fastenings must be equidistant and ensure contact between the tank and the heating element without damaging it.



When finished, check the insulation resistance and electrical continuity of the heating element before the insulation is applied, as described above. These checks must be repeated after the insulation has been completed; Then connect the heating element to the power supply box previously positioned and fastened to a suitable bracket.



**ATTENTION:**  
do not bend near the brazings



## 4.3. Examples of applications and installations and system dimensioning

### 4.3.1 Outdoor Surfaces - Prevention of snow accumulation and ice formation

The development of traffic in areas exposed to difficult atmospheric conditions asks at the technicians to solve problems related to the most appropriate methods to avoid the disadvantages caused by snow accumulations or ice formation. It is wrong, however, to assume that these problems are only related to mountain trails as they may also occur in plain areas.

It is of course a general need to reduce the possibility of damage to things and people due to road accidents, which can only be carried out by clearing snow or ice from roads, viaducts, terraces, staircases, garage access ramps, parking lots, hospitals, ramps for disabled people, etc..

The elimination of snow and ice, until a few years ago, was carried out exclusively by manual, mechanical, chemical (salt) or architectural (shelter, shelter, etc.). These methods, in addition to not ensuring complete removal of snow or ice, have adverse effects and are difficult to control for environment and existing structures.

Therefore, to prevent ice formation or snow build up on outdoor surfaces without causing adverse effects to the environment, it is necessary to heat the surface by installing a heat source beneath the drivable floor.

Among the possible methods, the electrical one has proved to be the most suitable for this type of system. In fact it combines the simplicity of transport of electricity with a remarkable response speed, proven uniformity in the heat transmission throughout the heating element, great flexibility and safety. Furthermore, the use of electric heating allows to partialize the system and to avoid any maintenance and control problems of other systems such as hot water heating.

In particular, the use of mineral insulating cable, due to the wide range of conductors with different specific resistance, ensures a more accurate and uniform heat distribution by allowing an installed specific power (W / m<sup>2</sup>) considerably lower than other similar systems, without causing additional fuel consumption when it is not necessary to heat the area. Thanks to the circular section, it's easy to install and does not require any special arrangements during installation.

In order to protect the copper cable sheath from any corrosive agents contained in the cement or soil and to allow the cable to slide as a result of light thermal expansion, a HDPE extra coating (high density polyethylene) is extruded on it,.

It should also be recalled that heating by mineral-insulated heating cables, like other similar systems, has a preventative action in relation to the intended purpose. It is therefore necessary to provide for the start-up of the system before the ice formation on the surface to be kept usable.

Details of the duration of these start-up times are given at the end of this section.

#### DETERMINING THE POWER FOR THE SNOW MELTING

In relation to snow characteristics, density, specific heat and thermal conductivity, ambient temperature and hence the thermal leap in relation to flooring, it was proposed (\*) to evaluate the power needed to dissolve the snow during precipitation, the following function:

$$P = 1,52 \cdot d \cdot y \cdot \left( 144 + \frac{32 - T}{2} \right)$$

where:

**P** = power needed (W/ft<sup>2</sup>);

**d** = intensity of precipitation (inch/h);

**y** = snow density during precipitation (g/cm<sup>3</sup>);

**T** = air temperature (°F)

#### CHOOSE THE HEATING ELEMENTS

The choose the heating elements, when calculating the specific power (W / m<sup>2</sup>) with the method described above, the following procedure has to be performed::

- determine the total power to be installed (specific surface power to be heated in advance);
- the total power to be dispensed will be divided into several elements (except in the case of really modest surfaces, no single heating element can be used) so that the current absorbed by each element is compatible with the normal control, distribution and interrupting equipment available on the market;
- calculate the length of each heating element according to the laying step that normally, to ensure uniform distribution of heat, ranges from 15 to 20 cm;
- determine the required electrical resistance (Ω / m) according to the supply voltage;

- choose the type of cable that has the electrical resistance immediately below the predetermined value and calculate, depending on the actual value, the power to insert the heating element.

Normally the choice of the heating cable will fall on the copper-sheathed and copper conductor types, so it is necessary to check the temperature assumed by the cable sheath under the concrete depending on the specific power delivered to insert the heating element and to correct the resistance to temperature. It should be noted that the sheath temperature value under concrete or bitumen must not exceed the value of 50 ° C at running time. Operatively it is necessary to:

- Determine the thermal stress (W / cm<sup>2</sup>) of the heating cable with the following function:

$$\text{Thermal Stress} \left[ \frac{\text{W}}{\text{cm}^2} \right] = \frac{P}{L \cdot \Phi \cdot \pi \cdot 10}$$

where

**P** = power to insert the heating element (W);

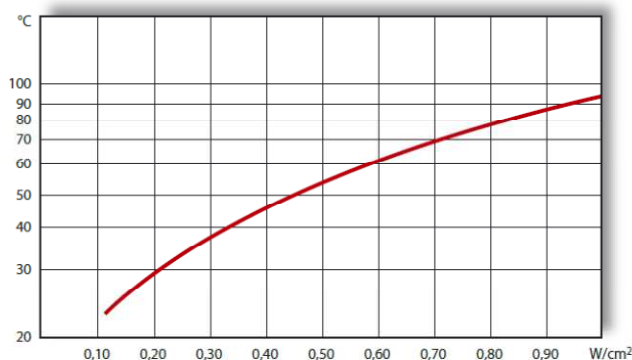
**L** = heating element lenght (m);

**Φ** = outer diameter of the cable sheath (mm);

- identify the value of the thermal stress on the following diagram and read the temperature of the corresponding sheath;
- perform the resistance value correction using the following function:

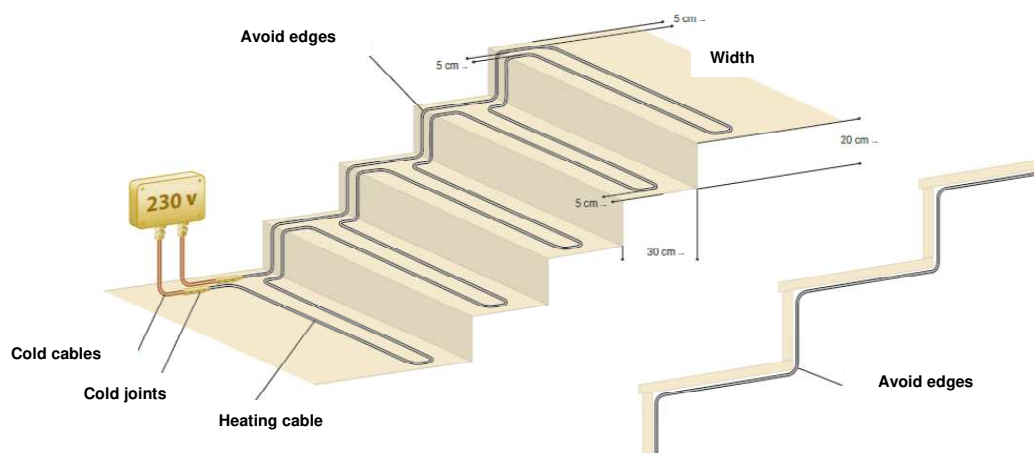
$$R_t = R_{20} \cdot [1 + \alpha \cdot (t - 20)]$$

- determine, with the value of the correct resistance, the resulting running power.

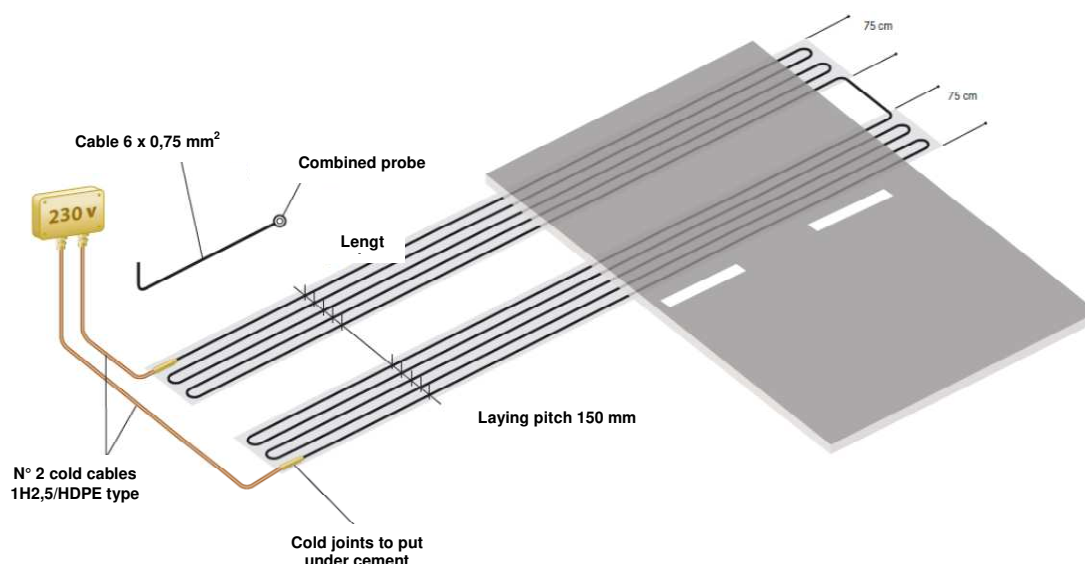


- commercial control units can be used to control the system.

### Staircase heating



#### Heating two drivable strips



### 4.3.2 Roofs and gutters - Prevention of snow accumulation and formation of ice

The mineral insulating elements are the ideal system to keep gutter or rain pipes free from ice and snow for all types of buildings. With them it is also possible to prevent the ice accumulations on the gutter channels that not only damage the gutters themselves, but represent a potential danger to people safety.

Mineral insulation heaters are also used to prevent ice formation or snow accumulation in drainpipes or along the edges of the roof. In this way it is avoided that the water formed by the melting of the snow, finding the ice as an obstacle, penetrates the attic damaging the structures.

#### DETERMINING THE POWER NEEDED

In these applications the power to be installed varies depending on the weather conditions and the orientation of the buildings, but experience shows, in most cases, a sufficient specific power value of  $50 \div 70 \text{ W / m}$  for the gutter or drainpipe.

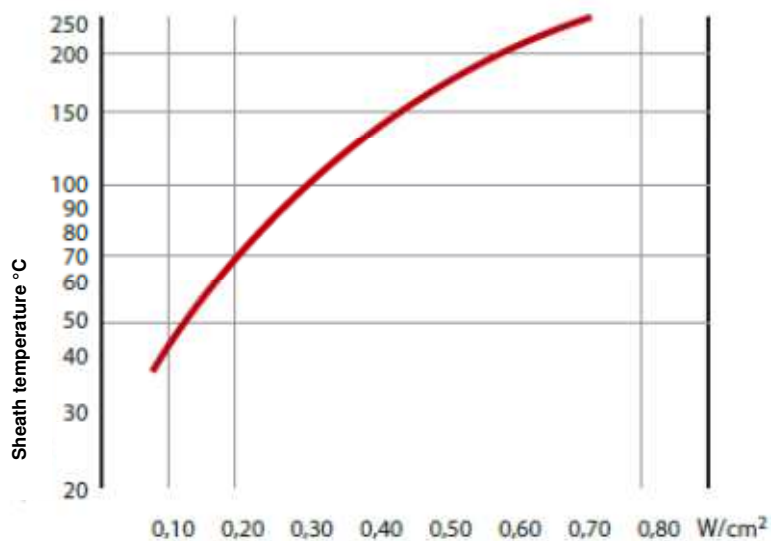
Normally, the mineral insulating cable is laid in the gutter channels with a back and forth path (for widths greater than 100 mm, the number of passages should be increased) to the drain well even if this is buried. However, if ice is felt to move the cable, it is necessary to attach it to the gutter with some tin-welding points or staples.

For drainpipe on roofs or ceiling blades, normally the power required is  $400 \div 600 \text{ W / m}^2$  and the heating part must be about 30 cm wide with a zigzag path to evenly distribute the heat. Therefore the length of the heating cable should be about 2.5 times the length of the roof concerned.

Even in this case, it is necessary to fasten the cable to the metal roof with tin-plated welds or staples.



First determine the total power to be installed by choosing the most suitable unitary power for the site of installation (specific power of  $50 \div 70 \text{ W / m}$  for drainpipes or gutters,  $400 \div 600 \text{ W / m}^2$  for the extreme bands of the roof ). At the end of this calculation, we find the number of circuits in which the total load is distributed and so the power  $P_i$  and the length  $L_i$  are established for each circuit. The unitary resistance of the appropriate cable for that circuit will be:



$$P_i = \frac{V^2}{R_i \cdot L_i}$$

The potentially suitable cable is therefore the one with unitary resistance just below the calculated one. However, it must be verified that:

- 1) the cable sheath temperature, function of the thermal stress imposed on the cable selected, is compatible with the characteristics of the outer sheath;
- 2) the increase in the resistance of the conductor, due to such temperature increase, is not able to reduce too much the power output.

If one of these checks is negative, recheck length and number of circuits and restart the calculations.

The evaluation of the above-mentioned thermal stress  $P_i$  results from the following function:

$$\hat{P}_i = \frac{P_i}{\pi \cdot \Phi \cdot 10 \cdot L_i}$$

where  $\Phi$  is the cable diameter (mm).

On non-metallic roofs it is possible to greatly improve the performance of the cable by mounting a suitable metal sheet that, in addition to distributing evenly the heat, prevents damage to the covers for localized heating. If gutters, ducts, drainpipes and roof channels are made of galvanized metallic material (eg zinc plating), it is necessary to install cables with extra HDPE coating, but the cable sheath have not to exceed 105 ° C.

### 4.3.3 Industrial applications

This section presents the technical details for solving heating or maintaining problems for temperature of pipes or tanks in industrial processes.

The use of mineral insulated heating cables is particularly suitable in situations where there are high temperatures, long installation lengths or high specific powers.

#### THERMAL CALCULATION

The problems that arise in regard to the thermal dimensioning of pipes, storage tanks, valves, tools, etc. can be categorized and discussed in the following ways.

##### 1 Thermally insulated piping temperature maintenance

In order to determine the specific power (in W / m of piping) required to maintain the required temperature (compensation of thermal losses through the insulating material) the following relationship can be used:

$$W_m = 2,75 \frac{K \cdot (t_m - t_a)}{E \cdot \log_{10} \left( \frac{D + 2 \cdot s}{D} \right)}$$

where:

**W<sub>m</sub>** = unitary power needed to compensate leaks through the insulator (W / m) along the pipeline;

**K** = insulator thermal conductivity (W/m °C);

**D** = pipe external diameter (mm);

**s** = insulator thickness (mm);

**t<sub>m</sub>** = temperature to maintain (°C);

**t<sub>a</sub>** = minimum external temperature (°C);

**E** = efficiency factor (usually 0,7).

To facilitate calculation, the following table shows the required power (W / m), depending on external temperature, pipe diameter and insulation thickness, for temperature maintenance against icing, for the most common pipe diameter.

Insulator Thickness	20 mm		30 mm		40 mm		50 mm	
External temperature	-10 °C	-20 °C	-10 °C	-20 °C	-10 °C	-20 °C	-10 °C	-20 °C
½" (21,3 mm)	4,6	7,7	3,7	6,2	3,2	5,3		
¾" (26,9 mm)	5,4	9,0	4,2	7,0	3,6	6,0		
1" (33,7 mm)	6,3	10,5	4,8	8,0	4,1	6,8	3,6	6,0
1-1/4" (42,4 mm)	7,4	12,3	5,6	9,3	4,7	7,8	4,1	6,8
1-1/2" (48,3 mm)	8,1	13,5	6,1	10,2	5,1	8,5	4,4	7,3
2" (60,3 mm)	9,6	16,0	7,1	11,8	5,8	9,7	5,0	8,3
2-1/2" (76,1 mm)	11,6	19,3	8,5	14,2	6,8	11,3	5,9	9,8
3" (88,9 mm)	13,2	22,0	9,5	15,8	7,3	12,2	6,5	10,8
4" (114,3 mm)	16,3	27,2	11,6	19,3	9,2	15,3	7,8	13,0

Below we report the thermal conductivity (W / m ° C) of the most common types of insulator, as a function of the operating temperature.

Insulator	Working temperature	Density [kg/m <sup>3</sup> ]	0 °C	50 °C	80 °C	100 °C	150 °C	200 °C	250 °C
Crosslinked polyethylene foam	-80÷100 °C	25	0,034	0,041	0,043				
Hard foam polyurethane	-150÷90 °C	32	0,021	0,026	0,028				
Mineral wools	800 °C	120	0,035	0,041	0,044	0,047	0,056	0,066	0,081
HT Resinated fiberglass	400 °C	63		0,036	0,040	0,044	0,055	0,066	0,077
Asbestos fiber	600 °C	150		0,053	0,055	0,057	0,068	0,081	0,096

Pipe Diameter		Fluid Temperature			Pipe diameter		Fluid temperature		
[Inch]	[mm]	55 °C	-86÷105 °C	>105 °C	[Inch]	[mm]	55 °C	-86÷105 °C	>105 °C
1/8"	10,2	15			2"	60,3	40	50	50
1/4"	13,5	15			2-1/2"	76,1	40	50	50
3/8"	17,2	20			3"	88,9	40	50	50
1/2"	21,3	25	30	40	3-1/2"	101,6	50	50	50
3/4"	26,9	30	40	40	4"	114,3	50	50	50
1"	33,7	30	40	50	6"	168,3	50	60	60
1-1/4"	42,4	30	40	50	8"	219,1	60	70	80
1-1/2"	48,3	30	40	50	10"	273,0	60	70	80

The following table shows the length increments required for valve and flange tracing according to diameter.

Pipe diameter	Flanges	Valves	Pipe diameter	Flanges	Valves	Pipe diameter	Flanges	Valves
3/4"			4"	0,6	1,2	14"	1,3	2,7
1"	0,3	0,3	6"	0,6	1,2	16"	1,3	3,0
1-1/2"	0,3	0,6	8"	0,6	1,5	18"	1,3	3,6
2"	0,3	0,9	10"	1,0	1,8	20"	1,6	3,6
3"	0,3	0,9	12"	1,0	2,4	24"	1,6	3,6

### 2 Heating of thermally insulated pipes

The power required to increase the temperature of the fluid contained in the piping is determined by the following function:

$$W_{rT} = \frac{P \cdot S + C \cdot Q}{E \cdot H} \cdot \Delta T + \frac{2}{3} \cdot W_{mT}$$

where:

**W<sub>rT</sub>** = unitary power required for heating (W/m) equal to  $\Delta T$  along the pipeline;

**W<sub>mT</sub>** = unitary power needed to compensate for losses through the insulator (W/m) along the pipeline;

**P** = unitary pipe weight (kg/m);

**S** = specific heat capacity of the pipe material (Wh/kg °C);

**C** = unitary weight of the fluid in the pipe (kg/m);

**Q** = specific heat capacity of the fluid in the pipe (Wh/kg °C);

**$\Delta T$**  = thermal difference (°C);

**H** = heating time (h);

**E** = efficiency factor (usually 0,7).

### 3 Thermally insulated vessels temperature maintenance

The total power required to compensate heat losses through the insulator is obtained with this function:

$$W_{mS} = \frac{A \cdot K \cdot (t_m - t_a)}{S \cdot E}$$

dove:

**W<sub>mS</sub>** = total power needed to compensate leaks through the insulator (W) for the total volume of the vessel;

**A** = surface area of the vessel (m<sup>2</sup>);

**K** = insulator thermal conductivity (W/m °C);

**T<sub>m</sub>** = temperature to maintain (°C);

**T<sub>a</sub>** = minimum external temperature (°C);

**S** = insulator thickness (mm);

**E** = efficiency factor (usually 0,7).

### 4 Heating of thermally insulated vessels

The total power to raise the fluid temperature in the vessel is determined by the following function:

$$W_{rS} = \frac{P \cdot S + C \cdot Q}{E \cdot H} \cdot \Delta T + \frac{2}{3} \cdot W_{mS}$$

where:

**WrS** = total power required for heating (W), equal to  $\Delta T$ , for the total volume of the vessel;

**WmS** = power needed to compensate leaks through the insulator (W);

**P** = weight of the material in the vessel (kg);

**C** = specific heat capacity of the material in the vessel (Wh/kg °C);

**S** = weight of the vessel (kg);

**Q** = specific heat capacity of the vessel material (Wh/kg °C);

$\Delta T$  = thermal difference (°C);

**H** = heating time (h);

**E** = efficiency factor (usually 0,7).

### 5 Non thermally insulated piping of vessels temperature maintenance

When the pipe (or the vessel) is not thermally insulated, the power required (W) to compensate heat dispersions is proportional:

- to the exchange surface S, that is the external surface of the pipe ( $m^2 / m$ ) or the vessel ( $m^2$ );
- the coefficient of heat exchange K between the outer surface of the pipe or vessel ( $Wh / m^2$ ) and the environment; under normal conditions the value of K is usually equal to  $11 \div 13$ ;
- the difference between the temperature to maintain ( $t_m$ ) and the external temperature ( $t_a$ ).

With an approximation, the following experimental function can therefore be used:

$$W_m = K \cdot S \cdot (t_m - t_a)$$

where Wm is reported in W/m for pipes and in W for vessels.

To facilitate calculation, the table below indicates the exchange surface ( $m^2/m$ ) of the most common diameter pipes.

Pipe Ø (inch)	Pipe Ø (mm)	Exchange surface ( $m^2/m$ )	Pipe Ø (inch)	Pipe Ø (mm)	Exchange surface ( $m^2/m$ )
1/2"	21.33	0.067	4"	114.30	0.360
3/4"	26.67	0.084	6"	168.27	0.529
1"	33.40	0.105	8"	219.07	0.688
1-1/2"	50.54	0.158	10"	273.05	0.857
2"	60.32	0.189	12"	323.85	1.017
3"	88.90	0.279	14"	355.60	1.116

When pipes and vessels are not thermally insulated, the required power is very high, so the system is not economical.

### CHOOSING THE HEATING CABLE

You have to choose the heating cable as follows:

- calculate the required power through the functions in previous paragraphs;
- calculate the ohmic resistance R of the cable required to obtain the required power or,

$$R = \frac{V^2}{W}$$

where:

**V** = suppli voltage (V);

**W** = power (W);

- divide the R value for the length of the heating element to obtain the specific resistance ( $\Omega / m$ );
- choose the heating cable with the specific resistance that most closely matches this value.

### VERIFYING THE CHOSEN HEATING CABLE

- Calculate the temperature reached from the sheath of the heating cable and verify that it does not exceed the maximum working temperature, depending on the type of sheath, as defined in the tables in paragraph 3.1 *Range of products*.
- For cables with resistive copper conductors from the CC and CN series, perform the following steps: calculate, with the function given in the paragraph 4.3.1 *Outdoor Surfaces - Prevention of snow accumulation and ice formation*, the value of the temperature resistance reached by the sheath of the heating cable; This value is the definitive one to use in the relationships of the previous points.
- Check that at the operating temperature the power dissipated by the heating element is the required one; otherwise, choose the heating cable with the immediately lower resistance and repeat the procedure.

---

**DETERMINATION OF THE SHEATH TEMPERATURE OF THE HEATING ELEMENT**

The following graphs 1 and 2 allow to determine the sheath temperature at various loads in W / m, for a standard cable diameter and for different temperatures to maintain.

Temperature values can be reported to other diameters, calculating the equivalent Weq power as follows:

- divide the load (power in W of the heating element) for its length L in meters;
- multiply this value (W / m of cable) for the following ratios to get the equivalent value to look for on the diagram.

The temperature of the sheath of heating elements with insulator can also be determined, in approximate terms, with the following function:

$$T_g = T_m + \frac{9,33 \cdot W}{d_2}$$

where:

**T<sub>g</sub>** = sheath temperature (°C);

**T<sub>m</sub>** = external temperature of the cable, to assume as the temperature to maintain (°C);

**W** = power dissipated by every meter of cable (W/m);

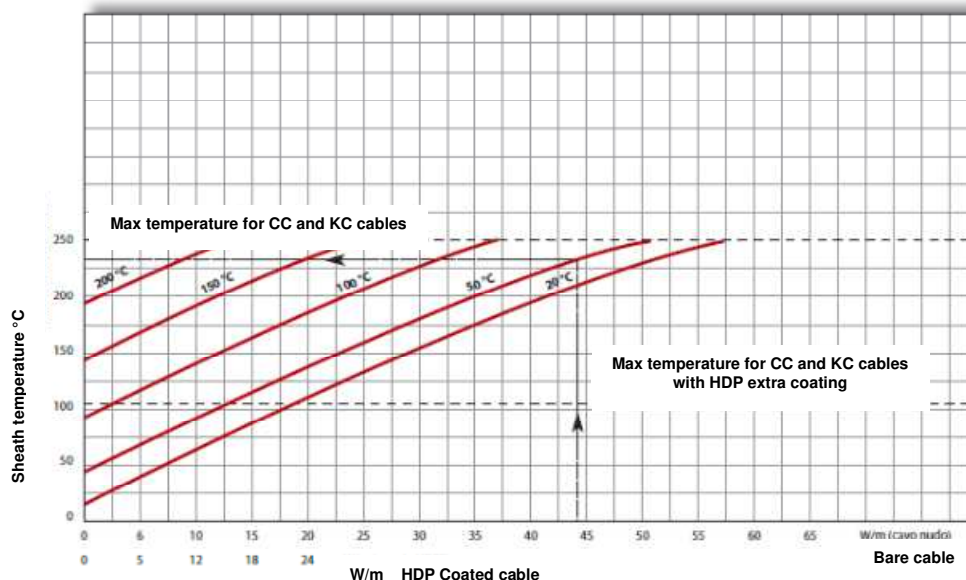
**d<sub>2</sub>** = heating cable external diameter (mm).

### Graph N°1

Cables with copper sheath (CC and KC series)

$$W_{eq} = \frac{W}{L} \cdot \frac{3}{\varnothing \text{ cavo (mm)}}$$

Sheath temperature of cables with copper sheath, CC and KC series



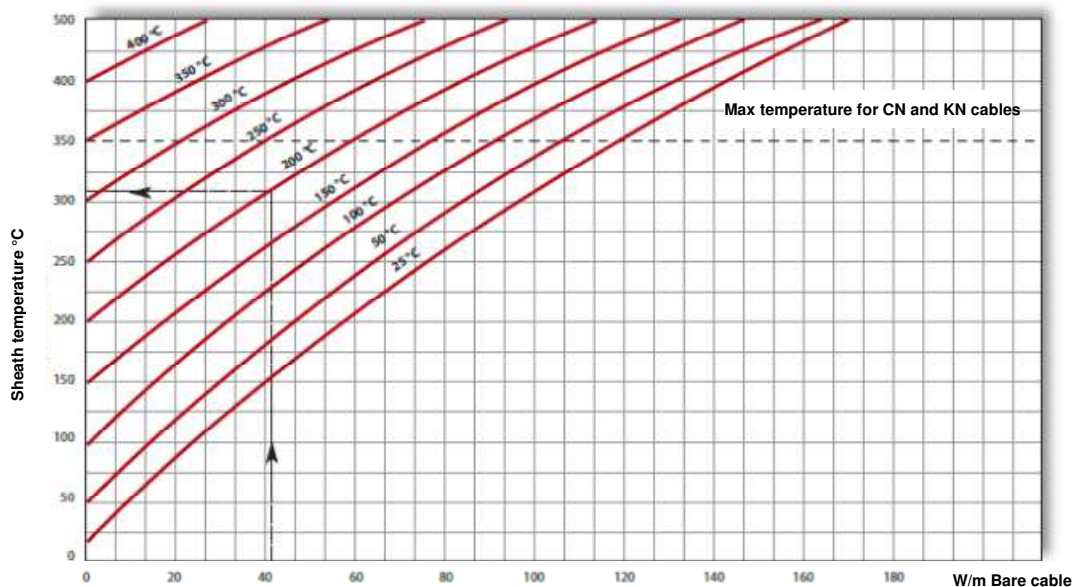
Example: KC 315 cable with 63 W/m power in 50 °C air temperature  
Equivalent power:  $63 \times 3 / 4,3 = 44 \text{ W/m circa}$   
To this value corresponds, for 50 °C air temperature, a 230 °C circa sheath temperature.

### Graph N°2

Cables with cupronickel sheath (CN and KN series)

$$W_{eq} = \frac{W}{L} \cdot \frac{3,2}{\varnothing \text{ cavo (mm)}}$$

Sheath temperature of cables with cupronickel sheath, CN and KN series



Example: KN 400 cable with 53 W/m power in 200 °C air temperature  
Equivalent power:  $53 \times 3,2 / 4 = 42,4 \text{ W/m circa}$   
To this value corresponds, for 200 °C air temperature, a 310 °C circa sheath temperature.

### 4.3.4 Cooling cells – Floor frost protection

Temperatures below 0 ° C must be kept within the refrigerating cells. Therefore, there is a loss of frigories through the floor and the relative insulation that will affect the underlying ground.

It is inevitable that such losses of frigates cause freezing of the underlying soil and cause damage to the floor and in some cases to the structure of the cell itself.

To overcome this disadvantage, it is necessary to realize a heating system that compensates the frigories dispersed from the floor to the ground. For this purpose mineral insulating materials will be used and sized according to the following procedure.

#### DETERMINATION OF THE NECESSARY POWER

The power required to protect the refrigeration storage stand from frost is determined by the following function:

$$P_s = \frac{K \cdot \Delta t}{E \cdot S}$$

where:

**P<sub>s</sub>** = Specific power (W / m<sup>2</sup>) required to protect the stand from frost;

**K** = Thermal conductivity coefficient of the insulator (W / m ° C); See the following table for the most commonly used types;

**Δt** = temperature difference (°C) indicating the difference between the temperature of the soil, conventionally assumed to be +5 ° C and the one made in the refrigerating cell;

**S** = Thickness of the thermal insulator (m);

**E** = Heating factor efficiency factor employed; In the case of an electric heating with mineral insulated heating cables it is assumed to be 0.8. This factor also takes into account thermal losses during plant stoppages.

Thermal conductivity coefficient of the insulator [W/m °C]	
Mineral fibers	0.041
Polystyrene	0.041
Cellular glass	0.053
Agglomerated cork	0.052

#### CHOOSING THE HEATING ELEMENTS

The choice of suitable mineral isolation elements is based on the knowledge of the following parameters:

- specific power (W / m<sup>2</sup>) calculated with the previous function;
- floor area (m<sup>2</sup>);
- voltage available.

To determine the type of heating cable necessary may be useful as the following example:

Stand area: 300 m<sup>2</sup>;

Cell temperature: - 30 ° C;

Voltage available: 220/380 V;

Thermal insulation material: expanded polystyrene;

Thermal insulating thickness: 0.2 m;

Presumed soil temperature under the floor: +5 ° C.

According to the previous report, the specific power required to protect the floor from freezing is equal to:

$$P_s = \frac{K \cdot \Delta t}{E \cdot S} = \frac{0,041 \cdot (5 + 30)}{0,8 \cdot 0,2} = 8,97 \text{ W/m}^2$$

Total power to install:

$$P = 8,97 \cdot 300 = 2700 \text{ W}$$

This power will be divided into n ° 3 heating elements, each one for one third of the surface to be heated, connected in order to realize a three-phase 3x400 V power supply with star connection.

So the electrical resistance of each element will be:

$$R = \frac{V^2}{P} = \frac{230^2}{900} = 58,77 \Omega$$

To determine the length of each heating element, the installation pitch of the heating elements is within the range of 0.3 ÷ 0.5 m (lower values give rise to very long and unnecessarily expensive heating elements, while higher values do not guarantee a uniform distribution of heat in the stand). Therefore, fixing to 40 cm the step of laying each element will have a length of:

$$L = \frac{\text{Area [m}^2\text{]} \cdot 100}{\text{Pitch [cm]}} = \frac{100 \cdot 100}{40} = 250 \text{ m}$$

It follows that the specific resistance of the heating cable will be:

$$R_t = \frac{R}{L} = \frac{58,77}{250} = 0,235 \Omega/\text{m}$$

The mineral insulation cable type with the specific resistance that is closer to the one above is the type KC220 / HDPE (0.22  $\Omega$  / m). The syster will thus consist of 3 heating elements of the type KC220 / HDPE, each having a power of:

$$P = \frac{V^2}{R_t \cdot L} = \frac{230^2}{0,22 \cdot 250} = 960 \text{ W}$$

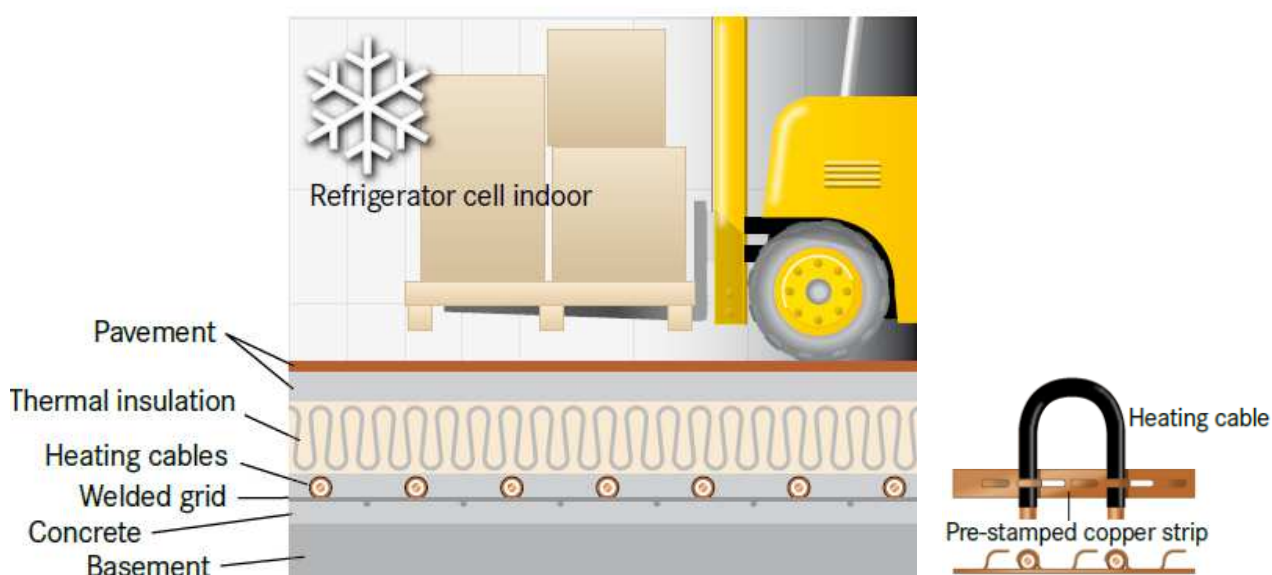
The specific power installed will be:

$$P_s = \frac{960 \cdot 3}{300} = 9,6 \text{ W/m}^2$$

In the example case, the mineral insulating elements can form a three-phase balanced system powered by 3 x 400 V and star-connected.

For connection to the power supply box, the mineral insulating elements are assembled, as previously described, with two cold joints to two cold section, of various length, depending on the geometric characteristics of the cell, usually fitted with a brass fitting of 1 / 2 "UNI EN 228 (ex UNI 338) gas with IP 67 degree of protection and a ground wire terminal.

The following figures show the typical layout of the heating elements in the floor of a refrigerating cell and the way of fixing them during installation: with common plastic bundles on an electrowelded net or with a pre-stamped copper strip.



### 4.3.5 Underfloor buildings heating

The underfloor heating system involves the use of electric heating cables drowned in the cement underneath the floor of the buildings. The system expects to exploit the thermal inertia of the concrete base, heating it for a short time (especially in periods of the day away from electricity absorption peaks) and using it as a "heat tank". The gradual release of thermal energy from the floor is enough to ensure well-being in heated environments, until the next "charge" period of the system. Obviously, this system is all the more efficient as the contractual flexibility is achieved by the electricity supply company.

#### HEATING SYSTEM MANAGEMENT

The problems that arise in regard to the thermal dimensioning of pipes, storage vessels, valves, tools, etc. can be categorized in the following ways and discussed.

A heating system, both electric and liquid fuel, must provide the customer with high performance in relation to certain parameters such as reliability, noise, installation, management and maintenance costs.

If we analyze a heating system made with mineral insulated heating cables, immersed in underfloor cement, it can be stated:

**Reliability:** It is extremely high, as the cables are drowned in the concrete and there is no mechanical part in motion. Materials used in the heating system design do not vary over time their physical, electrical, mechanical and dimensional properties, even if they are subject to prolonged and continuous use.

**Noise:** It is totally absent and this feature is extremely important for residential homes, both for ordinary use and for vacations, where the absence of background noise is particularly welcome.

**Maintenance:** It is totally absent since there is no mechanical part in motion; This aspect contributes greatly to making management of such a system easier and cheaper than traditional solutions.

**Heating speed:** The system is very fast and can be controlled by thermostats. Comfort sensations can be heard after 15 to 20 minutes after activation, since the heat source is uniformly distributed over the entire surface, and is not concentrated in a single heating element.

**Adjustment:** The required power output is carried out with different independent heating elements, so the system can be divided into several sub-systems (eg, dedicated to individual rooms): so only the electrically required energy is consumed, reducing the waste of power.

**Installation Costs:** The initial investment required for an electric heating system is approximately 60% of what is required for a hot water heating system at the same conditions and output power. This saving allows the customer to invest more in a better quality of the thermal insulation, thus reducing the total thermal energy required by a similar 60%. As a result of this reduction, the cost of management (which would represent Achilles' heel for that system, as a result of the high cost of electricity in Italy) is reduced to the point of being comparable to that of traditional systems.

**Management Costs:** The average annual cost can be calculated by multiplying:

- the heat demand per unit of volume (kW / m<sup>3</sup>);
- degrees of temperature difference between external and internal (° C) or global volumetric coefficient C<sub>g</sub>;
- number of degrees / day assigned to each specific location;
- number of hours of daily operation;
- volume of rooms to be heated (m<sup>3</sup>);
- unit cost of electricity (including charges and taxes).

Since there is no uncertainty as to the conversion yield between electric and thermal energy (unlike for fossil fuel heat generators for which this magnitude can assume any value between 0.5 and 0.9 as a function of Maintenance status, generator size, fuel type, without counting the uncertainty with which the calorific value of the fuels available on the market is known), the choice of a heating system leads to knowing exactly the average annual cost. The complete analysis of all these aspects (management and installation) therefore causes the electric heating system to be cheaper than the traditional fuel-based system.

#### DETERMINATION OF THE NECESSARY POWER

In order to properly execute the project and dimension the system to achieve the thermal conditions required by the Customer, you must be aware of the following parameters:

- total thermal power for each of the rooms to be heated;
- surface to be heated by a single heating element;
- supply voltage;
- laying pitch.

The spacing between one loop can vary between 15 and 40 cm: it rarely drops below 15 cm (otherwise the length of the cable used for installation increases too much, and with it the cost) and almost never exceeds 40 cm (too short lines generate dangerous sheath temperature increases for the cables, but above all the heat distribution is not homogeneous along the drawn surface).

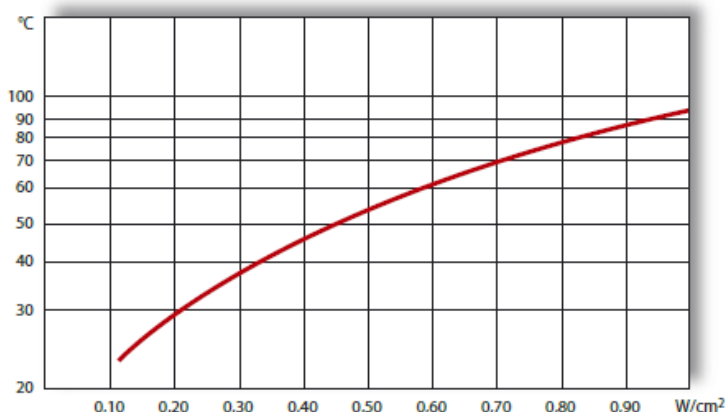
Since the thermal calculation required for heating an apartment requires knowledge of data not easily or immediately obtainable, the calculation can be simplified and accelerated based on the following considerations:

- Thermal losses vary greatly depending on the structural characteristics of the building, so it is best to base their calculations on a maximum specific power value of 180 W / m<sup>2</sup> of surface to be heated. This is the result of our experience of work already done.
- This value is able to guarantee accumulation heating and generate a temperature on the surface of the floor to be heated which is around 30 ° C.

- Generally, the temperature difference between the cable and floor outer sheath is around 10 ° C.
- The sheath temperature of the mineral insulation cable depends on the thermal stress (see graph in the next paragraph).
- The system's incoming time depends on the following factors:
  - unitary power output (W / m)
  - specific installation conditions such as: depth of laying, laying pitch, physical characteristics of the floor and concrete in which the cables are drowned.
- In accordance with our experience, the optimal solution for efficiency and cost savings is achieved by imposing high loads on cables, ie designing the heating cables so that the unit power delivered is approximately 30 ÷ 33 W / m (ie 170 ÷ 180 W / m<sup>2</sup> if laying pitch is about 15 ÷ 17 cm).
- Considering the full range of mineral insulation cables, installed at standard depths of 7 ÷ 8 cm, if the unit power delivered is 33 W / m then the cable sheath temperature range is between 30 ° C and 40 ° C. This means obtaining a floor temperature between 20 ° C and 30 ° C as required.
- If designing based on such high power and specific powers, the thermal yield of the mineral insulation cables, drowned in a good thermal conductor such as cement, is very high: such performance (temperature and time of inertia) inevitably decays if the power Dedicated to the system is limited.

### CHOOSING THE HEATING ELEMENTS

- Select the number of rooms to be heated by floor electrical system.
- Divide the total area into smaller areas, according to any customer requests.
- Calculate the required thermal power, based on the specific calculations made or using the simplified formula:  $P = 180 \text{ (W / m}^2\text{)} \cdot S \text{ (m}^2\text{)}$  where S is the surface to be heated.
- Select the mineral insulation cable using the following function:



$$P_i = \frac{V^2}{R \cdot L}$$

where:

$\overline{R}$  is the specific resistance [ $\Omega/\text{m}$ ] of the cable (unknown),

$L$  is the lenght of cable,

$V$  is the voltage supply,

$L$  is calculated according to the size of the room and the pitch (usually 15 cm).

Calculate the thermal stress of the cable using the formula

$$\hat{P}_i = \frac{P_i}{\pi \cdot \Phi \cdot 10 \cdot L_i}$$

where  $\Phi$  is the cable diameter.

- Estimate the sheathed temperature of the selected mineral insulation cable, previously calculated thermal load (W / cm<sup>2</sup>), using the graph above.
- Modify the resistance of the conductor as a result of the temperature rise, as described in the paragraph 3.2. *Technical data.*

The mineral isolation cables suitable for such applications belong to the KC / HDPE and CC / HDPE range in the table in section 3.1 Product Range: Depending on the design parameters, these cables are able to guarantee a high power output (and therefore A sheath temperature of 30 to 40 ° C) while the presence of HDPE plastic (high density polyethylene) prevents corrosion of copper due to the presence of parasitic currents.

### INSTALLING SUGGESTIONS

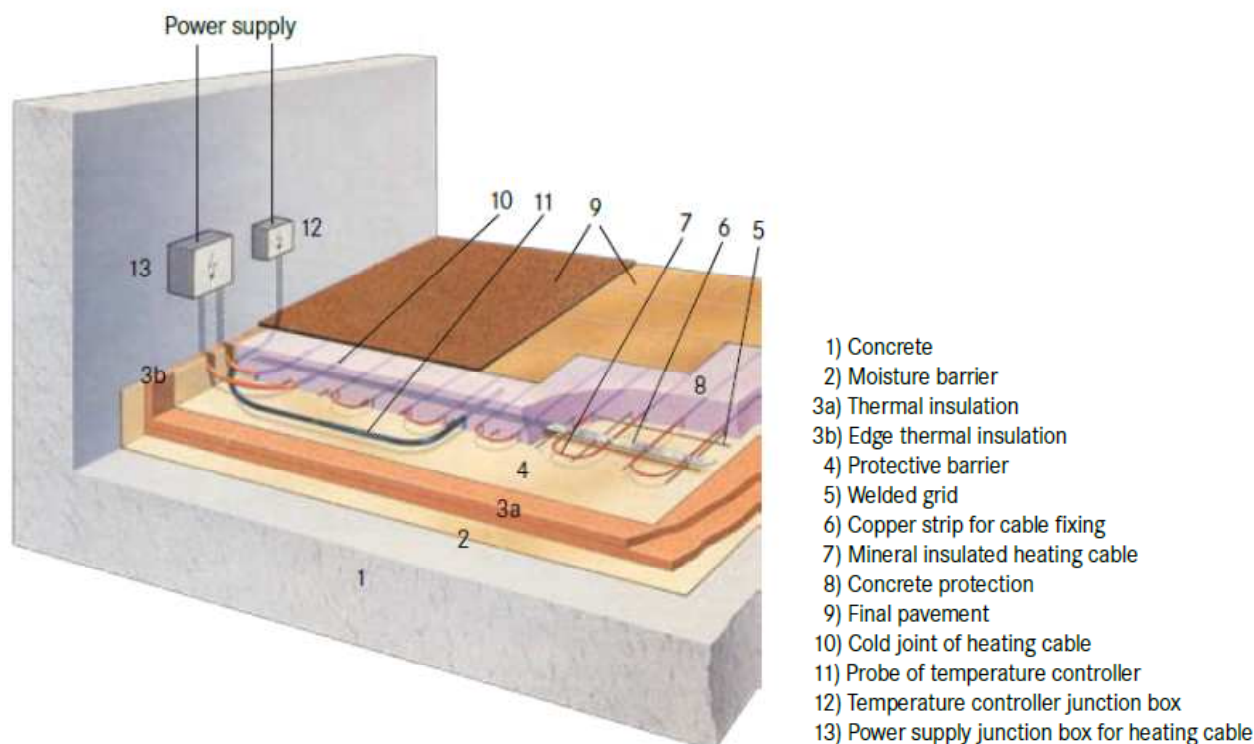
Mineral insulated heating cables can be immersed in concrete without any contraindication, even one of the most obvious features is mechanical strength. However, during the installation, you have to follow some troubleshooting steps to avoid damaging it:

- monitoring during cement casting;
- constant control of insulation resistance (between conductor and outer sheath) and continuity of conductor.

In rare cases where the cable may be damaged, it is possible to make a hot junction and weld the conductor and the outer sheath, thus creating the continuity and original insulation.

However, it is always possible that accidents occur when installing and installing the cable, so it is mandatory to perform electrical circuit monitoring before and after installation. The continuity and insulation tests carried out at the end of the installation ensure the correct functioning of the system and ensure its durability over time, limiting the maintenance of the system to only control the connections in the drawer: the cable Mineral insulation is protected from any corrosion, thanks to the additional HDPE coating.

Usually the mineral insulated heating cables are laid at a depth of 5 cm from the walkable surface, but depending on the floor finishing material or the speed required for the system, this value can fluctuate from 3 to 8 cm. Obviously, at the same power level, deeper depth implies a slower system entry. It is also recommended to maintain a wide spacing (about 50 cm) between the last cable of the heating cable and the outer wall, in order to limit the thermal energy dispersion to the outside of the building.



---

# Chapter 5

## Execution of terminations and joints

---

This section, which is connected with earlier known techniques, has the objective of integrating previously disclosed information with news and suggestions that we consider useful for technicians and installers of heating cable.

The instructions contained in this section can not be considered substitutional elements of operational experience that every installer of mineral insulated cable must have.

For this purpose, KME Italy SpA provides, in its own branches, equipment and personnel for education and qualification on the use of cable.

### 5.1 Testing

At the end of the production cycle, 100% of the coils of mineral insulation cable, in accordance with the requirements of construction standards and testing procedures, is subjected to the following acceptance tests:

- electrical resistance of conductors;
- dielectric strength;
- insulation resistance ( $\geq 1000 \text{ M}\Omega/\text{km}$ ).

### 5.2 Temporary sealing of the ends of the cables

In order to retain as long as possible the level of insulation resistance, at the end of the production line each coil of cable is temporarily sealed, at the ends, to prevent the infiltration of moisture until its installation.

Such sealing is made with waterproof plastic materials, resistant to mechanical stress.

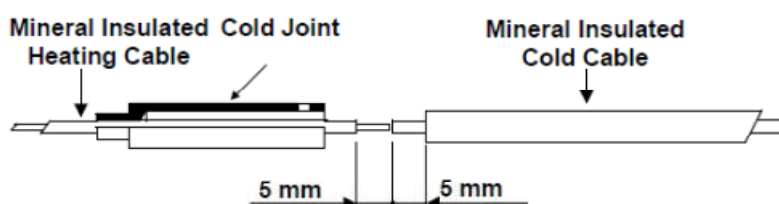
In the case where it is intended to store for a long period of time the cable is a good practice to seal the ends not terminated of the cable using one of the following methods:

- wrapping the ends of the cable with self-agglomerating tape;
- wrapping the ends of the cable with common insulating tape.

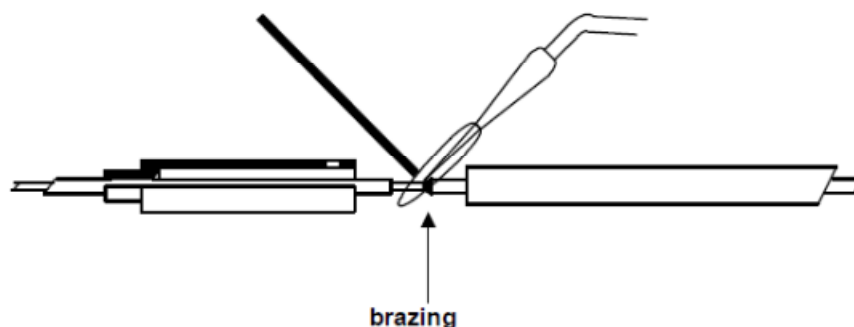
## 5.3 Cold joint execution

For the power supply of the heating cables must be used appropriate cold leads, in the table below are listed the most commonly used cables.

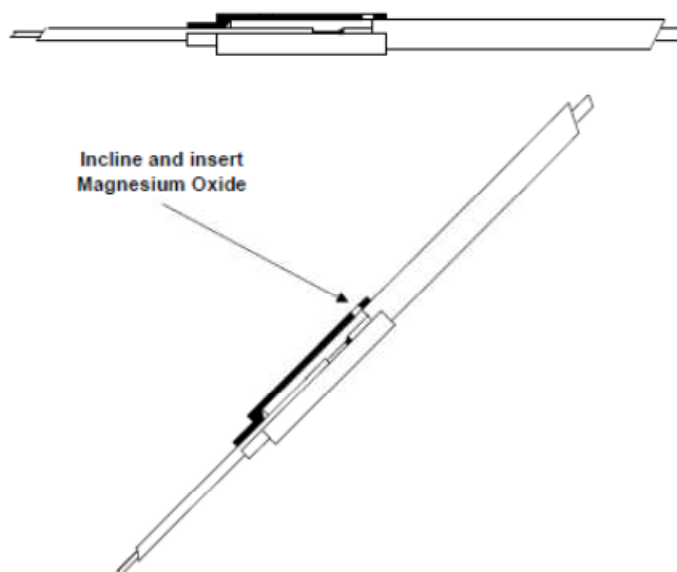
1. Before starting execution of cold joints, you must check heating cable and 2 cold cables insulation resistance (by a megger); measured values must not be lower than 1000 MW with test voltage of 500 Vcc.
2. Remove about 5 mm of the outer sheath at the ends of the heating cable and cold cables to join; put the cold joint on the heating cable, as shown in the following picture; if you have to join Copper and Nickel/Chrome conductors (Stainless Steel Heating Cables) perforate the Copper conductor end to let Nickel/Chrome conductor get inside.



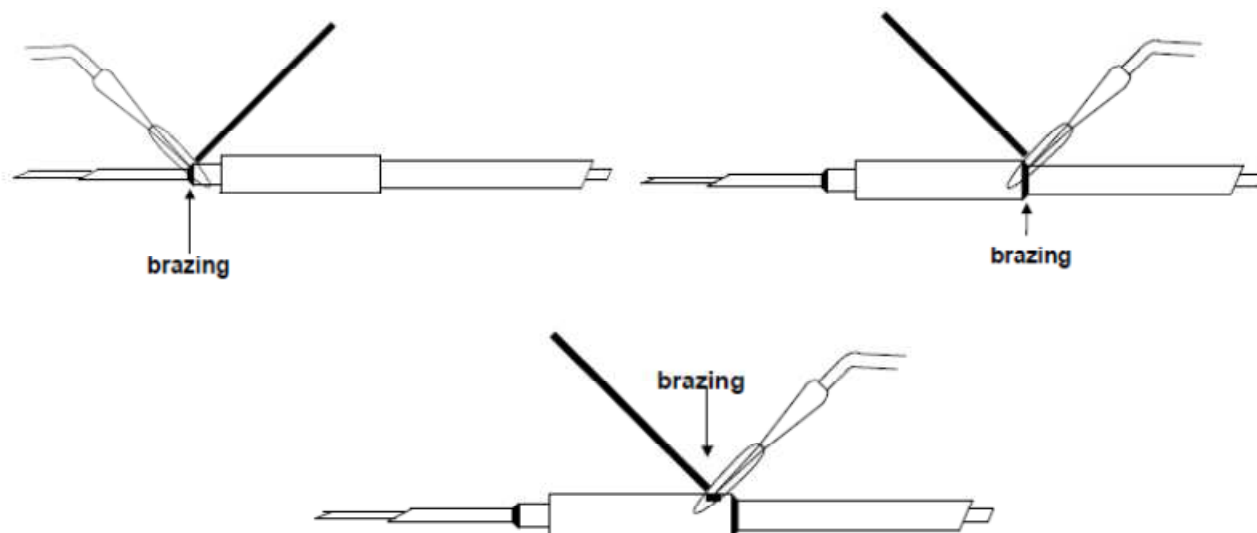
3. Make the brazing of the conductors by a oxyacetylene burner, using a silver alloy with the following melting point: about 500 °C for copper and cupronickel heating cables; about 700 °C for stainless steel and iniconel heating cables. For a correct brazing, it's necessary to heat up at the same temperature the 2 conductors; this can be achieved heating much more the larger size conductor; After the brazing, to check its correct execution, it's enough to make a light traction on the cables.



4. Clean the brazing and Magnesium Oxide from eventual slag and dirt; shift the cold joint to cover the cold cable, then turn them to oblique position (see picture below) and, through the side hole, fill the joint with dry Magnesium Oxide, vibrating it to make the filling regular.



5. When the cold joint is completely filled by Magnesium Oxide, move it to cover the hole with the cold cable sheath; dry it all, slowly warming from hot part and from cold cable to the cold joint, so to remove moisture in Magnesium Oxide. Then check with a Megger (test voltage < 35 Vcc) the conductor continuity and insulation resistance between sheath and conductor, whose value must not be lower than 100 MW with test voltage of 500 Vcc; if such value is lower, the warming of the joint must be repeated until measured insulation resistance is correct.
6. Make the brazing of the cold joint, first on the heating cable then on the cold cable; at last braze the filling hole (in order to achieve the correct progression in the joint warming, limit oxidation risk and make easier the removal of eventual moisture residual inside the joint).



7. Cool the joint by a wet cloth and check insulation resistance and electric continuity, following the same procedure previously described; if a low insulation resistance is measured, cut the joint and repeat above described operations.
8. Dip the joint in water for 4 hours (minimum time); after that, repeat the insulation resistance check. If a low insulation resistance is measured, it's clear that brazing operations were defective; then it's better to cut the joint and repeat again the operations described.

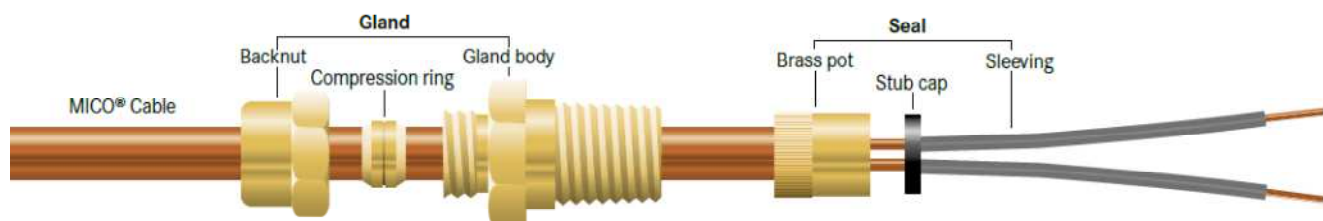
COLD LEAD IN FOR POWER SUPPLY CONNECTION						
Cold Cable Type			Cross Section mm <sup>2</sup>	Ø Coppe router sheath mm	Ø HDPE outer sheath mm	Ø Core mm
COPPER	COPPER+HDPE	COPPER NICHEL				
1H2.5	1H2.5/ HDPE	1H2.5 CN	2.5	5.30	6.60	1.78
1H6	1H6/ HDPE	1H6 CN	6	6.40	7.70	2.76
1H10	1H10/ HDPE	1H10 CN	10	7.30	8.80	3.57
1H16	1H16/ HDPE	1H16 CN	16	8.30	9.80	4.51
1H25	1H25/ HDPE	1H25 CN	25	9.60	11.10	5.64

## 5.4 Cold joint termination

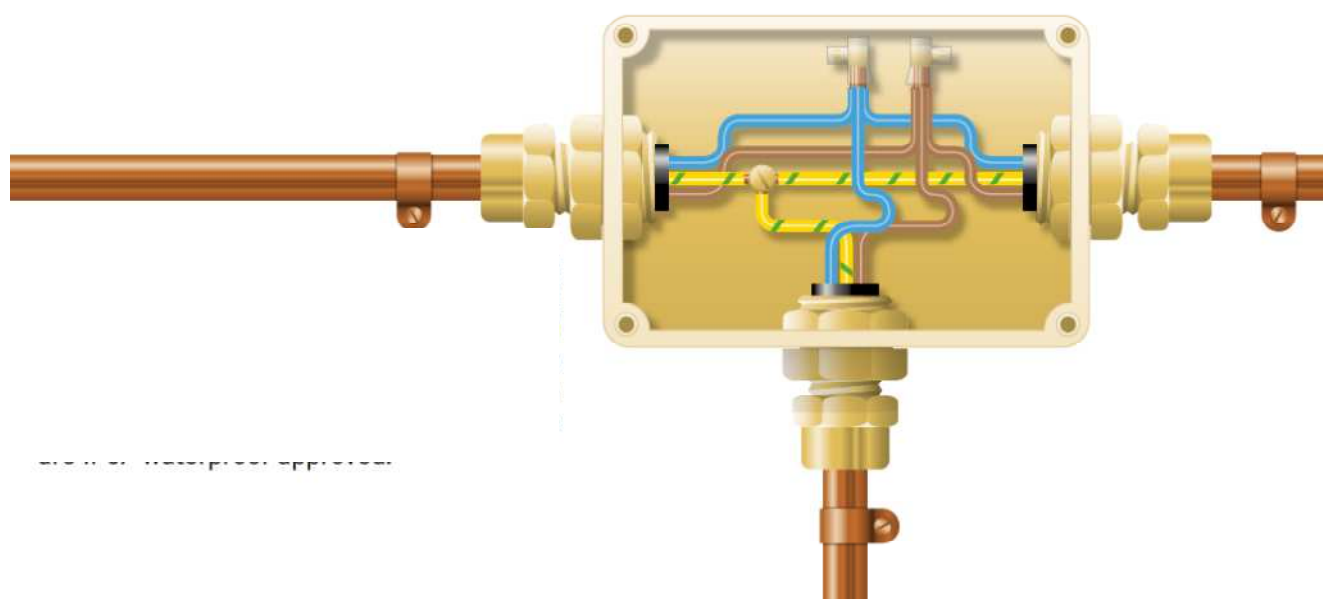
The method of mineral insulated cable laying is clearly distinguished from that of traditional cables with organic insulation, because the ends must be closed with appropriate terminations.

The terminations built by KME Italy SpA, in accordance with standard CEI 20-39/2 (EN 60702 – 2: 2004-06), are formed by:

- GLAND
- SEAL



Standard termination



Termination with ground wire

### 5.4.1 Gland

The gland connect the mineral insulation cable with the distribution box. Use only KME glands for carrying out terminations.

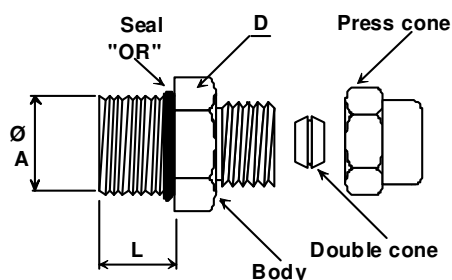
With reference to the previous figure, the use of the locknut is not intended for ATEX applications. The following types of glands are provided, depending on type of system to be realized.

#### GLANDS TYPE "RN" FOR ELECTRICAL HERMETIC INSTALLATIONS

The fittings of this type allow easy anchoring of the cable to sealed distribution boxes; the body, the double cone and the press cone are made of brass and the external thread is of type cylindrical gas UNI ISO 228 (ex UNI 338); with the aid of a synthetic rubber seal type "OR" the fitting ensures a degree of protection IP 67 (CESI GR 015 certificate as attached).

Are indicated below the maximum value of Diameter, in case you need to drill a hole crossing the wall of an enclosure, to maintain the degree of protection IP 67.

The type of connection corresponding to each cable type is indicated in "Table technical data cable with mineral insulation" of the general catalog.



Ø A (gland thread)	Max. Ø of the through hole (mm)	Length L (mm)	D (mm)
1/2"	21,50	10,50	24
3/4"	27,00	11,00	30
1"	34,00	11,00	38
1-1/4"	41,50	19,00	46

### GLANDS TYPE "RAD ISO" AND "RAD GAS"

RAD ISO and RAD GAS cable glands, complying with the directive 2014/34/EU-ATEX, are built according to the following harmonized European Standards.

- EN 60079-0:2012-08, Explosive atmospheres – Part 0: Equipment – General requirements
- EN 60079-0/EC+A11:2013-11, Explosive atmospheres – Part 0: Equipment – General requirements
- EN 60079-1:2014-10, Explosive atmospheres – Part 1: Equipment protection by flameproof enclosure "d"
- EN 60079-7:2015-12, Explosive atmospheres – Part 7: Equipment protection by increased safety "e"
- EN 60079-31:2014-07, Explosive atmospheres – Part 31: Equipment dust ignition protection by enclosure "t"

Having the glands successfully passed the tests described in the above standards (IMQ Certificate 17 ATEX 027 X) the glands are marked as follows and are suitable for installations in potentially explosive areas (zone 1 and 21):

Ex II 2G Ex eb IIC Gb Ex db IIC Gb

Ex II 2D Ex tb IIIC Db IP65

Ambient temperature -20°C ÷ + 70°C

Service Temperature -20°C ÷ +250 °C

Also this gland is constituted by a press cone, a double cone and a brass body; the external thread of the body, for coupling with the junction box, can be:

- Conical gas EN 10226-1 (ex UNI ISO 7-1);
- Isometric ISO 262 (or UNI 4535 with coupling tolerances according to ISO 965-1 e ISO 965-3).

The gland corresponding to each type of cold lead cable is shown in the tables on pages 48.

The glands are suitable to be inserted inside Ex d and Ex e enclosures and through threaded holes of the suitable size (the use with enclosures with not-threaded holes and the use of counter-nuts is not guaranteed). The Ex d enclosures used must guarantee more than 5 fully engaged threads, while the use for Ex t protection is guaranteed with 3.5 fully engaged threads. The IP 65 degree is guaranteed without the use of gaskets.

To prevent the loosening of the body with the enclosure, use Loctite on a thread.

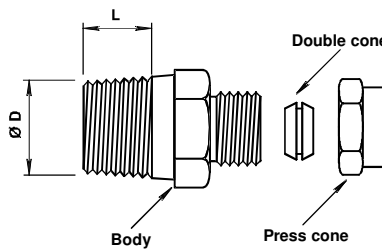
Before coupling the glands with the terminal use a sealant such as Loctite or Gasket Eliminator 510.

**ATTENTION: Our Heating Cables are NOT approved for installations in ATEX zones.**

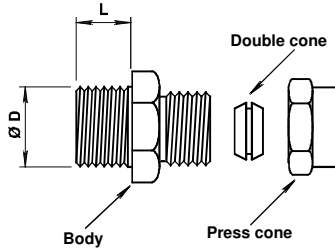
EN 10226 (ex UNI ISO 7-1)		ISO 262 (UNI 4535)	
Conical gas		Isometric (cylindrical)	
Ø D	Length L	Ø D	Length L
1/2"	15,40	M 20x1,5	11
3/4"	15,40	M 25x1,5	12
1"	19,70	M 32x1,5	12
1-1/4"	19,70	M 40x1,5	12

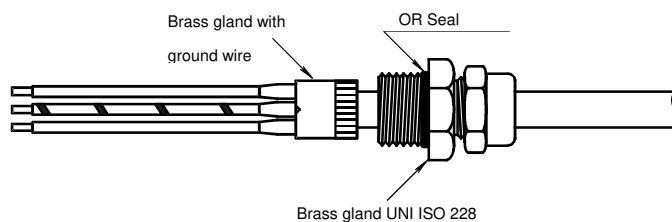
**Conical Gas Thread**



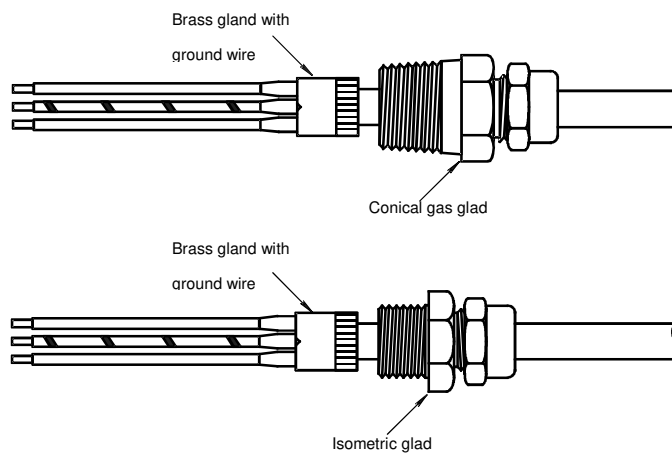
**Isometric Thread**



### TERMINATION FOR ELECTRICAL HERMETIC INSTALLATIONS (IP 67)



### TERMINATION FOR ELECTRICAL INSTALLATION IN ATEX ZONES (IP 65)



CABLE GLANDS AND SEAL USED WITH COLD LEADS CABLE					
Cable Code	Nr. of Conductors x Section (mm <sup>2</sup> )	Seal with Ground wire	Gland Series	Gland Type (ground wire)	Gland Code (ground wire)
<b>1 H 2.5</b>	1 x 2.5	GFT 1H2.5	RAD ISO	ISO 20	ISO 20 - 1 H 2.5
			RAD GAS	RAD G 1/2"	RAD G 1/2" - 1 H 2.5
			RN	1/2" o ISO 20	RN/ * /1 H 2.5
<b>1 H 6</b>	1 x 6	GFT 1H6	RAD ISO	ISO 20	ISO 20 - 1 H 6
			RAD GAS	RAD G 1/2"	RAD G 1/2" - 1 H 6
			RN	1/2" o ISO 20	RN/ * /1 H 6
<b>1 H 10</b>	1 x 10	JFT 1H10	RAD ISO	ISO 25	ISO 25/T - 1 H 10
			RAD GAS	RAD G 3/4"	RAD G 3/4" - 1 H 10
			RN	ISO 25 o 3/4"	RNT/ * /1 H 10
<b>1 H 16</b>	1 x 16	JFT 1H16	RAD ISO	ISO 25	ISO 25/T - 1 H 16
			RAD GAS	RAD G 3/4"	RAD G 3/4" - 1 H 16
			RN	ISO 25 o 3/4"	RNT/ * /1 H 16
<b>1 H 25</b>	1 x 25	KFT 1H25	RAD ISO	ISO 32	ISO 32/T - 1 H 25
			RAD GAS	RAD G 1"	RAD G 1" - 1 H 25
			RN	ISO32 o 1"	RNT/ * /1 H 25

**RN/ \* /** Cable Type

Standard Waterproof Glands for Mineral Insulated Cables

Thread type:  
 - Isometric: M20; M25; M32; M40  
 - Gas: G1/2"; G3/4"; G1

### 5.4.2 Seal kits

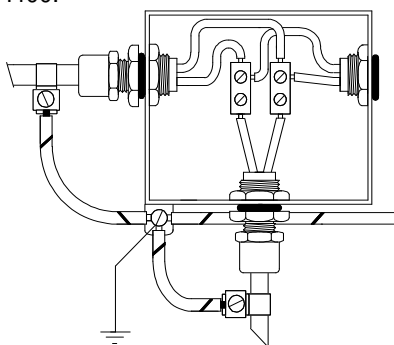
The seal is used to permanently inhibit the absorption of moisture by the insulation of the cable (magnesium oxide); the components of the seal are:

- brass cup;
- spacers of conductors;
- sealant;
- insulating sheaths.

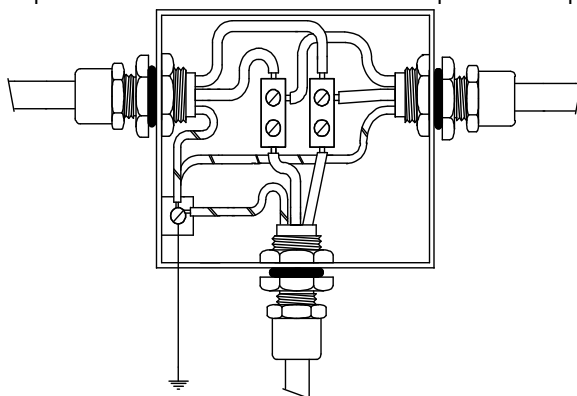
#### BRASS CUP

The cup body is constituted by a cable body made of brass with self-tapping base of variable diameter depending on the diameter of the cable, for screwing on the outer sheath of the cable in copper; there are the three types of cup available.

- **Standard:** with this kind of cup is necessary to use a suitable copper staple for connecting the outer sheath of the cable, which performs the protective ground conductor, with the ground terminal of the distribution box; they are not available for cables 1H300 and 1H400.



- **With ground wire:** this kind of glass is provided with a copper wire of an appropriate section (as per standard CEI 64-8 / 5 par. 543.1.2) welded on the bottom that allows you to bring directly inside the box the earth conductor (outer sheath); they are not available for unipolar cables from 70 mm<sup>2</sup> up to 400 mm<sup>2</sup> and for cables to 24:19 conductors. Such seal type is particularly suitable in electrical plants where the aesthetic factor is of particular importance.



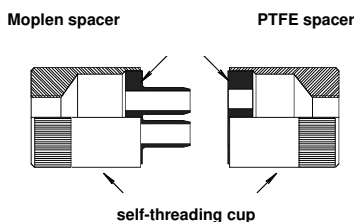
Both types are supplied complete with everything needed (spacers, insulation and sealant sheath) and four different sizes are provided (which, for the correct supply, must follow the cable type); in the following table are the codes are indicated, the size and the number of parts contained in a package.

Cup type		Dimensions (mm)		Packs (N° pieces)
Standard	With ground wire	Ø	hight	
XG	XGFT	14,9	16,7	10
XJ	XJFT	21,2	25,4	2
XK	XKFT	26,8	31,7	2
XM	XMFT	33,0	34,0	2

- **Heat shrinking:** this kind of cup is used, normally, only for unipolar cables; is constituted by a sleeve of heat-shrinking tube with double wall, with length of approximately 70 mm; during the closing operation of the cable the inner sheath under the action of heat melts, sealing consequently the cable.

### SPACER

The spacer is supplied together with the cup and is made of a printed disc in plastic polymer; its function is to space the conductors and at the same time to prevent the leakage of the sealant; as a function of operating temperature of cables are provided two types of spacers: one in Moplen, of black color for operating temperatures up to 105 ° C; the other one in natural color PTFE for operating temperatures up to 250 ° C.



### SEALANT

Four types of sealant are provided as a function of the system operating temperature:

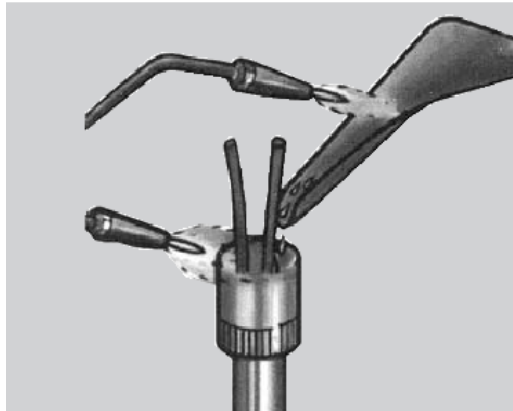
- **CS:** is an insulating paste in packs of 100 g and is suitable for operating temperatures up to 135 ° C;
- **HT:** is a two component sealant (binder + hardener) contained in tubes of 100 g and is suitable for operating temperatures up to 185 ° C;
- **HT/W:** is a silicone dielectric grease contained in tubes of 100 g and is suitable for continuous operating temperatures of up to 185 ° C;
- **GF:** is a granulated glass fiber-based packed in metal pipes of 100 g and is suitable for operating temperatures up to 250 ° C.

The table below shows the number of terminations that can be performed with a pack of 100 g of the sealants described above.

Termination type	N° of terminations that can be performed with a sealant pack of 100 g
G-GFT	36
J-JFT	12
K-KFT	6
M-MFT	2

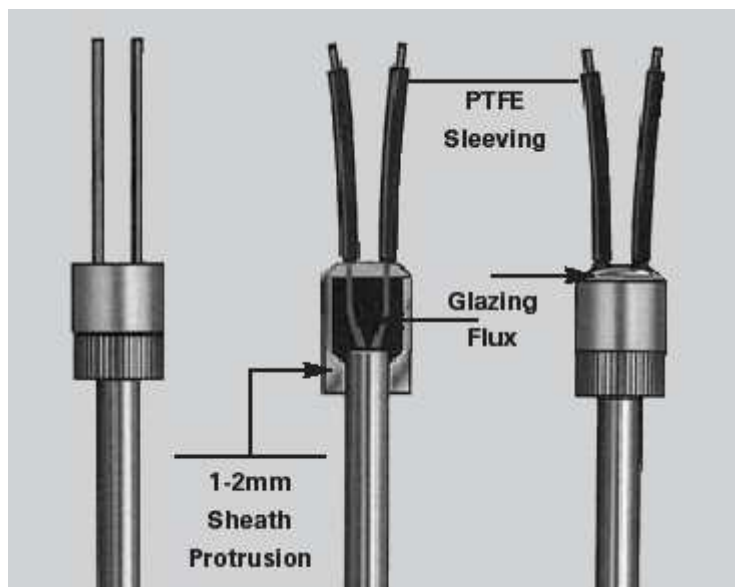
#### Positioning Glazing Flux (GF) sealant

- Using a torch, heat the cable up to a pale red color, approximately 150 mm from the cup, making the heat flow through the seal.
- Pour the Glazing Flux in the center of a metal blade (see figure below) and juxtapose to the conductor , just above the cup.
- Heat the cup, the conductors and the tip of the blade simultaneously. As soon as the Glazing Flux begins to melt, slightly tilt the blade to direct the molten liquid inside the cup (see figure below).
- The cup should be filled slowly, allowing the sealant to cool and solidify progressively from the bottom, ensuring excellent adhesion to the seal and to the conductors and reducing the volume near the surface.
- For the G seal, fill up to the top of the cup. For all other measures of seals, fill up to form a dome. Bring to melt the sealant to the surface if there is a reduction in volume.
- The formation of bubbles through the sealant indicates that the cable has been insufficiently heated before the filling described above. If this should occur, the final stretch of the cable adjacent to the cup must be heated while the sealant is maintained in a fluid state until the bubbles cease.



- For the G terminal, insert the ceramic spacer on the conductors. Heat the spacer and the surface of Glazing Flux and, at the same time, caulk with a screw tool until the spacer flange is at level with the rim of the cup. The sealant should escape from the holes above the surface thanks to the heat of the spacer. If necessary, it is possible to encourage this phenomenon by applying more sealant on the surface, but avoiding excesses.
- Wrap the insulating PTFE tape around the conductors exposed to the ceramic spacer or in contact with the dome of Glazing Flux. The sheath must be secured in position with a wire weave around the end of the conductor.
- One of the constituents of the sealant is lead oxide that can be reduced and thus form free of lead globules, in the case of excessive heat is applied with a reducing flame. For this reason, with greater than 50 mm<sup>2</sup> unipolar cables they should be taken further precautions, always using oxidizing flames (characterized by short internal cones)
- With this sealant you should always avoid the application of harmful mechanical stress, such as those originating from incorrect manipulation of the ends of conductors. This could give rise to breakage (cracking) of the relatively fragile glass poured between the conductors.

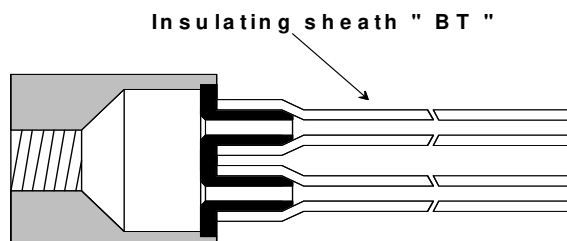
The Glazing Flux powder that is melted and poured into the seals to realize the insulation to 250 ° C contains lead compounds. It must be kept in a dry environment and avoid high temperatures. Adequate ventilation should be provided so that the vapors can not be inhaled.



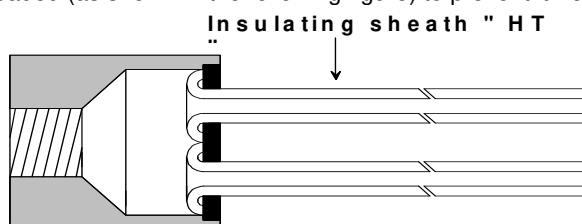
### INSULATING SHEATHS

Insulating sheaths have the purpose to isolate the conductors of the cable coming out from the spacer; as a function of the operating temperature three types of sheath are provided.

- **BT:** PVC jackets are fire retardant (black BT / section cable code) for all sections of active conductors except of conductors 300 and 400 mm<sup>2</sup> and up to 25 mm<sup>2</sup> section for yellow / green terminals ground wire; they are supplied in coils of 3 m and are suitable for maximum operating temperatures of 105 ° C; the sheath clips are threaded onto the conductors and then forced slightly on the spacer.



- **HT:** They are made of PTFE (HT / section cable code) and are indicated when the system operating temperature is higher than 105 ° C; they are supplied in lengths of 30 or 120 cm; this type of sheath must be introduced through the holes of the spacer, and then beaded (as shown in the following figure) to prevent it from shifting as indicated below.



- **Heatshrinkable:** is necessary for the conductors of cables 1H300 and 1H400; their implementation is described later. This sheath type is also used as a terminal for all unipolar cables; is constituted by a sleeve of double wall heat-shrink tubing, with length of approximately 70 mm; during the closing operation of the cable the inner sheath under the action of heat melts sealing consequently the cable.

Here are described the procedures for the proper execution of the terminations; these are simple operations, but require attention from operators.

## 5.5 Termination execution

### 5.5.1 Preliminary test of the insulation resistance

As previously indicated each coil of cable is controlled and sealed to maintain unchanged over time the insulation resistance; however, before starting the installation operation of the seal is good rule to cut approximately 10 cm of cable from both ends; thereafter it must be controlled, via a megohmmeter with a voltage imposed between the sheath and the conductors of 500 V DC, the insulation resistance whose value must be greater than 100 MΩ.

It may happen that some cable present a resistance of less than 100 MΩ isolation (also about MΩ 5); in this case you can still proceed with the execution of the termination because, as subsequently shown, the value of the insulation resistance will assume the value required after 5÷10 minutes.

### 5.5.2 Specific tools

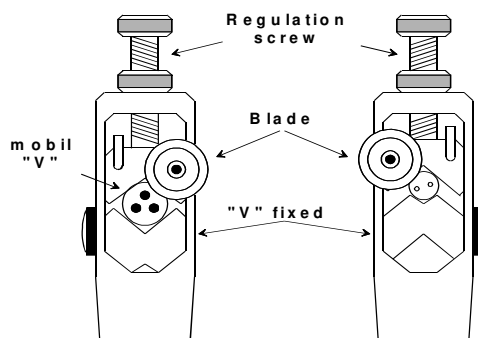
Use only KME accessories for installation and terminations execution.

The operation takes place in three phases during which only two specific tools are needed in addition to those forming part of the operator's normal kit, visible in the figure below.



### STRIPPER

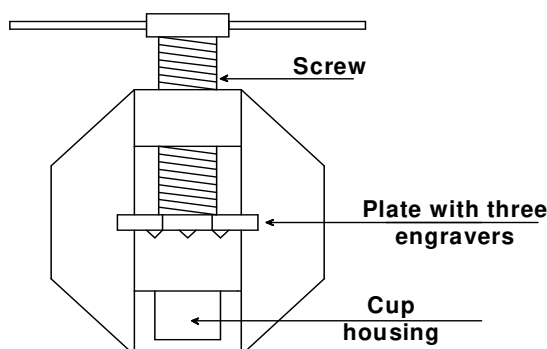
It is a tool necessary to remove the cable sheath to make the conductors available for subsequent operations and is usable on mineral insulated cables up to the section of 185 mm<sup>2</sup>; is composed of two opposing "V" blocks, one of which is fixed (positioned in two different orientations depending on the Diameter of the cable) and the other is movable, adjustable in height with of a screw, carrying the blade to cut the sheath in the copper cable.



### CRIMPING TOOL FOR CUP/SPACER

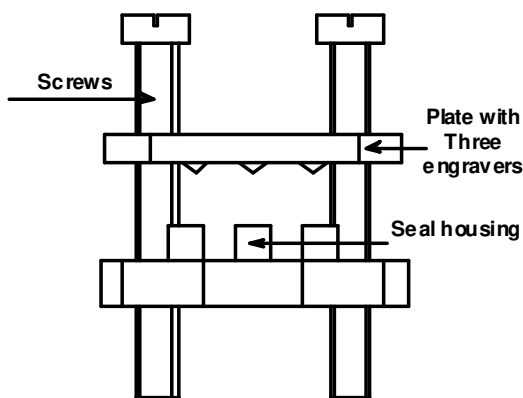
To make integral the spacer with the brass cup is necessary to use this tool which, with a plate equipped with three engravers arranged at 120 ° from each other and adjustable in height, allows to drill three incisions on the edge of the cup preventing the escape of the spacer; three types of tool are available, as a function of the size of the terminal.

- **Type G and J/K**



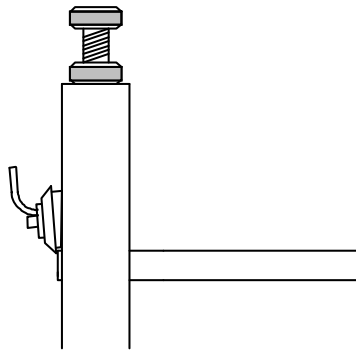
The screw J / K tool is accompanied by a reduction sleeve (for the terminal housing) and a engraving plate for Type J terminals.

- **Type M** for type M seals

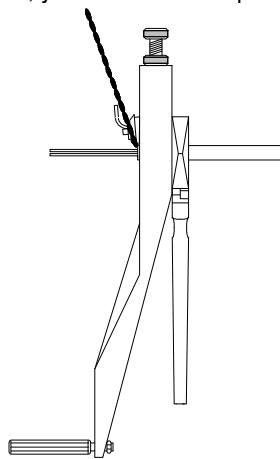


### 5.5.3 Preparation of the ends of the cables

- Cut the end of the cable to terminate by a small saw (approx 1 cm);
- place the stripper on the cable and tighten it: the blade must be in contact with the copper outer sheath and the V shaped clamp must be tightened on the cable by its screw, so to let the tool spin round with the cable without stopping it.;



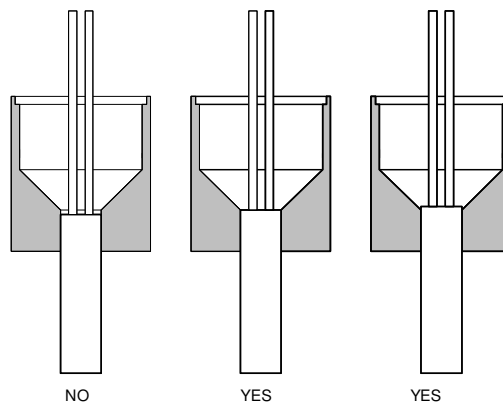
- start rotating the tool pushing it towards the inner part of the cable;
- avoid the rolling up of the copper shaving on the conductors, fixing it on the suitable hook.
- when you have stripped enough copper sheath, you can insert the pliers to cause the drop of the copper shaving.



### 5.5.4 Seal mounting

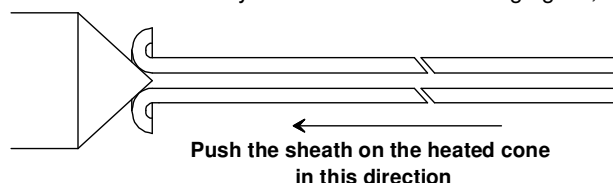
Only for use in explosion-proof applications, glands and seals shall be ATEX or IECEx marked.

- Remove from the conductors the Magnesium Oxide shattered during previous operation.
- Insert the gland on the cable.
- Revive the edge of the sheath and remove any burrs.
- Screw with pliers or with a special tool (wrench pot) the brass cup on the cable, taking care that is axis; the cup must be screwed up to match or as or slightly exceed the cable edge with the inner edge of the hole.

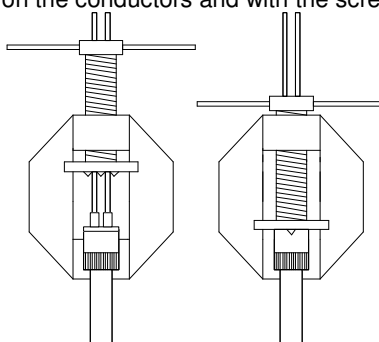


- Remove from the brass cup the Magnesium Oxide shattered during previous operation;
- Slightly stretch conductors with a pair of pliers;
- Fill the cup with the sealant; this must always be introduced on the same side thus avoiding the formation of air bubbles; it is considered essential to fill the cup with an excessive amount of sealant.

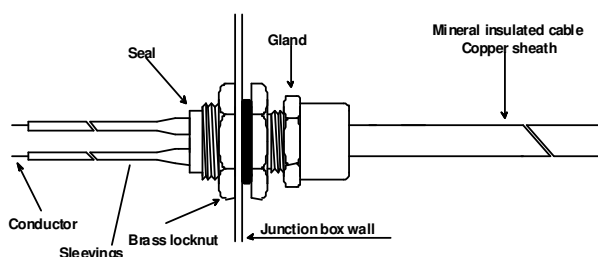
- As described above applies to the sealant CS, HT and HT / W; with regard to the GF sealant operate as reported on p. 56 regarding the installation of the sealant Glazing Flux (GF).
- Insert the spacer on the conductors, in the case of using the sealant CS and BT sheaths with the spacer in Moplen, and pressing it with the appropriate tool on the cup up to practice the three fixing incisions. When using other types of sealant (HT, HT / W and GF) together with the spacer in PTFE, the corresponding sheaths must be bordered as already shown, and then threaded through the holes in the spacer; the PTFE sheaths can be edged using a cone suitably heated with a torch or electrically as shown in the following figure;



- Then insert the spacer with the sheaths on the conductors and with the screw tool press it on the cup.



- Pull the cable with the glass from the tool and eliminate the sealant spilled during compression;
- Insert the insulating sheaths on the conductors up to overcome the spacer.



### 5.5.5 Test of the insulation resistance before installation

After the terminal mounting operation on the two ends of the cable, it must be made of the insulation resistance control; are two possible scenarios:

- 1) the terminal has been performed on the cable that had an insulation resistance  $>100 \text{ M}\Omega$ ; if the termination has been well performed the megohmmeter will indicate a value of resistance of  $>100 \text{ M}\Omega$  isolation.
- 2) the terminal has been performed on the cable that had a resistance of  $<100 \text{ M}\Omega$  insulation; in this case you might encounter an insulation resistance value  $<100 \text{ M}\Omega$  (also  $1 \div 5 \text{ M}\Omega$ ), but if the termination has been well performed after  $5 \div 10$  minutes the value of the insulation resistance will assume a much higher value  $100 \text{ M}\Omega$ .

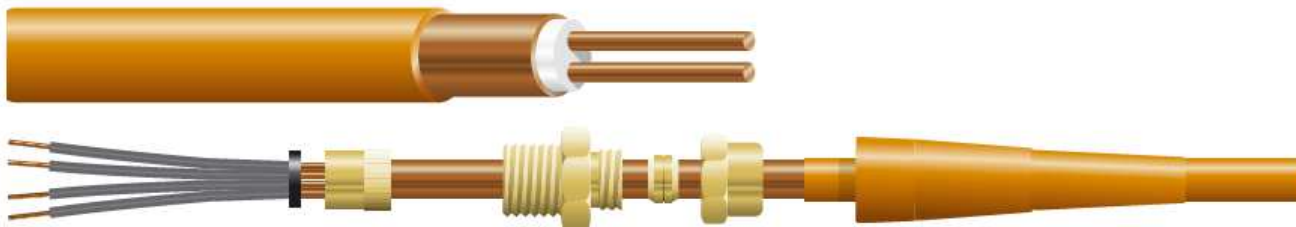
### 5.5.6 Test of the insulation resistance after installation

Rarely can occur, during the final testing of the system, to find a low insulation of the system due to a not well executed termination; in this case proceed as follows:

- identify the defective termination;
- Remove the termination;
- eliminate the residual sealant removing  $2 \div 3 \text{ mm}$  sheath with the appropriate tool;
- restore the insulation resistance as previously indicated;
- again proceed to the assembly of the termination as described above.

### 5.5.7 Positioning the seal on cable with LSF sheath

The operations described in the previous paragraph refer to the assembly of a terminal on mineral insulated cable with bare copper sheath, but in particular environments, where it is advisable to put into practice the cable MICO with additional LSF sheath, it is essential to use a PVC cone.

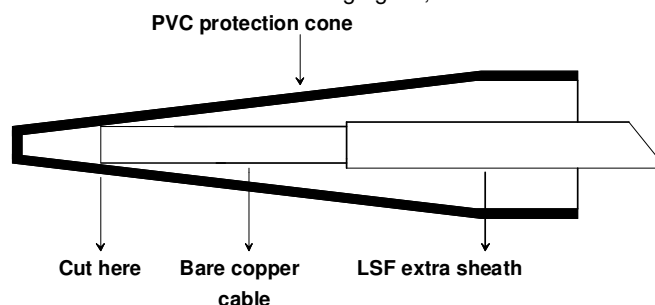


Cable with LSF sheath

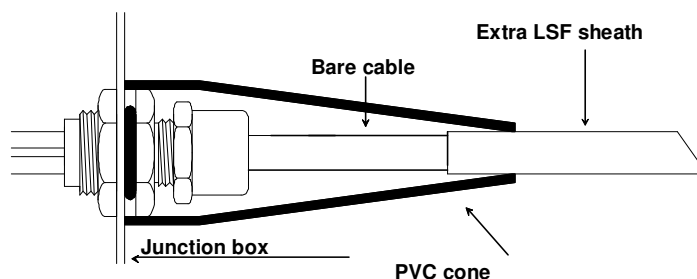
The cone is used to restore the additional protection (up to the connection box) on that part of the cable which is released from the coating to perform the seal assembly operations.

In this case the assembly operations of the terminal are the following:

- remove the extra LSF cover for a suitable length "L" for the execution of the operation; below we indicate the approximate value of the length "L" (including a length of conductors to be stripped of about 150 mm) for the various sizes of the termination:
  - 1/2" gland : mm 250;
  - 3/4" gland : mm 250;
  - 1" gland : mm 260;
  - 1-1/4" gland: mm 300;
- cut the end of the protective cone as shown in the following figure;



- insert the cut cone and insert it on the cable and repeat the operations described in the previous paragraph.



- There are four sizes of PVC cones according to the sizes of the terminations:
  - code CO1: for gland 1/2" (packs of 10 pieces);
  - code CO2: for gland 3/4" (packs of 2 pieces);
  - code CO3 for gland 1" (packs of 2 pieces);
  - code CO4 for gland 1-1/4" (packs of 2 pieces).

## 5.6 Other accessories

### 5.6.1 Locknuts

If you have a junction box with smooth holes, it is necessary, for the anchoring of the connector, a brass nut inside the box itself; the following table shows the codes for GAS and ISO thread locknuts, and the number of pieces for each package.

Locknut code	Ø thread	Pieces for any package	Locknut code	Ø thread	Pieces for any package
C1	1/2"	10	C1-20	M20x1,5	10
C2	3/4"	2	C2-25	M25x1,5	2
C3	1"	2	C3-32	M32x1,5	2
C4	1-1/4"	2	C4-40	M40x2	2

6

### 6.1.1 Junction boxes

When the electrical system must be carried out in places of artistic, historical or monumental it is necessary to mitigate the unpleasant aesthetic impact of the common junction boxes; for this purpose, upon completion of the mineral insulated cable, two types of junction box are available whose main characteristics are the followi:

- molten body of copper alloy (brass);
- lid molten copper alloy (brass);
- sandblasted surface finish;
- neoprene gasket;
- degree of protection against entry of liquids or dusts IP 67 as certificate CESI GR-93/0226610; currently this certification is valid for the CA Type 1;
- solid construction;
- pleasant appearance;
- the possibility, by means of two slits on the lid of the CA1 Type of housing supports for switches or sockets of the series 502.

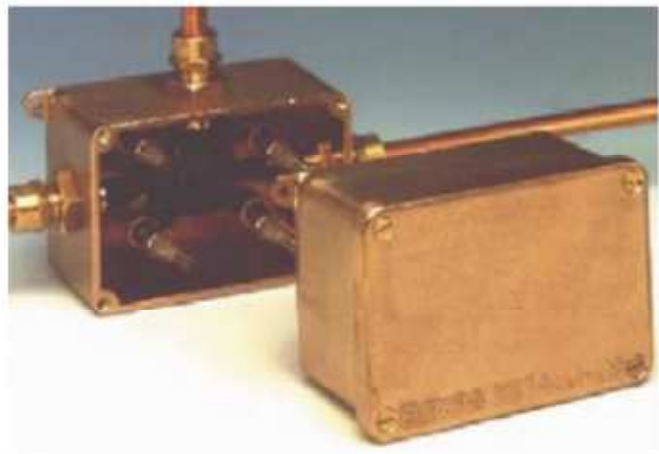
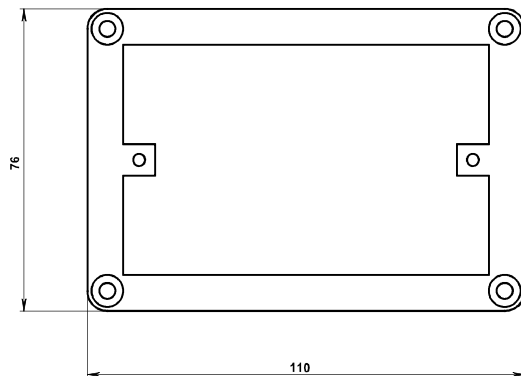
These boxes are made in three types:

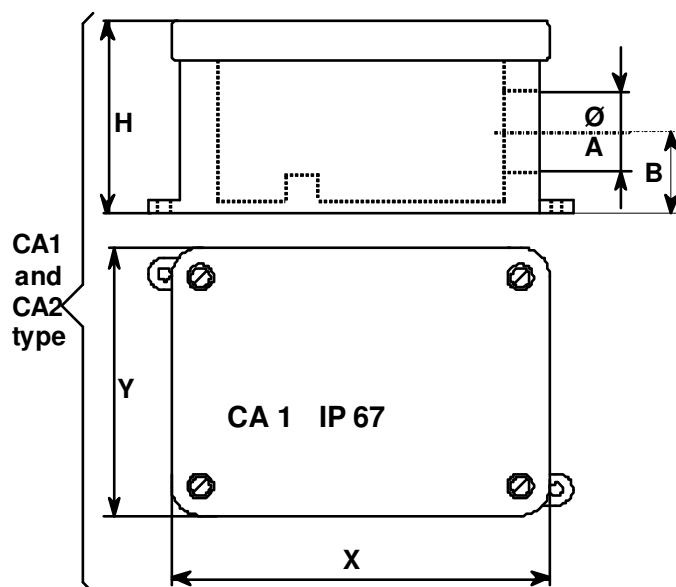
- CA1
- CA1/2F (when there are two slits on the lid of the Type CA1)
- CA2

These boxes are provided in a package comprising the screws for fixing the cover on the body and the screw for the ground terminal that is located within the body of the box.

Please note that the boxes CA1 and CA1 / 2F are suitable for cable MICO terminations that provide glands up to 3/4" gas or ISO 25 and a top section of the cable conductors of 4 mm<sup>2</sup>.

It is also possible to use a plate of the series 503 (with only two active fruits) using the copper adapter below, mounted on the body of a cassette CA1.





Box type	X mm	Y mm	H mm	Gland type IP 67	Ø A max. mm	B mm
CA1- CA1/2F	117	83	63	½" gas UNI ISO 228	22	33
CA2	191	132	72	¾" gas UNI ISO 228	27	41

## Chapter 6

# Annexes

---

### **1. MINERAL INSULATED HEATING CABLE – Facsimiles EU DECLARATION OF CONFORMITY delivered with the product**

On the next page (page 63) there is a Facsimile of the CE Declaration of Conformity, prepared in accordance with Directive 2014/35/EU, supplied with the mineral insulated heating cables.

The CE Declarations of Conformity are available for each cable series. The above mentioned Annex reproduces an example of Declaration for the CC series of heating cables.

### **2. MINERAL INSULATED HEATING CABLE AND THEIR TERMINATIONS - Documentation delivered with products**

With the heating cables, the following documentation is also supplied:

- The instruction sheet, HEATING CABLE FOR MINERAL INSULATION AND RELATED TERMINATIONS - *Instructions and warnings*;
- A CMTR test certificate.

The cable glands and seals kits are supplied with the relative instruction sheet: MINERAL INSULATED CABLE MICO AND THEIR TERMINATIONS - Instructions and warnings.



## EU DECLARATION OF CONFORMITY

### *Dichiarazione di conformità UE*

The manufacturer:

*Il fabbricante:*

**KME ITALY SPA**, Via della Repubblica 257, 55051 Fornaci di Barga (LU), Italia

Declare that the product:

*Dichiara che il prodotto:*

**HEATING CABLES IN ELECTRICAL RESISTANCE FOR BUILDING APPLICATIONS**  
**CAVO SCALDANTE A RESISTENZA ELETTRICA PER APPLICAZIONI EDILI**

type:

*modello:*

Mineral insulated heating cables with Cu-DHP (Alloy Nr. C12200) Sheath and Cu ETP (Alloy Nr. CW004A)

Conductors – Maximum operating voltage see table below – CC SERIES

*Cavi scaldanti ad isolamento minerale con Guaina esterna in Cu-DHP (Lega N. C12200) e Conduttori in Cu ETP (Lega N. CW004A)- Tensione massima di esercizio vedi tabella- SERIE CC*

<b>Cable type/Tipo di Cavo</b>	<b>Max. Operating Voltages / Tensione Max. di Esercizio</b>
CC4, CC7, CC11, CC17	750 V
CC25, CC40, CC63	600 V
CC88	400 V

is in conformity with the relevant Union harmonization legislation:

*è conforme alla pertinente normativa di armonizzazione dell'Unione:*

2014/35/EU Directive - LOW VOLTAGE DIRECTIVE (LDV)

*Direttiva 2014/35/UE – DIRETTIVA BASSA TENSIONE*

Reference to relevant harmonized standards used:

*Riferimento alle pertinenti Norme utilizzate:*

**CEI EN 62395-1:2014-10** - Electrical resistance trace heating system for industrial and commercial applications, Part 1: General and testing requirements / *Sistemi di cavi scaldanti a resistenza elettrica per applicazioni industriali e commerciali, Parte 1: Specifiche generali e per le prove*

This declaration of conformity is issued under the sole responsibility of the manufacturer

*La presente dichiarazione di conformità è rilasciata sotto la responsabilità esclusiva del fabbricante*

Name/*Nome:* Ing. Michele Manfredi

Position/*Funzione:* Plant Manager

Place and date of Issue/ *Luogo e data di emissione:* Fornaci di Barga, February 21<sup>st</sup> 2018