HEAT TRACE™

SETTING THE STANDARDS LEADING THE WAY

***The* Heat Tracing Authority™**

HEAT TRACE™
SETTING THE STANDARDS LEADING THE WAY

Heat Trace Limited.....

40 YEARS ON!

The History

When Neil Malone founded Heat Trace Limited in 1974, electric heat tracing was still in its formative years. In the four decades since then, it has developed into a significant industry based on quality principals.

Throughout this time, Heat Trace Limited has been at the forefront, deeply involved in the development of BS6351 - Electric Surface Heating, the first European standard published in 1982, through to IEC62086 - a harmonised World Standard launched in 2000 - now IEC60079-30.

From the start, Heat Trace developed products and systems not only satisfying the new standards, but also meeting Heat Trace's own corporate objectives of improving...

"safety, efficiency, reliability and performance".

These highly focused objectives engendered a corporate culture within the company that remains to this day. The result has been a stream of novel, patented products – both heating cables and control and monitoring equipment – that have seriously influenced the direction and focus of the heat tracing industry.

Heat Trace's ground breaking "EVOLUTION" Heat Tracing System Design Software enables engineers, either within the Heat Trace organisation, or in Engineering Houses, to quickly, accurately and competitively design and engineer heat tracing systems of the highest calibre - with emphasis on safety, efficiency and lowest cost of ownership for the end user.

Today Heat Trace Limited is a global company providing complete heat tracing solutions. In addition to systems manufacture, services include consultancy, system design, installation and commissioning, project management, maintenance and training.

Heat Trace Limited has become .....

The **Heat Tracing Authority™**

Heat Trace Limited ..... In the U.K.

Heat Trace Ltd has been manufacturing electrical heating cables in the U.K. since 1974.

The main manufacturing facility and headquarters of the company is at Helsby in the North West of England. This factory houses the main processing equipment for the manufacture of semi-conductive self-regulating heating cables; core compounding, heating matrix extrusion, and other more recognised standard cable making processes. The main item of capital equipment is the Electron Beam Unit – one of only two similar units in the U.K., and one of only a few in Europe.

The Helsby Headquarters handles sales to all countries around the world. Exports account for over 90% of Heat Trace sales.

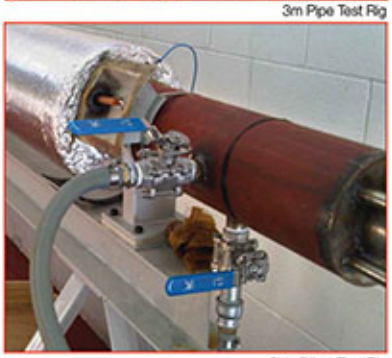
In addition, the Heat Trace Innovation & Technology Centre is located close to Manchester, only 56 km from the Helsby headquarters. The Bredbury complex has been a Heat Trace owned premises for over 25 years, and constant power heating cables are made here.


Control Panel for 3m Pipe Test Rig


3m Pipe Test Rig


24 Spindle Braider


Extrusion Temperature Control Unit


Skin Effect Test Rig

Heat Trace Limited.....

Heater Technology

Heat Trace Limited developed and patented the world's first cut-to-length parallel resistance heating cable in the 1970's. This was followed in the early 80's by 3 phase Longline series cables for heating long pipelines. Both of these heaters were based on foil conductor technology, a principle that remains within the company's product range today.

More recent developments include the patented AHT, the world's first mineral insulated, metal-sheathed cut-to-length parallel resistance cable for high temperatures or high power duties.

Today, Heat Trace Limited manufacture the widest range of heating cables, including what is now considered to be the world's largest range of self-regulating, semi-conductive heating cables, with voltages from 12 volts to 1000 volts, outputs up to 150W/metre and withstand temperatures of up to 300°C. With the self-regulating style of heater accounting for around 80% of the world market for heating cables, Heat Trace are the world leaders in this technology.

Heat Trace invests a significant proportion of its revenue into research and development, resulting in many new patents and innovative products and processes.

A recent investment in a purpose-built state of the art metal extrusion facility, installed at our Innovation and Technology Centre in Bredbury, Cheshire, now improves our ability to extrude continuous lengths of metallic sheathing on our range of heaters.

New product developments also include patented self-regulating heated tubes for the automotive and aerospace industries, as well as "Hotwat Pipe" an insulated and heated tubing for maintaining hot water distribution systems in residential, commercial and industrial buildings.

Control and Monitoring

Heat Trace Limited were perhaps the first heat tracing company to recognise the important link between control technology and the "safety, efficiency, reliability and performance" of heat tracing installations.

The company patented Powermatch, a self-regulating controller (as opposed to ON/OFF control) that turns heater power up or down in response to changes in heat losses. Although launched over 20 years ago, the benefits are even more relevant today now that energy efficiency is one of the world's major environmental issues. The new PowerMatch Micro Plus Controller incorporates these benefits in a small low cost digital controller, with the extra benefits of additional line control and High / Low temperature alarm facilities.

Today, Heat Trace's range of electronic control and monitoring equipment extends from simple thermostats, to microprocessor controls capable of integration with full plant SCADA and DCS systems.

Innovation led technology has ensured that Heat Trace remains .....

The **Heat Tracing Authority™**

Heat Trace Limited.....

INDUSTRIAL

Electric heat tracing

Industrial applications may be found in oil and petro-chemical plants, refineries, pharmaceutical production, power generation, water and waste treatment plants, food processing, plus many others.

Heat Trace manufacture full heat tracing systems for:

- Short or long pipelines
- Complex in-plant piping systems
- Above ground, buried, or sub-sea pipelines
- Externally or internally traced pipelines
- Safe or hazardous area installations
- Heated helidecks
- Tanks and vessels
- Hoppers
- Instrumentation and sample lines
- Instrument enclosures
- Temperature maintenance, or heat raising, to temperatures up to 600°C.

Steam heat tracing

Since the early 1900's, steam tracing has been the primary means of industrial heat tracing – even today 70% of all industrial heat tracing systems are in fact steam.

Where steam supplies are available, steam for heat tracing is considered to be "free" surplus energy. However, steam tracing of pipe work and vessels is generally inefficient and difficult to control, when compared with electric heat tracing systems. Furthermore, no energy can be considered "free"!

Heat Trace can assist in ensuring that steam tracing systems operate at their optimum efficiency.

For several decades, Heat Trace's thermal transfer compounds have been successfully aiding the efficiency of steam tracing systems around the world in petro-chemical, processing, power generation and other strategic industries.

Heat Trace's thermal transfer compounds cover temperatures up to 600°C. Additional low temperature "flexible" compounds complete a comprehensive product line capability.

OFFSHORE

In the harsh offshore environment safety and reliability are high priorities. Heat Trace are able to supply high quality products and services to meet the demands of the industry. Flexible sub-sea heated pipelines, heated riser systems, topside pipeline heating (freeze protection and temperature maintenance) helicopter platform snow and ice prevention systems - these are just some of the application solutions available from Heat Trace Limited.

SPECIALIST APPLICATIONS

For above ground and buried long pipelines, where a limited number of power supplies are available, Heat Trace is able to provide a comprehensive range of special long pipe line heating systems, using series resistance heaters and skin effect current tracing systems.

Other specialist applications include hopper heating modules for electrostatic precipitator hoppers, oilwell downhole heating systems, flexible sub-sea heated pipe system for off-shore use in deep sea oil and gas exploration and production applications, also in-shore applications for FPSO and tanker off-loading systems.

Heat Trace Limited.....

TRANSPORTATION

Heat Trace's Transportation Division specialises in heating systems for all modes of transport.

The range of track and points heating systems is designed to meet the exacting standards required in the transportation industry. Whether the requirement is for high power constant wattage output heaters, or for high power self-regulating heaters, you may be sure that the Heat Trace range of products has the reliability and durability required for all heating applications, including the heating of points systems, swing nose crossings, live contact rails, monorail system tracks, urban transit systems and tramway rails.

Heat Trace provide complete systems incorporating heaters, ancillary equipment and all the necessary control and weather monitoring systems.

Additional products have also been developed for door threshold heaters, pantograph shoe heaters, snow and ice prevention systems for platforms, walkways, access ramps, station canopies, etc., Under-floor heating for offices and waiting rooms, together with freeze protection systems for rolling stock water and fuel supplies.

COMMERCIAL

Commercial applications for heat tracing exist almost everywhere and systems may be found in domestic, municipal and institutional buildings; hospitals; nursing homes; office blocks; leisure complexes; educational establishments; etc.

Heat Trace can supply energy efficient systems for:

- Freeze protection of pipes/tanks
- Heating of hot water pipes
- Heated walls
- Roof and gutter heating for snow/ice prevention
- Snow/ice prevention on roads/ramps/walkways/steps & access areas, etc.
- Heating fuel storage tanks

RESIDENTIAL

A new brand, 'HeatSafe', has been launched to satisfy the heating requirements for residential applications.

The HeatSafe system comprises a complete range of safe, modular, easy-to-fit, heating and freeze protection solutions, designed by the customer to meet his own specific requirements. All systems are designed to be easily installed in residential and light commercial applications without the need for a professional installer, or electrician.

Employing multi-purpose, self-regulating heaters, incorporating Inherently Temperature Safe technology, the HeatSafe range is a low cost, affordable solution for the consumer. Systems can be designed and then purchased directly using a step-by-step on-line guide on the HeatSafe interactive e-commerce site at: http://www.heat-safe.com

Applications are available for, pipe freeze protection; roof and gutter heating; snow and ice prevention on paths, steps and driveways; horticultural soil warming for seed and plant propagation; plus many others.

Heat Trace Limited.....

As you would expect from a high calibre company, Heat Trace is able to fulfil the expectations of clients who wish to entrust the widest possible range of services to a single contractor able to manage all aspects of a heat tracing project.

A complete range of Design & Engineering Services is available - ensuring that all requirements of the client are satisfied.

Consultancy
From Concept through to Commissioning – Heat Trace Limited offers a full turnkey project capability, from the initial enquiry through site surveys to final client handover.

Design
All design work is carried out in accordance with ISO9001 certification. Using Evolution, Heat Tace's own state-of-the-art electric heat tracing design software, ensures that system design complies with the latest national and international standards for electrical heat tracing systems.

Bespoke Software
Heat Trace's Evolution Design Software empowers our partners, be they customers, distributors or engineering houses, to produce safe, reliable, competitive and detailed heat tracing system designs. Designs for frost protection, temperature maintenance and heat raising of pipes, tanks and vessels are all possible, calculating stabilised designs and temperature control requirements where appropriate. The completed design package can then be assembled and presented, either as a quotation, or tender document, for submittal to the client, all from within a single software package.

Installation
Fully qualified installation and site supervision engineers are available to ensure that systems are installed in full accordance with the specified design and that systems conform to national and international standards and codes.

Design & Engineering Services

Commissioning
Our commissioning engineers will carry out final inspection and testing, ensuring system operation is in accordance with design specification, prior to handing over to the client.

Project Management
Dedicated Project Managers will ensure the smooth operation and completion of all major projects.

Maintenance
Annual Maintenance Contracts are available to ensure the system always remains at its optimum operating efficiency.

Personnel Training
Training in product knowledge, system design, installation and maintenance procedures can be provided, either on-site, or at one of our Affiliate/ Partner company premises.

Typical Applications / market sectors

Bakery equipment
- heating fuel oil pipes to the ovens
- bread fat heating
- anti-condensation for flour storage
- heating glucose and sucrose products

Brewing
- heating malt, glucose and water pipes and tanks
- fuel oil systems

Chemicals
- heating numerous viscous liquids and/or gases
- research projects
- many refinery applications

Ceramic industry
- heating fuel oil
- paint and varnish heating

Chocolate and sweets
- heating chocolate in pipes and vats
- heating chocolate in road tankers
- heating liquid sugars
- heating cocoa butter and fats

Detergent and soaps
- heating various viscous liquids
- general frost protection

Medicine
- many applications especially in the pharmaceutical industry where waxes, tallows and stearates are used.

Non-ferrous metal industries
- fuel oil heating and frost protection
- Oil industry
- fuel oil heating
- lubrication oil heating
- grease line heating
- oil additives heating
- many refinery processes require tracing

Drying and cleaning
- heating fuel oil
- dyestuffs manufacture

Electric motors
- curing glass-fibre banding tape
- heating commutators during manufacture
- anti-condensation heating

Electric transformers
- curing glass-fibre banding tapes
- drying out oil-filled transformers
- frost protection of water-filled transformers

Tank base heating

Pipe tracing

Internal pipe tracing

Typical Applications / market sectors

Final Settlement Tank de-icing

High Temperature Tank heating

Buried pipeline tracing

Food processing
- heating many food process materials, eg malt, sugars, molasses, sauces, honeys, jams,
- Chocolates, waxes, fats, cooking oils
- keeping powdered food dry
- heating storage tanks
- tracing refrigeration rooms

Fertiliser industry
- tracing liquids used in manufacturing inorganic fertiliser

Power generation stations
- boron water
- carbon dioxide
- fuel oil
- caustic solutions
- instrument lines
- frost protection
- pre-heating steam lines to prevent stress
- Precipitator - fly ash hoppers and silos
- flue gas desulphurisation processes, i.e. frost protection and liquid sulphur temperature maintenance

Road construction
- heating asphalt (bituminous tar) and pitch in road stone plants
- fuel oil
- frost protection of sand and aggregate in storage hoppers

Iron and steel
- fuel oil systems
- frost protection
- grease pipelines
- hopper heating

Printing
- inks and dyes during manufacture and storage

Plastics industry
- curing thermosetting resins
- accelerated curing of glass fibre

Paints
- paints and varnishes during manufacture and in paint spray applications

Refrigeration
- heating drain lines and drip trays
- heating refrigerator doors
- anti-frost heave of concrete floors

Rubber
- curing rubber sections and fabrications

Sprinkler & fire system manufacture
- frost protection of water-filled lines

Tar distilleries
- heating bituminous materials
- heating road tankers

Objective - a Safe system that works

A heat tracing installation should provide the highest appropriate levels of Safety. This is mainly provided for by:-

- **ensuring temperature safety**
- **over-current circuit protection**
- **earth-leakage protection**

Temperature safety is ensured by preventing the surface of the heat tracer from exceeding the limiting temperature. This limiting temperature may be the maximum rating of the tracer itself, or, for example, the Temperature Classification where the installation is within a hazardous area.

● Ensuring temperature safety

Temperature safety may be provided in a number of ways. The choice open to a specifier, in descending order of preference are:-

- **Inherently temperature-safe heat tracers.**

Many self-regulating tracers are inherently temperature-safe, their power output reducing with rising temperature such that limiting temperatures e.g. Temperature Classification or temperature withstand of the heater, cannot be exceeded due to the heat produced by the tracer. ***Inherently temperature-safe heat tracers therefore provide the highest level of temperature safety.***

- **Stabilised Design**

Here, a calculation is made to ensure that, under the worst case conditions, a tracer always operates at below the limiting temperature, without the need for external temperature control. Where inherently temperature-safe heat tracers are not available, stabilised design provides the favoured form of temperature safety.

Stabilised design calculations are complex and should only be undertaken by persons suitably skilled. Heat Trace's Evolution software is able to automatically confirm whether a design is temperature-safe. When it is not, the designer has the choice of selecting tracers having a lower power output or opting for a less safe temperature controlled system.

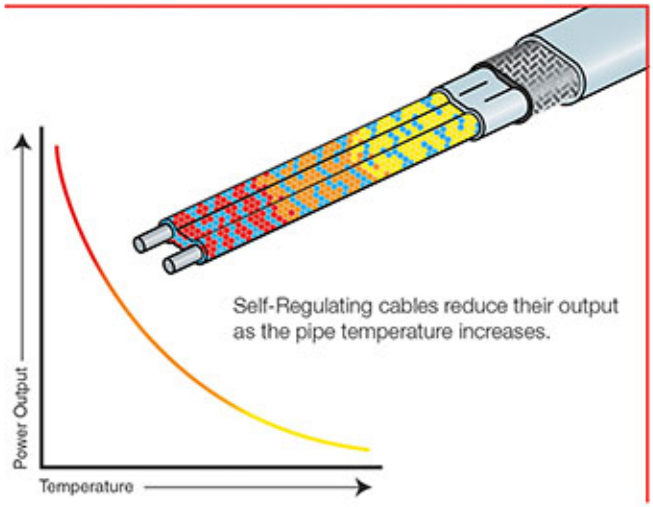
- **Temperature control**

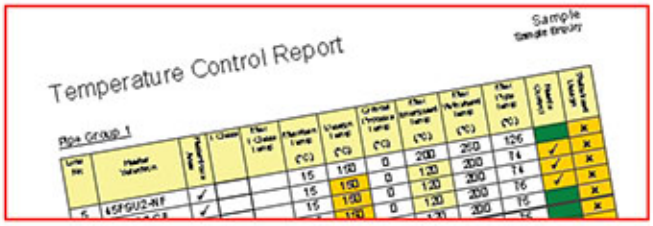
Where a stabilised design cannot be assured, it is then necessary to employ temperature control. Here the safety of the system is reliant on the correct functioning of the controller and the correct location and operation of the temperature sensor. ***This is therefore the least safe option.***

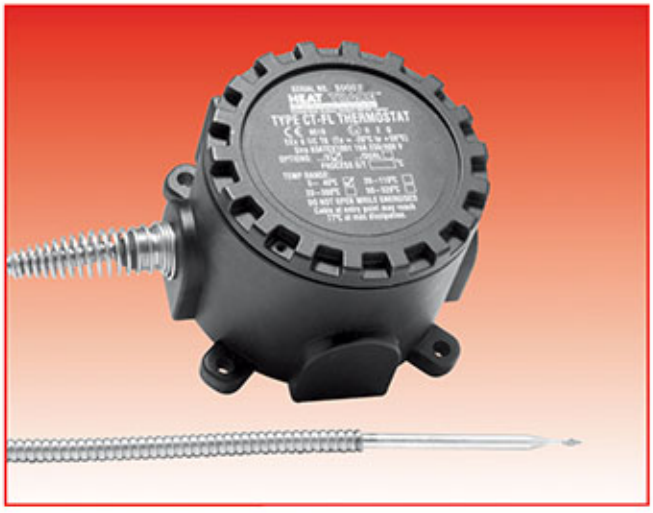
Specifiers should guard against being offered such designs, which may have capital benefits but with attendant safety risks.

Inherent Temperature Safety - Definition

" The inherent ability to self-regulate at a temperature level below the maximum product rating and withstand temperature of the insulating materials, without the use of temperature control."







Considerations in Hazardous Areas

Design and equipment selection for use in hazardous areas will be influenced by:-

- the area classification
- the gas (or dust) group
- the temperature classification and equipment selected providing an appropriate type of protection

As stated above, this document focuses on the international standards developed especially for electric heat tracing, IEC62395 – for Safe Industrial locations and IEC60079-30 – for Hazardous locations.

Area Classification

The probability of explosive conditions being present is defined by zone classification

- **Zone 0** may have explosive gas-air mixtures present continuously or for long periods. Heat tracing is rarely, if ever, used in Zone 0 areas.
- **Zone 1** may have explosive gas-air mixtures present in normal operation.
- **Zone 2** may have explosive gas-air mixtures present only under abnormal conditions.

North American hazardous locations are catagorised in divisions rather than zones. As stated above IEC60079 and IEEE515 are being harmonised as a dual-logo standard. Therefore Heat Trace's product approvals cater for divisions as well as zone locations.

Gas Groups

Gas groups relevant to heat tracing in hazardous locations are:-

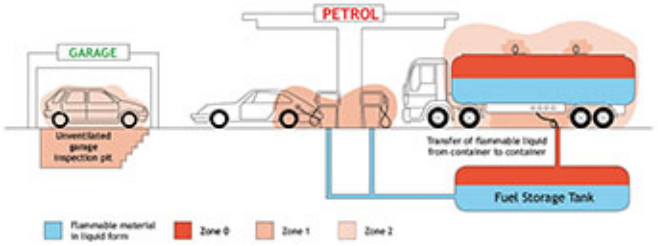
- **IIA** – Acetone, benzene, butane, ethane, methane, propane, etc..
- **IIB** - Ethylene, town gas etc..
- **IIC** – Acetylene, hydrogen

		Flammable Material Present Continuously	Flammable Material Present Intermittently	Flammable Material Present Abnormally
IEC/CENELEC		Zone 0 (Zone 20 Dust)	Zone 1 (Zone 21 Dust)	Zone 2 (Zone 22 Dust)
US	NEC 505	Zone 0	Zone 1	Zone 2
	NEC 500	Division 1		Division 2

IEC classification per IEC 79-10
CENELEC classification per EN 60 079-10
US classification per ANSI/NFPA 70 National Electric Code (NEC) Article 500 or Article 505

IEC / CENELEC

Example of hazardous area zones - Petrol Station Forecourt & Garage



NORTH AMERICAN APPROVAL MARKING

NORTH AMERICAN / EUROPEAN AREA CLASSIFICATION EQUIVALENTS - GAS

	Flammable Material Present Continuously	Flammable Material Present Intermittently	Flammable Material Present Abnormally
IEC / EU	Zone 0	Zone 1	Zone 2
US NEC 505	Zone 0	Zone 1	Zone 2
US NEC 500	Division 1		Division 2
CA CEC Section 18	Zone 0	Zone 1	Zone 2
CEC Annex	Division 1		Division 2

IEC classification per IEC 60079-10 IEC classification per EN 60079-10
US classification per ANSI / NFPA 70 National Electrical Code (NEC) Article 505
CA classification per CSA C22.1 Canadian Electrical Code (CEC) Section 18 or Annex J

NORTH AMERICAN / EUROPEAN EQUIPMENT GROUPING EQUIVALENTS - GAS

Typical Gas	US (NEC 505) CA (CEC Section 18) EU IEC	US (NEC 500) CA (CEC Annex J)
Acetylene	Group IIC	Class I / Group A
Hydrogen	(Group IIB + H^2)	Class I / Group B
Ethylene	Group IIB	Class I / Group C
Propane	Group IIA	Class I / Group D
Methane	Group I*	Mining*

**Not within scope of NEC. Under jurisdiction of MSHA. Not within scope of CEC.*

NORTH AMERICAN / EUROPEAN AREA CLASSIFICATION EQUIVALENTS - DUST

	Combustible Dust Present Continuously	Combustible Dust Present Intermittently	Combustible Dust Present Abnormally
IEC / EU	Zone 20	Zone 21	Zone 22
US NEC 506	Zone 20	Zone 21	Zone 22
US NEC 500	Division 1		Division 2
CA CEC Section 18	Division 1		Division 2

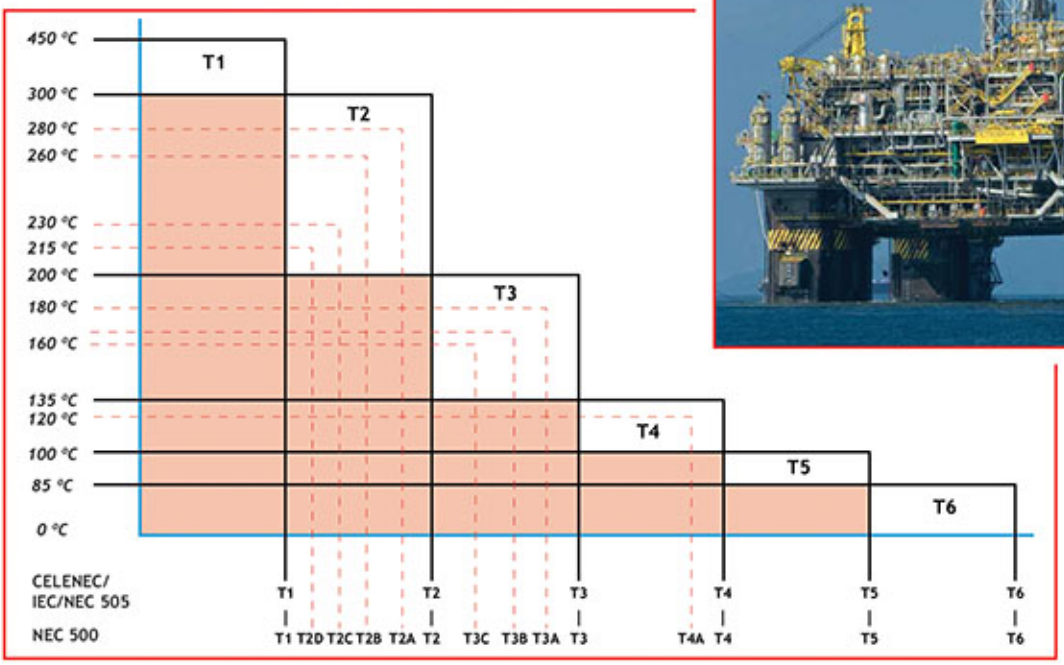
US area classification per ANSI / NFPA 70 National Electrical Code (NEC) Article 500 or 506
CA area classification per CSA C22.1 Canadian Electrical Code (CEC) Section 18
EU area classification per EN 61241-10 IEC area classification per IEC 61241-10

NORTH AMERICAN / EUROPEAN EQUIPMENT GROUPING EQUIVALENTS - DUST

Typical Material	EU (60079-0) IEC (60079-0)	US (NEC 506)	IEC (61241-0) EU (61241-0)	US (NEC 500) CA (CEC Section 18)
Metal dusts	IIIC	N/A	D	Class II, Group E
Carbonaceous dusts	IIIB	D	D	Class II, Group F
Non-conductive dusts	IIIB	D	D	Class II, Group G
Fibres and flyings	IIIA	D	D	Class III

Temperature Classification

The maximum surface temperature of the heater must be kept below the auto ignition temperature of the explosive gas or vapour mixtures which could be present. The classifications are:-



In reality, most gases encountered will have an ignition temperature of T1 or T2. However, it will be recognised that the lower the operating temperature of the heater, the safer the system will be.

For this reason, self-regulating heaters which are inherently temperature-safe should be the preferred safety option. When this is not possible, a calculated stabilised design is preferable to a system that relies on temperature controls for the safety of the system.

Types of Protection

As non-sparking devices, most heaters are likely to be approved to the concept 'e' – increased safety (EExe).

Sparking devices such as thermostats or circuit breakers are most commonly approved to the concept 'd' – flameproof or explosion proof (EExd), although concepts 'i' – intrinsic safety (EExi), and 'p' – pressurised apparatus (EExp) are also sometimes appropriate.

Heat Trace are able to uniquely provide tracers having a continuous metal extruded jacket. Such products can be provided with an EX'd' certificate, in addition to an Ex'e' certificate.

Sometimes, distribution boards and control panels can be located outside the hazardous area to avoid the need for the additional costly protection.

MORE DETAILED INFORMATION ON HAZARDOUS AREA CONSIDERATION IS AVAILABLE FROM THE HEAT TRACE LTD WALL CHART WHICH CAN BE FOUND ON THE WEBSITE www.heat-trace.com

Considerations in Hazardous Areas

European Environmental Protection Classification - IP System

The IP rating system for enclosures containing moving and electrical equipment is recognised in most European countries, meeting a number of British and European standards. It is usually quoted as two digits, in the form IP11.

Relevant standards to which this rating system applies include:

BS EN 60529 and IEC 60529

FIRST NUMERAL
Protection against solid objects
0 - No special protection
1 - Objects > 50mm diameter (e.g. part of a hand)
2 - Objects > 12.5 mm diameter (e.g. finger)
3 - Objects > 2.5 mm diameter (e.g. tool)
4 - Objects > 1.0 mm diameter (e.g. wire)
5 - Dust protected
6 - Dust tight

SECOND NUMERAL
Protection against water
0 - No special protection
1 - Vertically dripping water
2 - Vertically dripping water when enclosure tilted by 15°
3 - Sprayed water up to 60° from the vertical
4 - Sprayed water from all directions
5 - Water jets
6 - Powerful water jets
7 - Temporary submersion to a depth of 1m
8 - Extended submersion to a depth > 1m

IEC Enclosure Ingress Classification

NEMA Equivalents of IP Ratings

The NEMA and IP Ratings (IEC) differ due to the parameters measured and, to some extent, the methods used. NEMA 250 tests for external environmental conditions such as corrosion, rust, oil and coolants, which are not specified in the IEC standards IEC 60529.

Note: as many of the NEMA standards meet or exceed the equivalent IP ratings, it is incorrect to use this table to determine IP equivalents of NEMA Ratings.

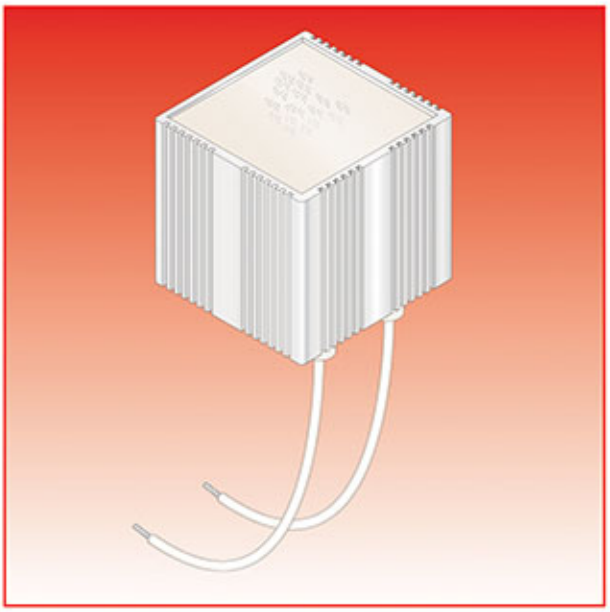
NEMA ENCLOSURE TYPE No. EQUIVALENT	IEC ENCLOSURE APPROXIMATION
2 - Drip tight indoor use	IP11
3 and **3S** - Outdoor weather resistant to rain, sleet, ice and blown dust	IP54
3R - As 3/3S except dust	IP14
4 and **4X** - Indoor/outdoor rain, ice, splashing and hosed water, blown dust. 4X - Also corrosion	IP56
5 - Dust tight indoor use	IP52
6 and **6P** - Outdoor/indoor, occasional limited immersion, ice	IP67
12 and **12K** - Indoor, dust/falling/non-corrosive liquid drips	IP52
13 - Indoor, dust, spraying water, oil and non-corrosive coolant	IP54

Methods of Protection

Protection Method	ID. Letter	IEC	CENELEC	CSA (IEC)	CSA (Annex J)	NEC 505	NEC 500	AS / NZS
Flameproof	d	IEC 60079-1	EN 60079-1	CSA E60079-1	CSA C22.2 No. 30	ISA 60079-1	FM 3618	AS/NZS60079-1 / AS2380.2
Intrinsic Safety	ia	IEC 60079-11	EN 60079-11	CSA E60079-11	CSA C22.2 No. 157	ISA 60079-11	FM 3610	AS/NZS60079-11 / AS2380.7
Intrinsic Safety	ib	IEC 60079-11	EN 60079-11	CSA E60079-11	CSA C22.2 No. 157	ISA 60079-11	FM 3610	AS/NZS60079-11 / AS2380.7
Pressurisation	p	IEC 60079-2	EN 60079-2	CSA E60079-2	CSA TIL. E13 A	ISA 60079-2	FM 3620	AS/NZS60079-2 / AS2380.4
Increased Safety	e	IEC 60079-7	EN 60079-7	CSA E60079-7	-	ISA 60079-7	FM 3619	AS/NZS60079-7 / AS2380.6
Oil Immersion	o	IEC 60079-6	EN 60079-6	CSA E60079-6	-	ISA 60079-6	FM 3621	AS/NZS60079-6
Encapsulation	m	IEC 60079-18	EN 60079-18	CSA E60079-18	-	ISA 60079-18	FM 3614	AS/NZS60079-18
Type 'n' Protection	n	IEC 60079-15	EN 60079-15	CSA E60079-15	CSA C22.2 No. 213	ISA 60079-15	-	AS/NZS60079-15
* Ventilation	v	-	-	-	-	-	-	AS 1482

Protection Method	ID. Letter	Type of Protection	Mode of Function	NEC 500 / CEC Annex J Permitted Division	IEC / CENELEC Permitted Zone
Flameproof	d	Explosion is Contained	Enclosure contains internal explosion	Division 2	Zone 1 or 2
Intrinsic Safety	ia	Sparks are not ignition capable (Safe 2 faults)	I.S. circuits are unable to cause ignition	Division 1 or 2	Zone 0, 1 or 2
Intrinsic Safety	ib	Sparks are not ignition capable (Safe 1 faults)	I.S. circuits are unable to cause ignition	Division 2	Zone 1 or 2
Pressurisation	p	Flammable atmosphere is eliminated	Protection by over pressured enclosure	Division 1 or 2	Zone 1 or 2
Increased Safety	e	Source of ignition eliminated	Electric sparks & high temp. possibilities eliminated	Division 2	Zone 1 or 2
Oil Immersion	o	Flammable atmosphere is eliminated	Protection by Immersion	Division 1 or 2	Zone 1 or 2
Encapsulation	m	Flammable atmosphere is eliminated	Encapsulated apparatus	Division 2	Zone 1 or 2
Type 'n' Protection	n	n Protection includes several methods of ignition protection	Non-Sparking apparatus	Division 2	Zone 2
* Ventilation	v	Flammable atmosphere is eliminated	Protection by Ventilation	-	-

** Only recognised in Australia*



SSD Softstart device can help reduce in-rush current

Off-Shore Helicopter platform, ice prevention systems

Heating Loads - Pipelines

Heat Trace's Evolution design software is able to automatically calculate the appropriate heating load in order to compensate for heat losses from a pipe, vessel and line equipment, or to heat raise the temperature of the equipment and its contents.

The following is a simplistic method for calculation of heating loads for pipes and vessels.

It should be stressed that the heat losses from pipeline fittings, such as valves, flanges, strainers, filters, pumps, are often significant, accounting for typically an additional 25% of the pipe work heating load requirements. Also, pipe supports, which are rarely detailed on drawings, can also account for significant heat losses unless the supports are thermally insulated.

Heat loss compensation for pipelines

As its name implies, this form of heating is used to balance or compensate for heat losses from a pipeline to the surrounding atmosphere. The following method may be used to calculate the amount of heat required:

1. Table 1a - select loss factor for pipe size and insulation thickness.
2. Table 1b - multiply the selected loss factor by the 'K' value of insulation used.
3. Multiply the resultant from Tables 1a and 1b by the temperature difference between lowest ambient and required temp (Δt°C).
4. Multiply - by an appropriate safety factor - typically 1.2
5. **The resultant number x is the heating load in watts/metre of pipe**

It should be noted that this heating load is only needed when the ambient temperature is at it's minimum design level. At all other times the heating load will be greater than necessary. *The excess heating load is normally accommodated by the temperature control system.*

Raising temperature of pipelines

In many cases, it is more economic to maintain the heating over short shutdown periods, eg. weekends, than to make provision for heating up from cold. Where it is essential to provide sufficient heat for warming up in addition to heat loss compensation, the time allowed for warming up should be at least 12-24 hours, as shorter periods normally involve inconveniently high loadings.

Heat required for warming up can be calculated as follows:

Formula 1

$$W = \frac{(P \times S) + (C \times Q) \times \Delta T}{E \times H \times 3600} \quad W/m$$

where
- W = heating required in watts/metre
- P = weight of pipe work in kg/m
- S = specific heat of pipe work in J/kg°C
- C = weight of contents in kg/m
- Q = specific heat of contents in J/kg°C
- ΔT = temperature rise °C
- H = time allowed in hours
- E = efficiency factor, use 0.73 but may vary

This figure must be added to the heat loss compensation calculated previously. It is not necessary to work on the full temperature because, during the heating-up period, the pipe temperature will be below the final temperature, therefore the following equation should be applied:

Total Load = heating up load + 2/3 steady loss at final temperature

Table 1a

Pipe nominal bore	Pipe O.D	Insulation thickness 12	25	37	50	75	100	125	150mm
in	mm	½	1	1½	2	3	4	5	6 in
		Normalised loss factor							
½	21.35	8.01	5.16	4.13	3.58				
¾	26.7	9.39	5.89	4.65	4.00	3.30			
1	33.4	11.34	6.91	5.36	4.56	3.71			
1½	48.3	14.86	8.74	6.63	5.54	4.41			
2	60.3	17.88	10.28	7.69	6.36	4.98	4.26		
2½	73.05	21.05	11.89	8.79	7.21	5.57	4.72		
3	88.9	25.00	13.90	10.15	8.24	6.29	5.28		
4	114.3		17.08	12.30	9.88	7.42	6.15		
6	169.3		23.82	16.82	13.30	9.74	7.93	6.83	
8	219.1		30.13	21.04	16.50	11.89	9.57	8.16	7.20
10	273		36.82	25.53	19.86	14.17	11.29	9.55	8.38
12	324		43.12	29.73	23.03	16.29	12.90	10.85	9.47
14	355		47.05	32.36	25.00	17.60	13.90	11.66	10.15
16	406		53.35	36.56	28.16	19.73	15.50	12.90	11.20
18	457		59.64	40.76	31.31	21.84	17.08	14.22	12.30
20	508		65.92	44.96	34.46	23.95	18.67	15.49	13.37
24	609		78.50	53.35	40.76	28.16	21.84	18.04	15.50
30	762		97.36	65.92	50.20	34.60	26.58	21.84	18.60

Heat loss compensation for tanks, vessels & hoppers

Similarly the design criteria for calculating heat loss compensating and/or raising and maintaining temperature associated with tanks, vessels, or hoppers are as follows:

Formula 2a (for flat surfaces)

$$\text{Loading required} = \frac{A \times K \times (T_1 - T_2)}{E \times t} \text{ watts}$$

2b (for cylindrical surfaces)

$$\text{Loading required} = \frac{2.72 \times K \times L \times (T_1 - T_2)}{E \times \log_{10}(D/d)} \text{ watts}$$

where
- A = total surface area of tank, vessel, etc. to be heated in square metres (m^2)
- K = thermal conductivity of the insulation in W/m°C
- T_1 = temperature to be maintained °C
- T_2 = min. ambient temperature °C
- t = thermal insulation thickness in mm
- L = length of surface
- D = diameter across insulation
- d = outside diameter of pipe
- E = efficiency factor, use 0.73 but may vary

Raising temperature of tanks, vessels and hoppers

Formula 3

Kilowatt loading required =

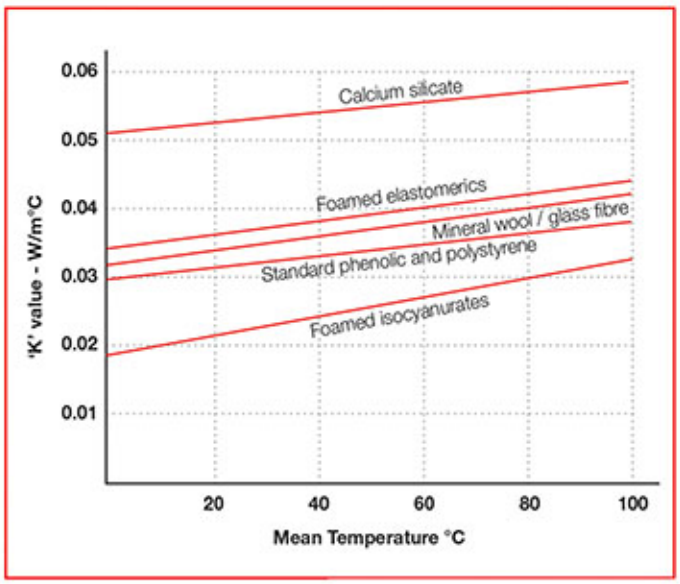
$$\frac{\text{mass(kg)} \times \text{sp heat (J/kg°C)} \times \text{temp rise °C}}{E(0.73) \times 1000 \times \text{hours} \times 3600} \text{ kW}$$

As for pipe work, it is necessary to consider both the vessel and its contents. Therefore apply the above formula to both vessel and contents and add the respective loads together to arrive at the total kilowatt loading.

After raising the tank and contents to the required level, it will be necessary to allow for heat losses as in FORMULAE 2a or 2b.
Therefore the total heat required = Amount of heat to raise temperature of contents + $^2/_3$ of amount of heat to maintain temperature.

Types of thermal insulation used for pipelines and vessels together with thermal conductivity, i.e. 'K' factor, are shown in Table 1b.

Table 1b



Heating Cables – Selection Guide

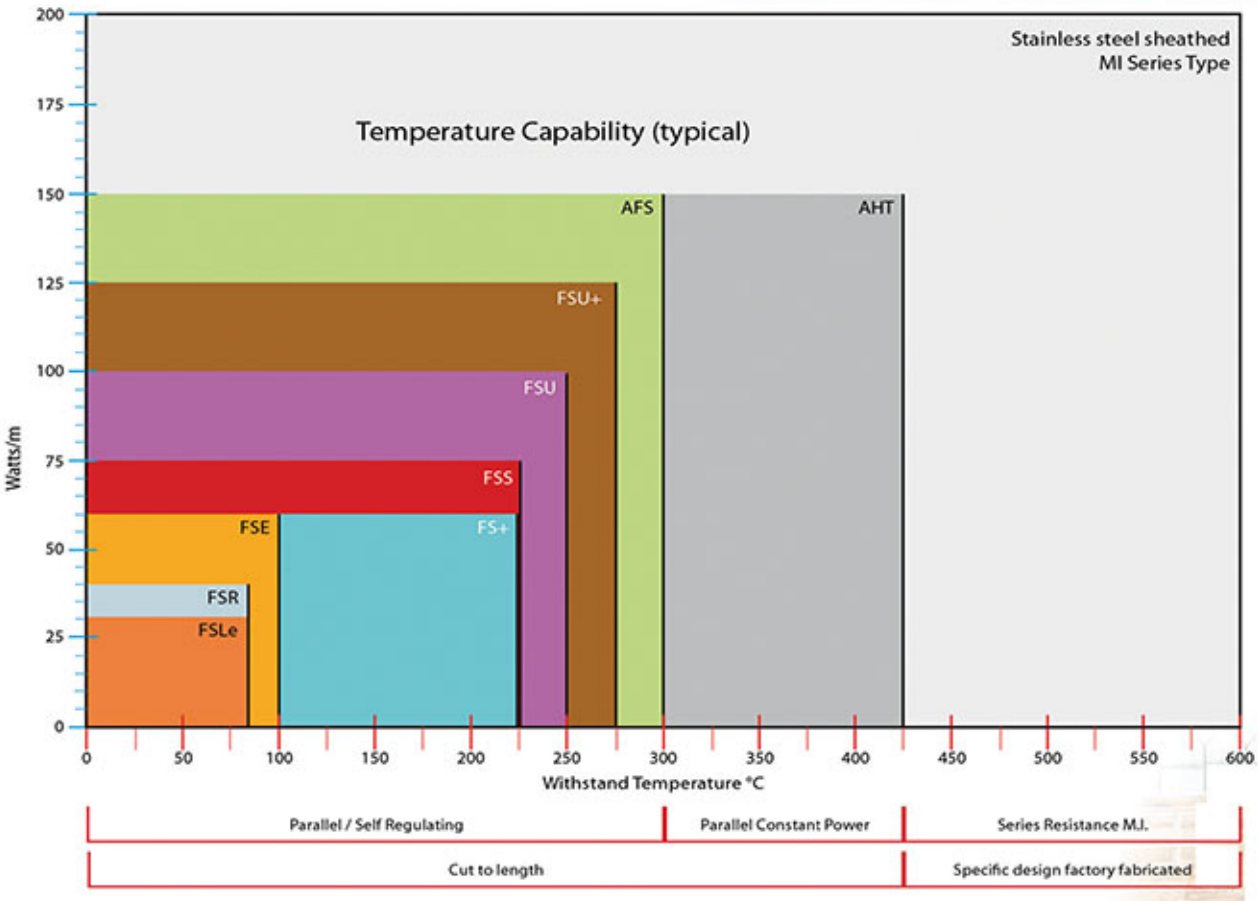
In-plant areas

Heat tracers for in-plant areas are usually selected according to the maximum temperature to which the tracer will be subjected, and the power output required from the tracer.

The following table shows the relationship between temperature withstand and power output for various self-regulating, constant power, and series MI tracers. It may be seen that self-regulating tracers, which can be conveniently cut-to-length and which are usually temperature-safe, are available for exposure temperatures up to 300°C.

AHT constant power tracers can cater for higher exposure temperatures up to 425°C and high power outputs up to 150W/m.

Only exceptionally is it necessary to employ series MI cables, which must be specifically designed for a particular length and output.



- **Transfer and long pipe runs**

Until recently, parallel resistance heaters – self-regulating or constant power – were limited by volt drop to around 150 metres circuit length.

Now, Heat Trace's patented 3 phase self-regulating tracer, particularly when connected to an elevated voltage e.g. 600 volts, is capable of circuit lengths of up to 700 metres. Consequently, inherently temperature-safe heating systems are now available for applications previously not possible.

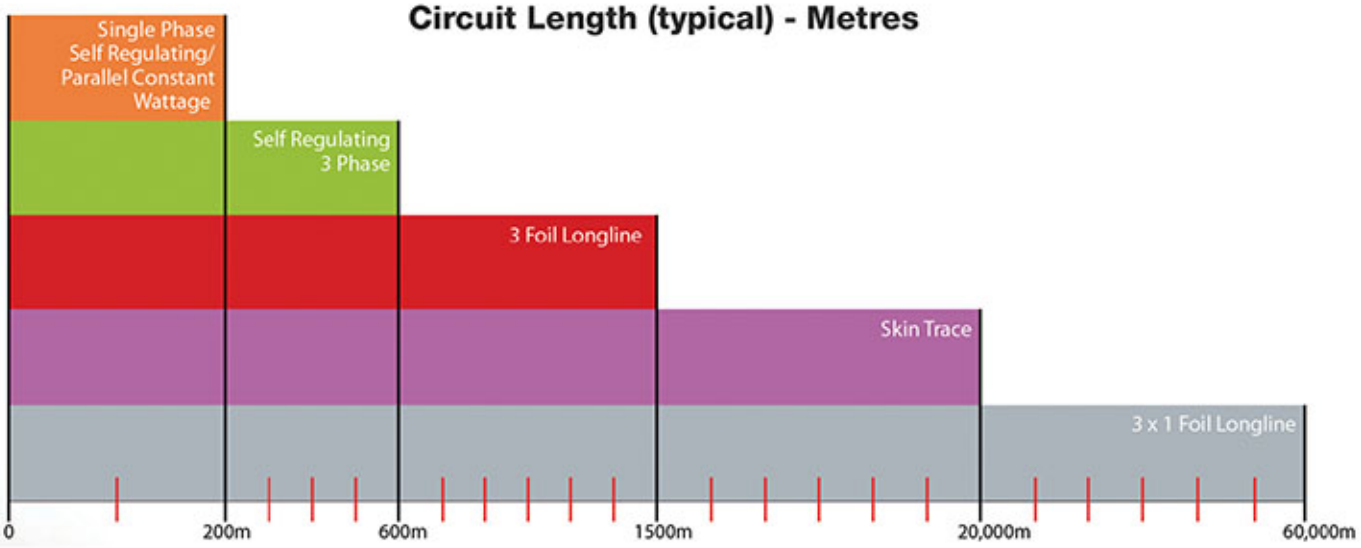
Beyond 700 metres, it is necessary to select series resistance 3 phase Longline heating cables, which have a capability to, for example 5km.

For very long pipe runs, e.g. >10km from a single electrical supply point, there was, until recently, no alternative to the Skin-Trace, skin-effect heating system. However, Heat Trace's new continuous metal extrusion facility has enabled Longline systems to heat up to 50km of pipe from a single electrical feed point.

The advantages of the Longline system over Skin-Trace are:-

- Lower capital cost
- Cheaper/ simpler installation
- Lower operating costs (Skin-Trace power factor is 0.85 against the unity factor of Longline)

Circuit Length (typical) - Metres



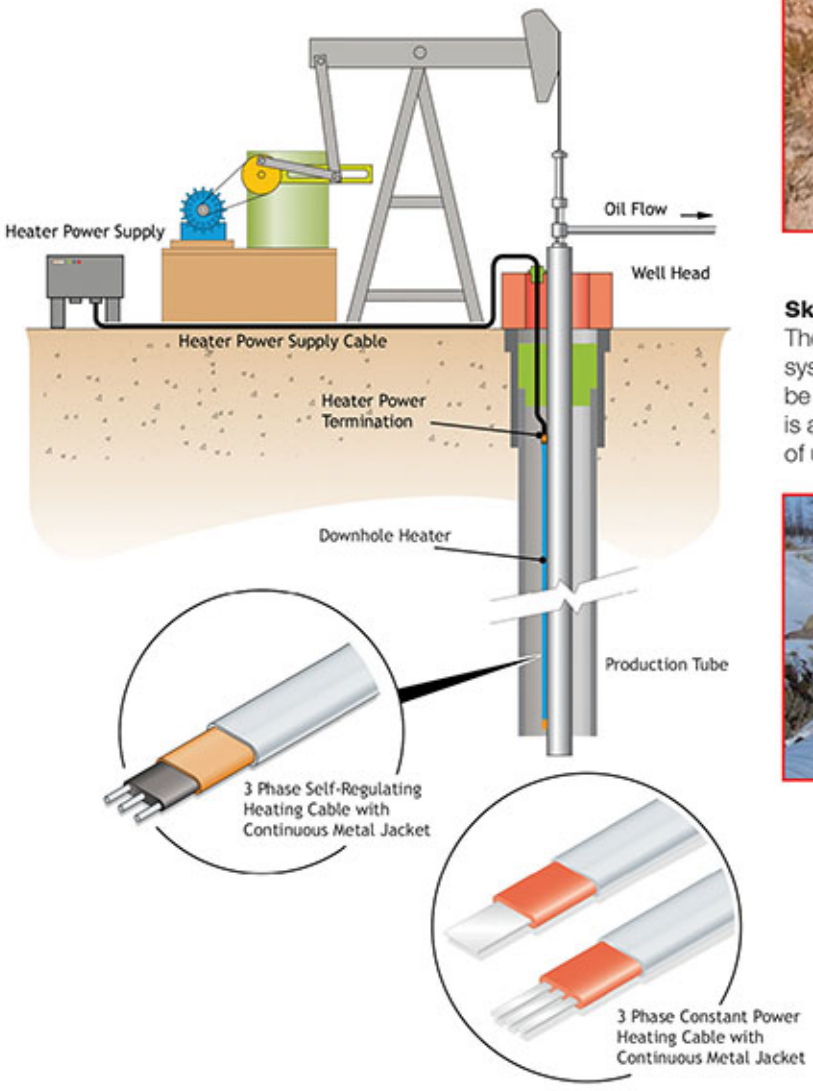
Typical Long Pipeline Applications

Heater selection is usually governed by the pipe length. Some interesting selections and applications are:-

'Downhole' oilwells

In these, oil exits the reservoir into the production tube at high temperature, cooling as it rises to the surface. To prevent the oil temperature falling below its pour point where waxing can occur on the walls of the production tube, the upper sections of the tube may be heated.

In 'Downhole' applications of heated depths to 700 metres, the benefits of inherently temperature-safe self-regulating heaters are preferred. The principle of self-regulating is attractive, because progressively more heat is produced as the oil rises towards the surface, cools, and the temperature falls. In the past this has not been feasible, but Heat Trace have developed the world's first self-regulating 3 phase heater, a patented product based on it's unique phase-balanced load design.



In another well, requiring heating down to 2km, a unique Heat Trace Longline product can be provided with heating conductors whose power output varies from point to point along the pipe route within a single heating cable. Heat Trace's conductor extrusion facility is able to vary it's cross-section, and hence the power output, at will in a continuous extruded length.

Long Pre-insulated Pipelines

The picture below shows a typical long pipeline application where a pre-insulated pipeline is fitted with an HTS3F-CS LONGLINE series resistance heating cable. The pre-insulated pipe is constructed with a metal "raceway" during construction. The heating cable is pulled through the raceway on site as the pre-fabricated pipe lengths are joined together at site, prior to being buried. The pipeline was carrying crude oil from the on-land oil well to a central gathering station.

Buried, Pre-insulated Pipe with Longline HTS3F

Skin Effect Heat Tracing

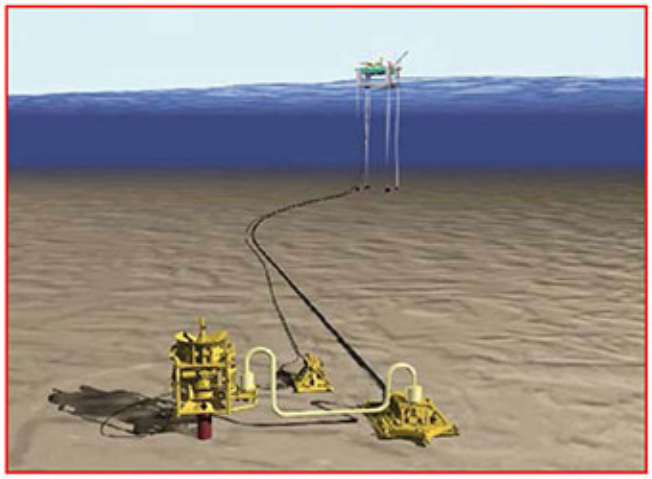
The picture below shows a completed skin effect tracing system prior to being buried. Skin effect tracing systems may be employed for very long cross-country pipelines. Skin trace is an inductive heating system and may be used for pipelines of up to 30km circuit lengths from a single power supply.

Completed Skin Trace system prior to burying

Off-shore Applications

As one of the world's leading suppliers of electric heat tracing products, Heat Trace Limited (HTL) can provide a wide range of heaters and ancillary products that are particularly suited to offshore applications.

In the harsh off-shore environment, safety and reliability are high priorities and HTL is able to supply high quality products and services to meet the demands of the industry. Heaters for subsea pipelines and risers, topside pipeline heating for both freeze protection and temperature maintenance, helicopter platform snow and ice prevention systems, under-floor heating for accommodation - these are just some of the application solutions available from Heat Trace Limited.



Typical subsea tie back from well head to production platform

Subsea Pipeline Heating

Heat Trace's 'Longline' heating system has recently been installed on the world's first reelable heat traced, subsea pipe-in-pipe for a 6.5km gas condensate pipeline, using 75km of heating conductors produced by our new continuous metal extrusion facility. The 2kV system is capable of maintaining the required pipeline temperatures from a single electrical supply point in a 3 phase balanced load configuration by a single heating cable. Temperature control and system monitoring is achieved through the use of fibre optic cables installed with the heaters on the inner production flowline. At the time of writing, several other larger subsea installations, for pipelines up to 50km in length, are in the process of being designed. Heat Trace's heat tracing system for pipe-in-pipe systems are suitable for relatively shallow water applications of around 80-100m depth or for deep sea applications down to 2500 - 3000 metres.

Completed electrically heat-traced pipe-in-pipe being reeled onto the pipelay vessel.

In-shore Applications

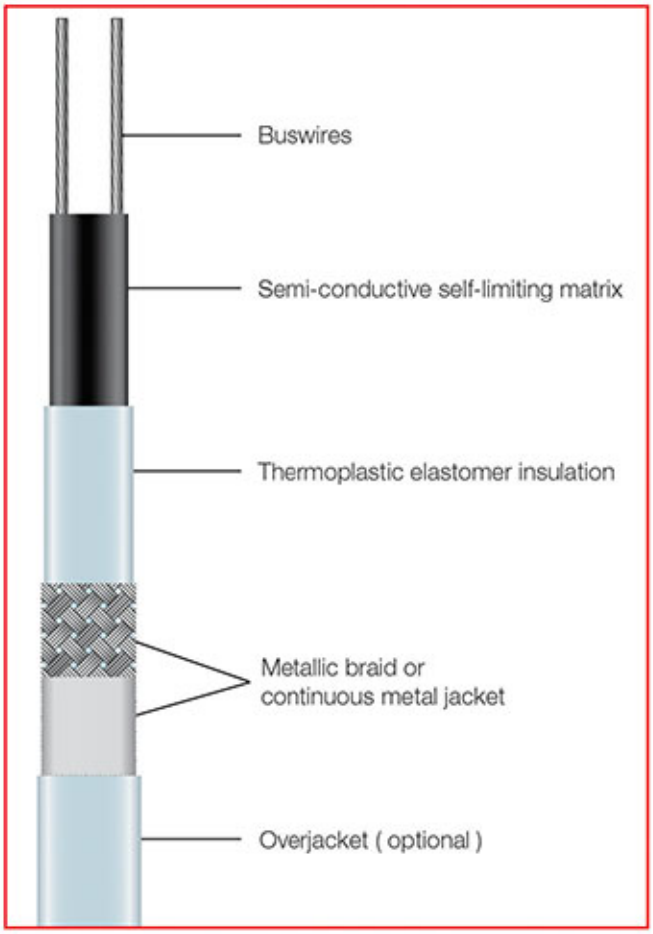
Subsea pipelines for in-shore applications are also used extensively around the world. A typical application might be a fuel tanker off-loading facility for an on-shore plant or power station. These systems are generally run from the on-shore plant storage tank, across the shore line and out to a PLEM located on the seabed and attached to a CALM buoy. The subsea section of the pipe can vary, usually between 1 - 3km from the shore, depending on the depth of water. The pipelines for these applications generally use pre-insulated pipe sections fitted with raceways for the heating cables. These sections are joined together on-shore and the completed pipeline floated/towed into position prior to sinking to the seabed. Alternatively, the pipe sections can be assembled and laid from a barge. Due to the shallow water, these pipelines are usually laid in a trench, or protected in some way, such as a "rock dump".

Helicopter platform, ice prevention systems

Product Data - Parallel Self-Regulating Heaters to 100°C

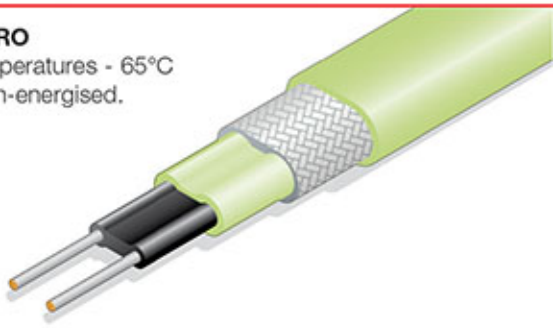
FREEZSTOP - Low Temperature Range
Self-Regulating Heating Cables for exposure temperatures up to 100°C

A versatile range of industrial grade self-regulating heating cables for freeze protection and **low** process temperature maintenance duties. All cables are available with a choice of flexible metallic braid or continuous metallic extruded jacket. Further corrosion resisting overjacket in thermoplastic or fluoropolymer is optional. Approved for use in both safe and hazardous areas. Available for voltages 100 – 120VAC and 208 – 277VAC.

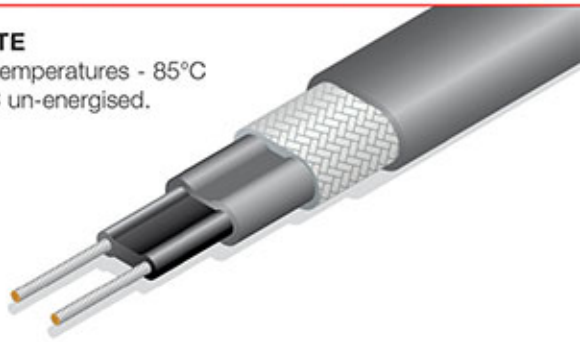


- **Use Type C or D motor rated circuit breakers**
- **Maximum circuit lengths are based on a start up temperature of 10°C**
- **If circuits are started up when heaters are below 10°C, circuit breakers may trip. If this happens, re-energise the circuits until the heaters warm up, and circuit breakers remain switched on**
- **For maximum circuit lengths for start up temperatures below 10°C, please consult Heat Trace Limited**
- **THERMAL RATINGS**
  Nominal power output at 115V or 230V when installed on insulated metal pipes.

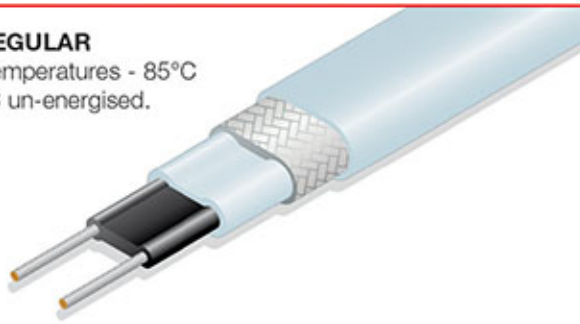
FREEZSTOP MICRO
FSM withstand temperatures - 65°C energised / 85°C un-energised.



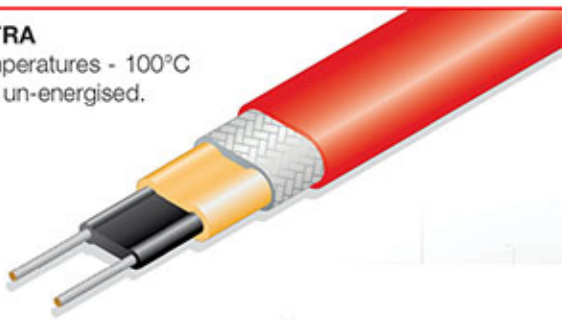
FREEZSTOP LITE
FSLe withstand temperatures - 85°C energised / 85°C un-energised.



FREEZSTOP REGULAR
FSR withstand temperatures - 85°C energised / 85°C un-energised.



FREEZSTOP EXTRA
FSE withstand temperatures - 100°C energised / 100°C un-energised.

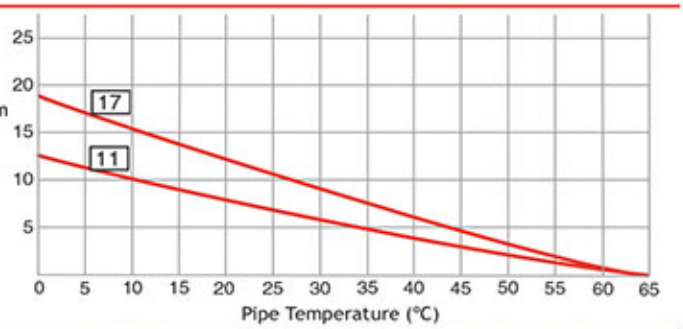


Low Temperature

MICRO - FSM Specification Data

MAXIMUM LENGTH (m) vs. CIRCUIT BREAKER SIZE

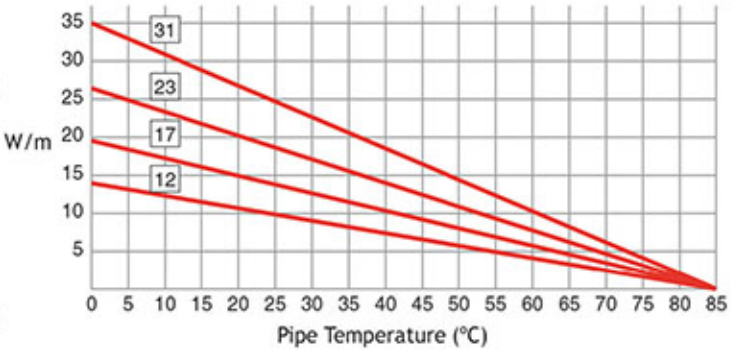
Cat Ref	115V 6A	115V 16A	230V 6A	230V 16A
11FSM	38	64	76	128
17FSM	27	51	54	102



LITE - FSLe Specification Data

MAXIMUM LENGTH (m) vs. CIRCUIT BREAKER SIZE

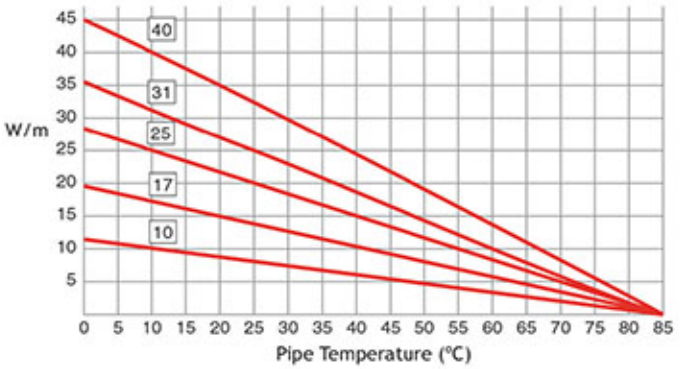
Cat Ref	115V 10A	115V 16A	115V 20A	230V 10A	230V 16A	230V 20A
12FSLe	38	90	-	132	180	-
17FSLe	31	73	-	104	146	-
23FSLe	23	62	-	76	124	-
31FSLe	17	46	51	58	92	102



REGULAR - FSR Specification Data

MAXIMUM LENGTH (m) vs. CIRCUIT BREAKER SIZE

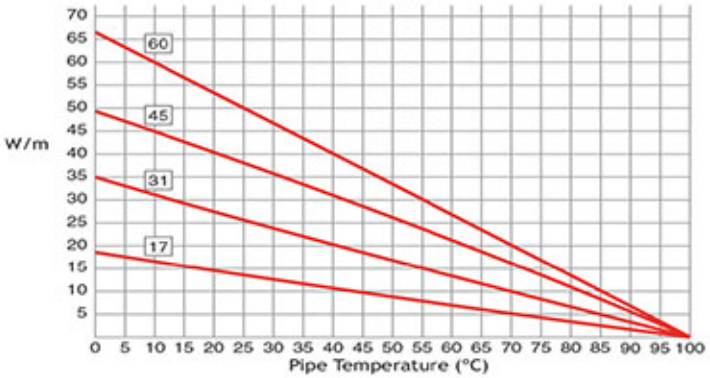
Cat Ref	115V 16A	115V 20A	115V 25A	230V 16A	230V 20A	230V 25A
10FSR	99	-	-	198	-	-
17FSR	77	-	-	154	-	
25FSR	62	-	-	124	-	
31FSR	37	46	55	74	92	110
40FSR	28	35	44	56	70	88



Extra - FSE Specification Data

MAXIMUM LENGTH (m) vs. CIRCUIT BREAKER SIZE

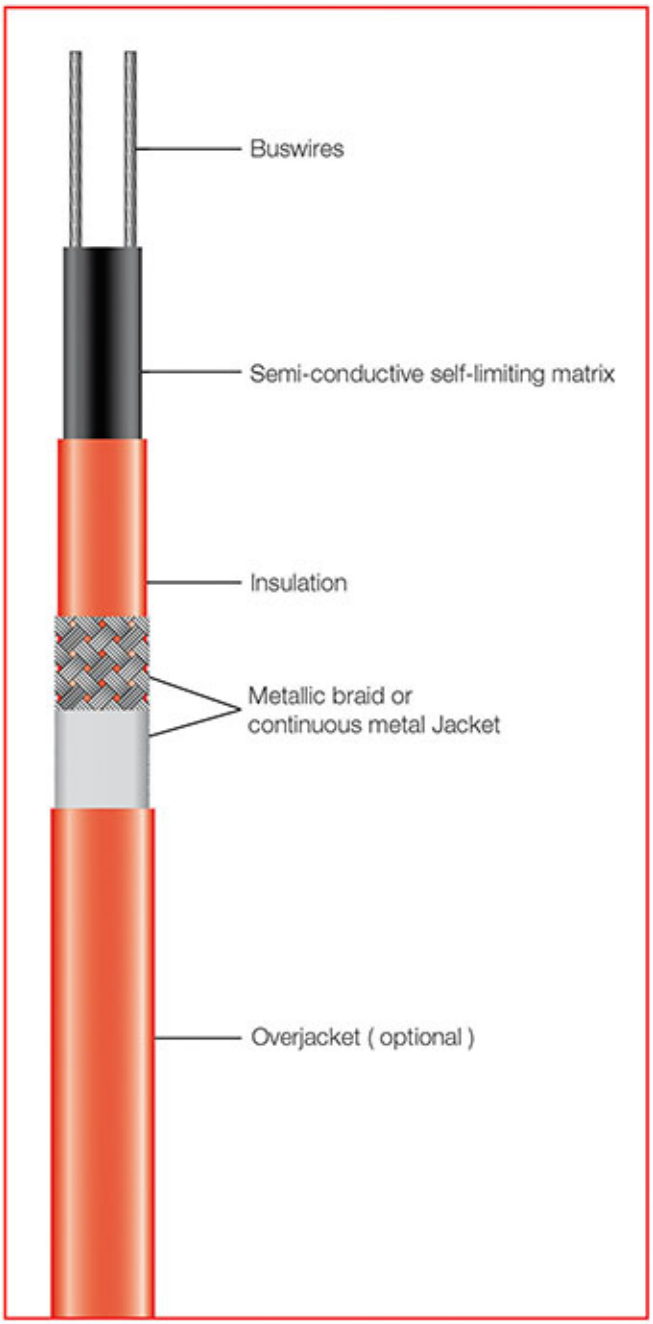
Cat Ref	115V 16A	115V 20A	115V 25A	230V 16A	230V 20A	230V 25A
17FSE	60	74	-	120	148	
31FSE	41	55	-	82	104	110
45FSEw	31	38	48	62	76	96
60FSEw	26	33	41	52	66	



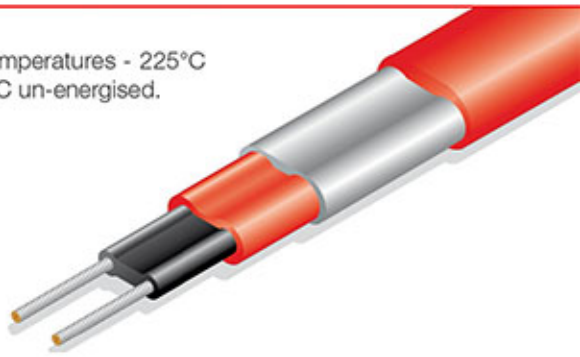
Product Data - Parallel Self-Regulating Heaters to 250°C

FAILSAFE - High Temperature Range
Self-Regulating Heating Cables for exposure temperatures up to 250°C

A versatile range of industrial grade self-regulating heating cables for freeze protection and **high** process temperature maintenance duties. All cables are available with a choice of flexible metallic braid or continuous metallic extruded jacket. Further corrosion resisting overjacket in silicone rubber or fluoropolymer is optional. Approved for use in both safe and hazardous areas. Available for voltages 100 – 120VAC and 208 – 277VAC.

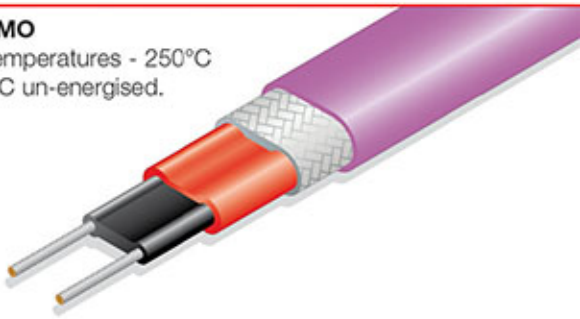


FAILSAFE +
FS+ withstand temperatures - 225°C
energised / 225°C un-energised.



FAILSAFE SUPER
FSS withstand temperatures - 225°C
energised / 225°C un-energised.

FAILSAFE ULTIMO
FSU withstand temperatures - 250°C
energised / 250°C un-energised.



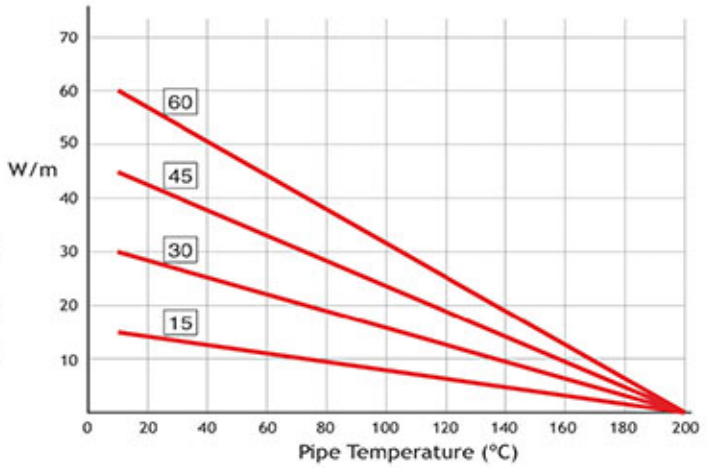
- **Use Type C or D motor rated circuit breakers**
- **Maximum circuit lengths are based on a start up temperature of 10°C**
- **If circuits are started up when heaters are below 10°C, circuit breakers may trip. If this happens, re-energise the circuits until the heaters warm up, and circuit breakers remain switched on**
- **For maximum circuit lengths for start up temperatures below 10°C, please consult Heat Trace Limited**
- **THERMAL RATINGS**
  Nominal power output at 115V or 230V when installed on insulated metal pipes.

High Temperature

FAILSAFE + Specification Data

MAXIMUM LENGTH (m) vs. CIRCUIT BREAKER SIZE

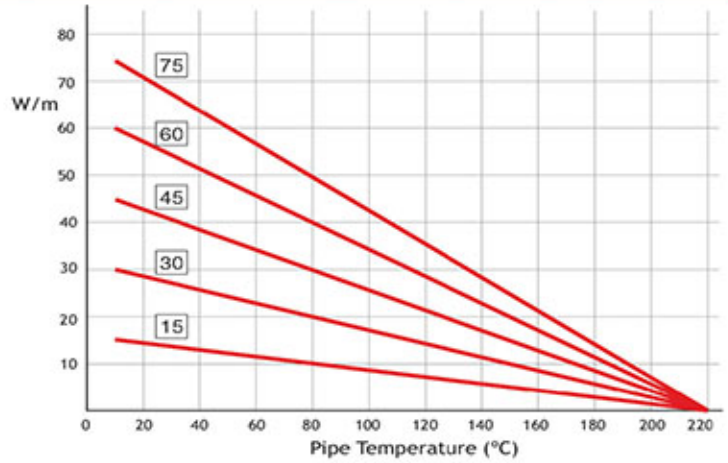
Cat Ref	115V 20A	115V 25A	115V 32A	230V 20A	230V 25A	230V 32A
15FS+	77	-	-	154	-	-
30FS+	51	-	-	102	-	108
45FS+	38	-	44	76	-	88
60FS+	31	-	38	62	-	76



FAILSAFE SUPER Specification Data

MAXIMUM LENGTH (m) vs. CIRCUIT BREAKER SIZE

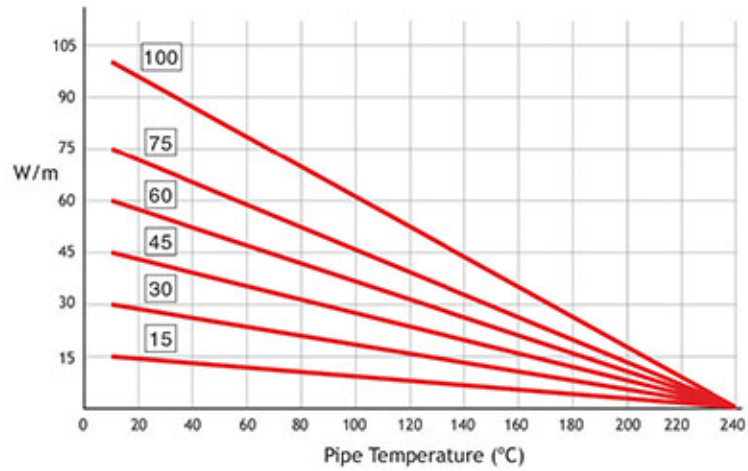
Cat Ref	115V 20A	115V 25A	115V 32A	230V 20A	230V 25A	230V 32A
15FSS	77	-	-	154	-	-
30FSS	51	55	54	102	110	108
45FSS	30	38	48	60	76	96
60FSS	26	33	41	52	66	82
75FSS	26	33	41	52	66	82



FAILSAFE ULTIMO Specification Data

MAXIMUM LENGTH (m) vs. CIRCUIT BREAKER SIZE

Cat Ref	115V 20A	115V 25A	115V 32A	230V 20A	230V 25A	230V 32A
15FSU	77	-	-	154	-	-
30FSU	51	55	-	102	110	-
45FSU	30	38	48	76	76	96
60FSU	26	31	41	62	62	82
75FSU	26	33	41	46	66	82
100FSUw	26	33	41	30	66	82

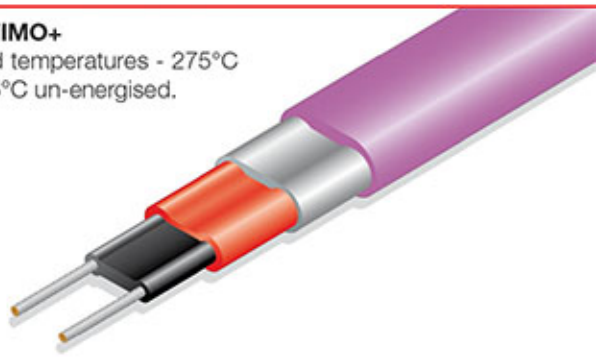


Product Data - Parallel Self-Regulating Heaters to 300˚C

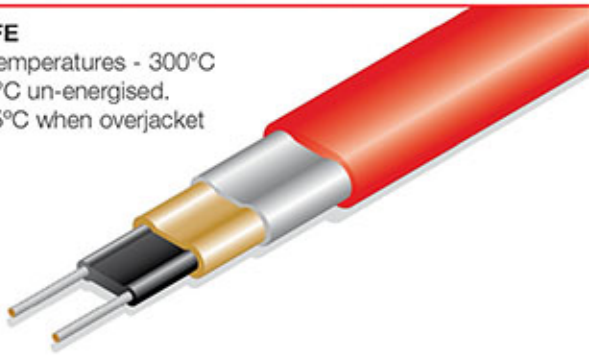
FAILSAFE - Ultra High Temperature Range Self-Regulating Heating Cables for exposure temperatures up to 300°C

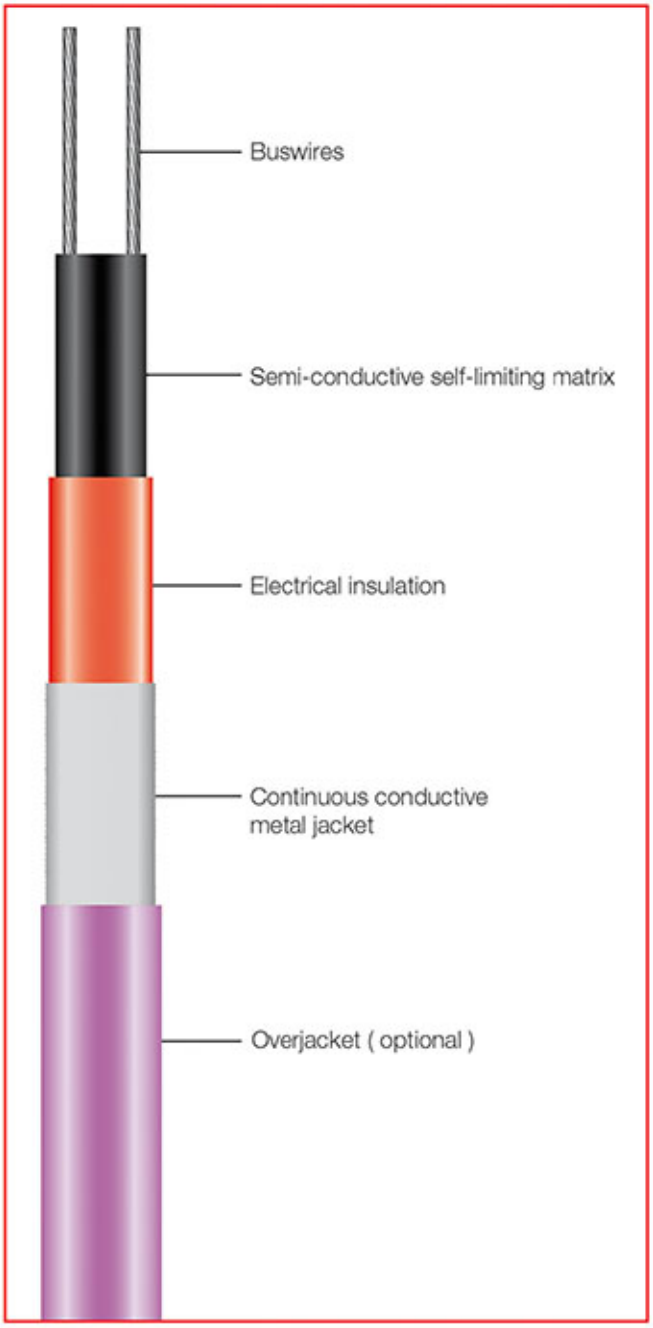
A versatile range of industrial grade self-regulating heating cables for freeze protection and **ultra high** process temperature maintenance duties.
All cables are available with a continuous extruded patented metal coating for earth protection and mechanical strength and optionally with a fluoropolymer outer jacket. Approved for use in both safe and hazardous areas. Available for voltages from 12 – 1000V (AC or DC).

FAILSAFE ULTIMO+
FSU+ withstand temperatures - 275°C energised / 275°C un-energised.



AUTO FAILSAFE
AFS withstand temperatures - 300°C energised / 300°C un-energised.
(reduced to 275°C when overjacket is provided).





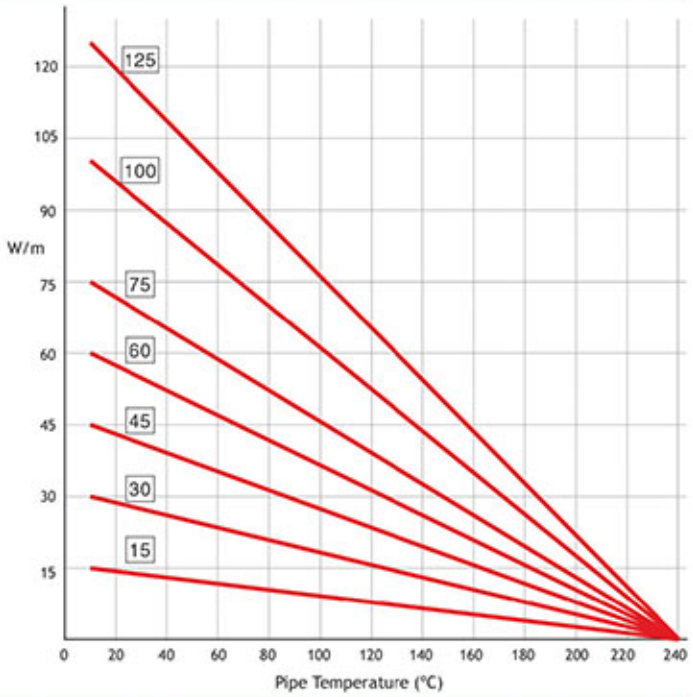
Very High Temperature

- **Use Type C or D motor rated circuit breakers**
- **Maximum circuit lengths are based on a start up temperature of 10°C**
- **If circuits are started up when heaters are below 10°C, circuit breakers may trip. If this happens, re-energise the circuits until the heaters warm up, and circuit breakers remain switched on**
- **For maximum circuit lengths for start up temperatures below 10°C, please consult Heat Trace Limited**
- **THERMAL RATINGS**
  Nominal power output at 115V or 230V when installed on insulated metal pipes.

ULTIMO - FSU+ Specification Data

MAXIMUM LENGTH (m) vs. CIRCUIT BREAKER SIZE

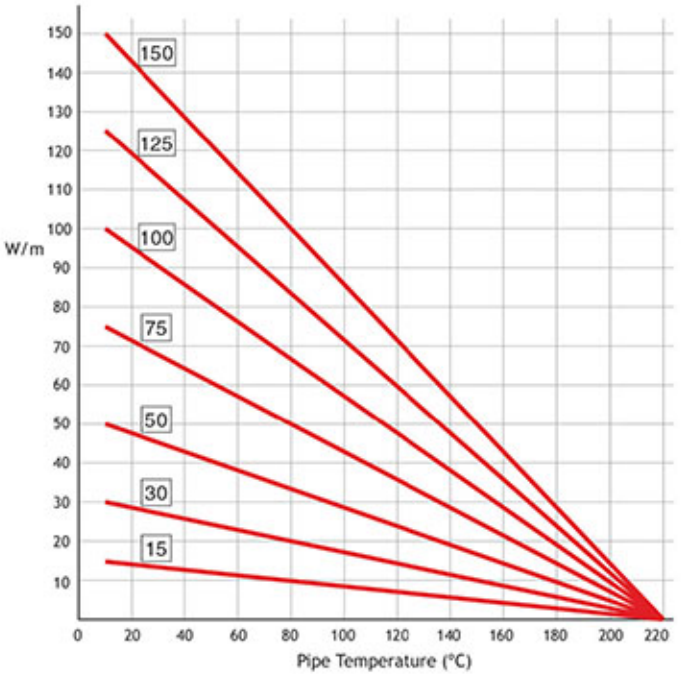
Cat	115V		230V	
Ref	20A	32A	20A	32A
15FSU+	77	-	154	-
30FSU+	51	54	102	108
45FSU+	38	44	76	88
60FSU+	31	38	62	76
75FSU+	23	34	46	68
100FSU+w	15	25	30	50
125FSU+w	10	10	20	20



AUTO - AFS Specification Data

MAXIMUM LENGTH (m) vs. CIRCUIT BREAKER SIZE

Cat	115V			230V		
Ref	20A	40A	63A	20A	40A	63A
15AFS	77	98	-	154	196	-
30AFS	46	69	-	92	138	-
50AFS	31	49	54	62	98	108
75AFS	23	37	44	46	74	88
100AFS	15	25	38	30	50	76
125AFS	10	15	30	20	30	60
150AFS	7	11	21	14	22	42



Very High Temperature

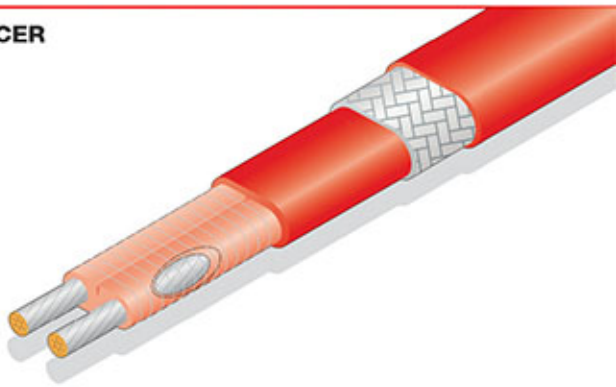
Product Data - Parallel Constant Power Heaters to 200°C

MINITRACER - Low to Medium Temperature Range Parallel Constant Power Heating Cables for exposure temperatures up to 200°C

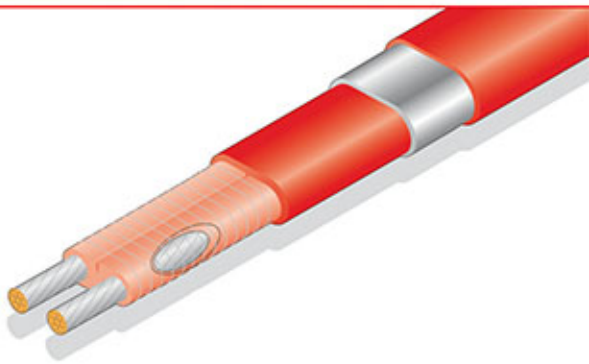
Types MTF and EMTF are parallel resistance, constant wattage, cut-to-length heating cables that can be used for freeze protection or low to medium process heating of pipe work and vessels. They can be cut to length at site and easily terminated. Suitable for use in both safe and hazardous areas. MTF and EMTF heaters are available with metallic braid, or braid and fluoropolymer outer jacket. As an alternative to the braid, a continuous metal jacket can be provided for additional mechanical protection.

Available for 100/120 and 208/240VAC. Installation of the heating cables is quick and simple and requires no special skills or tools. Termination and power connection components are all provided in convenient kits.

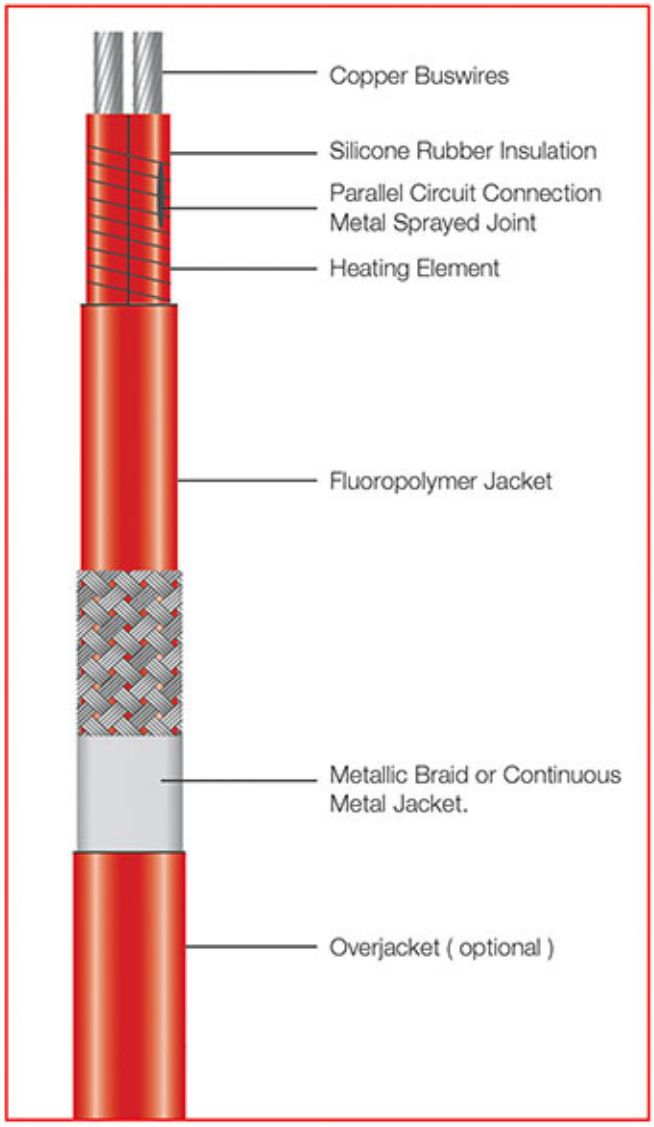
MICROTRACER



MINITRACER



Low - Medium Temperature



EMTF Specification Data

MAXIMUM LENGTH (m) vs. CIRCUIT BREAKER SIZE

OUTPUT (W/m)	MAX. CIRCUIT LENGTH* 115V	230V
6.5	82	164
13	58	116
23	44	87
33	36	73
50	30	59

* For ±10% end to end power output variation

MAXIMUM PIPE / WORKPIECE TEMPERATURES (°C)

NOM. OUTPUT (W/m)	EMTF-C EMTF-A	EMTF-CF EMTF-AF
6.5	190	190
13	175	185
23	145	155
33	100	100
50	60	70

MTF Specification Data

MAXIMUM LENGTH (m) vs. CIRCUIT BREAKER SIZE

OUTPUT (W/m)	MAX. CIRCUIT LENGTH* 115V	230V
6.5	106	212
13	75	150
23	56	113
33	47	94
50	38	76

* For ±10% end to end power output variation

MAXIMUM PIPE / WORKPIECE TEMPERATURES (°C)

CAT REF	NOM. OUTPUT (W/m)	AREA CLASSIFICATION HAZARDOUS T6	T5	T4	T3	T2	T1	SAFE
MTF..C	6.5	60	75	120	190	190	190	190
MTF..A	13	40	55	95	175	180	180	180
	23	-	30	65	155	155	155	155
	33	-	-	40	115	120	120	120
	50	-	-	-	70	80	80	80
MTF..CF	6.5	60	80	125	190	190	190	190
MTF..AF	13	35	50	100	185	185	185	185
	23	-	25	55	160	165	165	165
	33	-	-	35	115	120	120	120
	50	-	-	-	80	85	85	85

POWER CONVERSION FACTORS

115V HEATING CABLE	230V HEATING CABLE
125V Multiply output by 1.18	277V Multiply output by 1.45
120V Multiply output by 1.09	240V Multiply output by 1.09
110V Multiply output by 0.91	220V Multiply output by 0.91
100V Multiply output by 0.76	208V Multiply output by 0.82

For conditions other than worst case, or pipes of other materials (eg. plastic, stainless steel, etc..), consult Heat Trace Ltd. Tolerances: Voltage +10%; Resistance +10%; -0%

Product Data - Parallel Constant Power Heaters to 425˚C

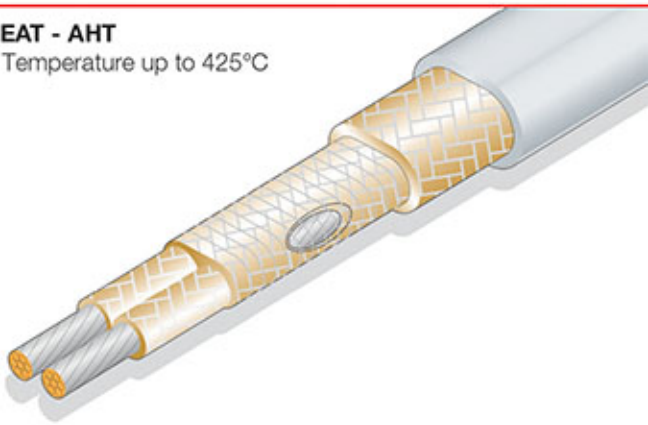
POWERHEAT - High Temperature Range
Parallel Constant Power Heating Cables for exposure temperatures up to 425°C

Powerheat range PHT and AHT are parallel circuit, mineral insulated, cut-to-length, constant power heating cables. They are used for freeze protection and process heating of pipe work and vessels, where very high withstand temperatures, or where high power outputs are required. Their cut-to-length capability means they can be easily terminated at site. They are suitable for use in both safe and hazardous areas.

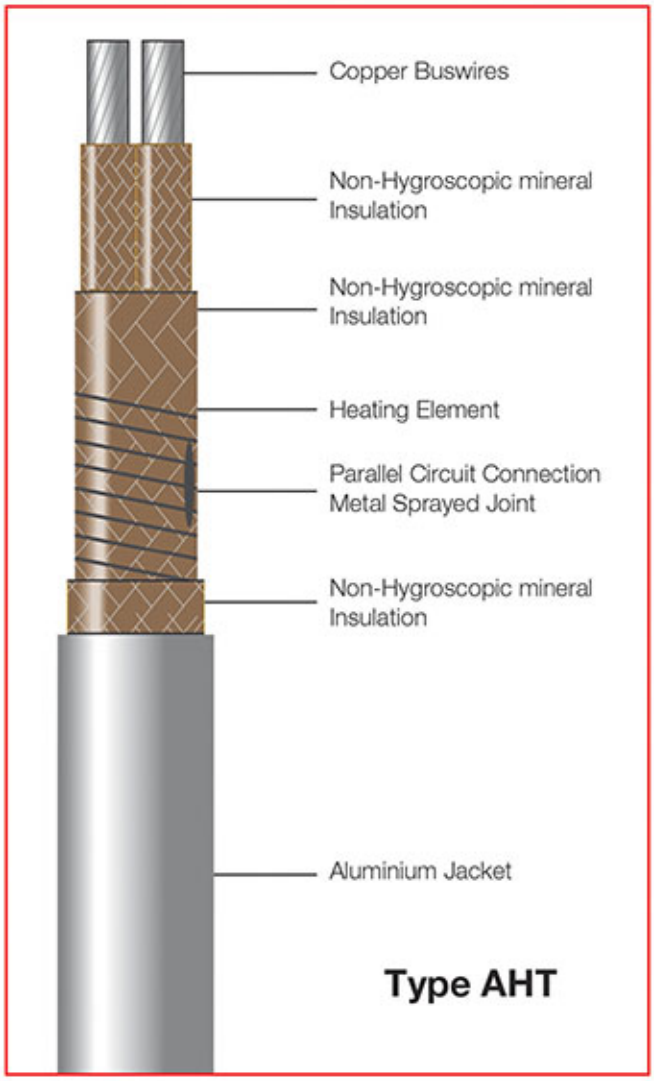
Powerheat cables are insulated with multiple layers of non-hygroscopic mineral materials to withstand high temperatures. PHT is available with a metallic braid, or braid and fluoropolymer outer jacket. AHT cables have an aluminium outer jacket, giving a high mechanical strength, yet still retaining flexibility. Available for 100/120 and 208/277VAC.

POWERHEAT - PHT
Withstand Temperature up to 285°C

POWERHEAT - AHT
Withstand Temperature up to 425°C



High Temperature



PHT Specification Data

MAXIMUM LENGTH (m) vs. CIRCUIT BREAKER SIZE

OUTPUT	MAX. CIRCUIT LENGTH*	
(W/m)	115V	230V
10	79	152
30	46	88
50	35	68
70	30	56

* For ±10% end to end power output variation

MAXIMUM PIPE / WORKPIECE TEMPERATURES (°C)

CAT REF	NOM. OUTPUT	AREA CLASSIFICATION HAZARDOUS						
	(W/m)	T6	T5	T4	T3	T2	T1	SAFE
PHT..N	10	44	61	102	180	275	275	275
	30	-	-	24	116	246	246	246
	50	-	-	-	48	200	200	200
	70	-	-	-	-	144	144	144
PHT..NF	10	40	60	105	186	275	275	275
	30	-	-	22	132	255	255	255
	50	-	-	-	63	215	215	215
	70	-	-	-	-	168	168	168

AHT Specification Data

MAXIMUM LENGTH (m) vs. CIRCUIT BREAKER SIZE

OUTPUT	MAX. CIRCUIT LENGTH*	
(W/m)	115V	230V
15	59	118
30	42	83
50	32	64
100	23	46
150	19	37

* For ±10% end to end power output variation

MAXIMUM PIPE / WORKPIECE TEMPERATURES (°C)

CAT REF	NOM. OUTPUT	AREA CLASSIFICATION HAZARDOUS						
	(W/m)	T6	T5	T4	T3	T2	T1	SAFE
AHT	15	-	36	71	160	289	350	350
	30	-	11	28	100	246	323	323
	50	-	-	-	39	178	276	276
	100	-	-	-	-	48	140	140
	150	-	-	-	-	-	36	36

POWER CONVERSION FACTORS

115V HEATING CABLE		230V HEATING CABLE	
125V	Multiply output by 1.18	277V	Multiply output by 1.45
120V	Multiply output by 1.09	240V	Multiply output by 1.09
110V	Multiply output by 0.91	220V	Multiply output by 0.91
100V	Multiply output by 0.76	208V	Multiply output by 0.82

For conditions other than worst case, or pipes of other materials (eg. plastic, stainless steel, etc..), consult Heat Trace Ltd. Tolerances: Voltage +10%; Resistance +10%; -0%

Product Data - Series Resistance Heaters to 125°C

LONGLINE - Low Temperature Range
Series constant power heating cables for long pipelines. Exposure temperatures up to 125°C

Longline HTP3F and HTP1F are series resistance, constant power heating cables used for freeze protection, or, process temperature maintenance of long pipelines where low temperatures are encountered.

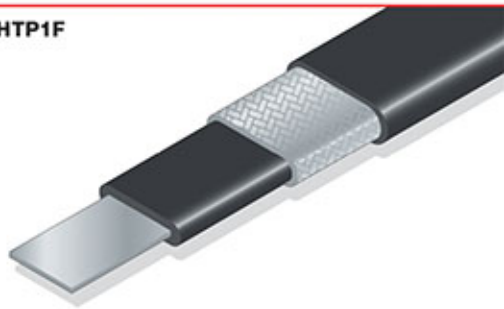
HTP3F cables are used typically for pipelines up to 2km between supply points. HTP1F cables are used where there is approx 10km between supply points.

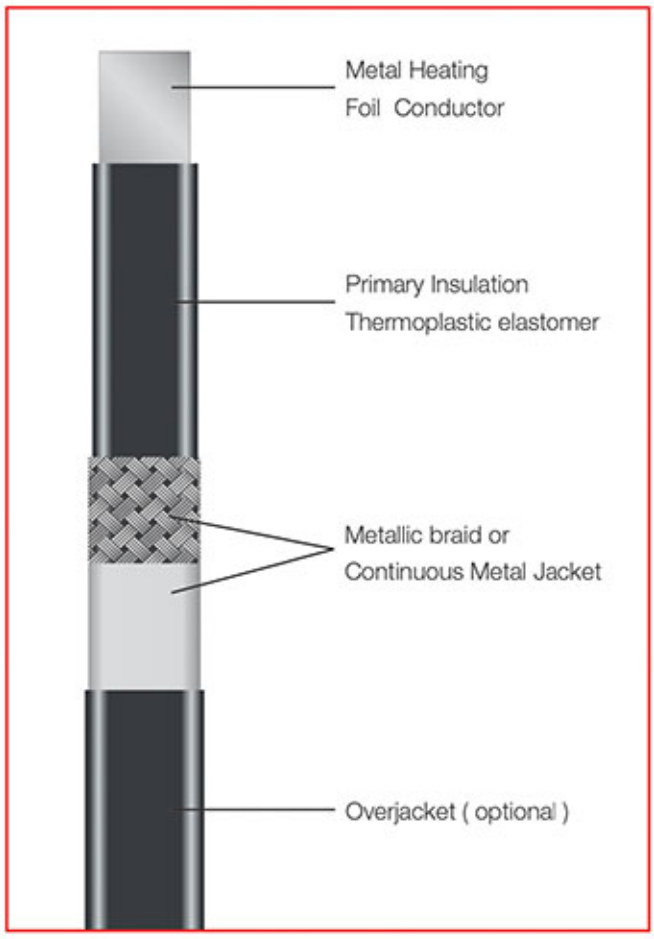
Longline series heating cables minimise the number of electrical supplies needed and so minimise supply cabling / distribution equipment costs. Circuits are often fed at the pipe ends only. All cables are available with a choice of flexible metallic braid or continuous metallic extended jacket. A further corrosion resisting overjacket in thermoplastic or fluoropolymer is optional. This style of cable is specifically designed to suit each application. The output of the heater is a function of the circuit length, the size of the conductor foils and the supply voltage.

Longline is an extremely viable option to skin effect heating for very long pipelines.

LONGLINE - HTP3F

LONGLINE - HTP1F





HTP3F Specification Data
MAXIMUM PIPE / WORKPIECE TEMPERATURES (°C)

NOM. OUTPUT (W/m)	HTP3F-C HTP3F-A	HTP3F-CT/CF HTP3F-AT/AF
10	109	100
15	95	85
23	80	70

For conditions other than worst case, or pipes of other materials (eg. plastic, stainless steel, etc..), consult Heat Trace Ltd.

Tolerances: Voltage +10%; Resistance +10%; -0%

HTP1F Specification Data
MAXIMUM PIPE / WORKPIECE TEMPERATURES (°C)

NOM. OUTPUT (W/m)	HTP1F-C HTP1F-A	HTP1F-CT/CF HTP1F-AT/AF
10	109	100
15	95	85
23	80	70

For conditions other than worst case, or pipes of other materials (eg. plastic, stainless steel, etc..), consult Heat Trace Ltd.

Tolerances: Voltage +10%; Resistance +10%; -0%

Typical Longline applications for heating of pre-insulated pipe work with heaters in raceways.

Low Temperature

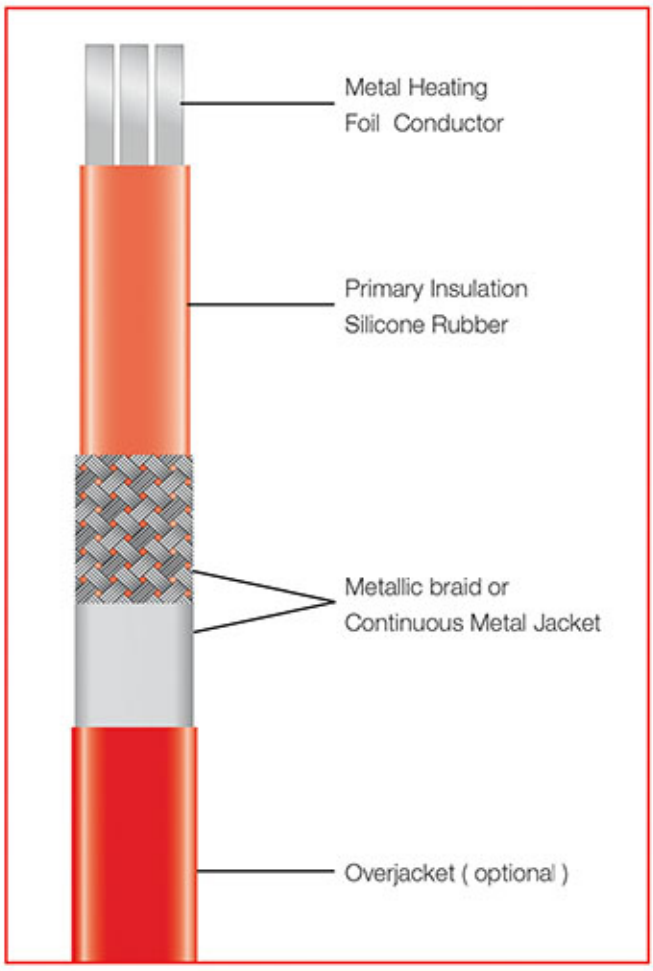
Product Data - Series Resistance Heaters - 230°C

LONGLINE - Medium Temperature Range
Series constant power heating cables for long pipelines. Exposure temperatures up to 230°C

Longline HTS3F and HTS1F are series resistance, constant power heating cables with silicone insulation, used for freeze protection, or process temperature maintenance of long pipelines where medium temperatures are encountered.

HTS3F cables are used generally for long pipelines up to 2km between supply points.

HTS1F cables are typically used where there is approx up to 10km between supply points. Longline series heating cables minimise the number of electrical supplies needed and so minimises supply cabling / distribution equipment costs. Circuits are often fed at the pipe ends only. All cables are available with metallic braid, braid and silicone rubber jacket, or braid and fluoropolymer jacket.
This style of cable is specifically designed to suit each application. The output of the heater is a function of the circuit length, the size of the conductor foils and the supply voltage. Longline is an extremely viable option to skin effect heating for very long pipelines.



Medium Temperature

HTS3F Specification Data
MAXIMUM PIPE / WORKPIECE TEMPERATURES (°C)

CAT REF	NOM. OUTPUT (W/m)	AREA CLASSIFICATION HAZARDOUS T6	T5	T4	T3	T2	T1	SAFE
HTS3F-C	10	48	66	107	181	218	218	218
-A	20	–	32	75	158	191	191	191
	30	–	–	41	133	164	164	164
	40	–	–	–	109	134	134	134
	50	–	–	–	76	97	97	97
	60	–	–	–	30	46	46	46
HTS3F-CS	10	58	74	112	181	208	208	208
-AS	20	37	54	94	166	180	180	180
	30	–	31	74	153	158	158	158
	40	–	–	51	127	127	127	127
	50	–	–	27	93	93	93	93
	60	–	–	–	–	–	–	57
HTS3F-CF	10	58	74	112	181	192	192	192
-AF	20	37	54	94	166	178	178	178
	30	–	31	74	153	165	165	165
	40	–	–	51	127	127	127	127
	50	–	–	27	93	93	93	93
	60	–	–	–	–	–	–	57

For conditions other than worst case, or pipes of other materials (eg. plastic, stainless steel, etc..), consult Heat Trace Ltd.

Tolerances: Voltage +10%; Resistance +10%; -0%

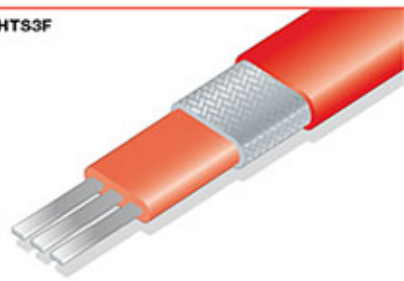
HTS1F Specification Data
MAXIMUM PIPE / WORKPIECE TEMPERATURES (°C)

NOM. OUTPUT (W/m)	HTS1F-C -A	HTS1F-CS -AS	HTS1F-CF -AF
10	218	208	192
20	191	180	178
30	164	158	165
40	134	127	127
50	97	93	93
60	46	57	57

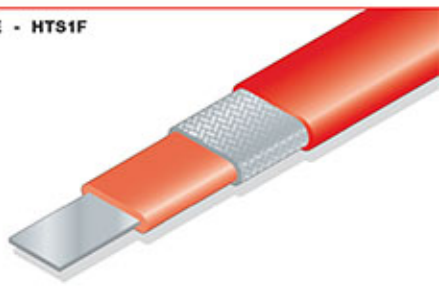
For conditions other than worst case, or pipes of other materials (eg. plastic, stainless steel, etc..), consult Heat Trace Ltd.

Tolerances: Voltage +10%; Resistance +10%; -0%

LONGLINE - HTS3F



LONGLINE - HTS1F



HEAT TRACE™
SETTING THE STANDARDS LEADING THE WAY

LLR-HV

230°C

Electrical heating cable for cross country pipelines.

LONGLINE R-HV

Series Resistance Heating Cables

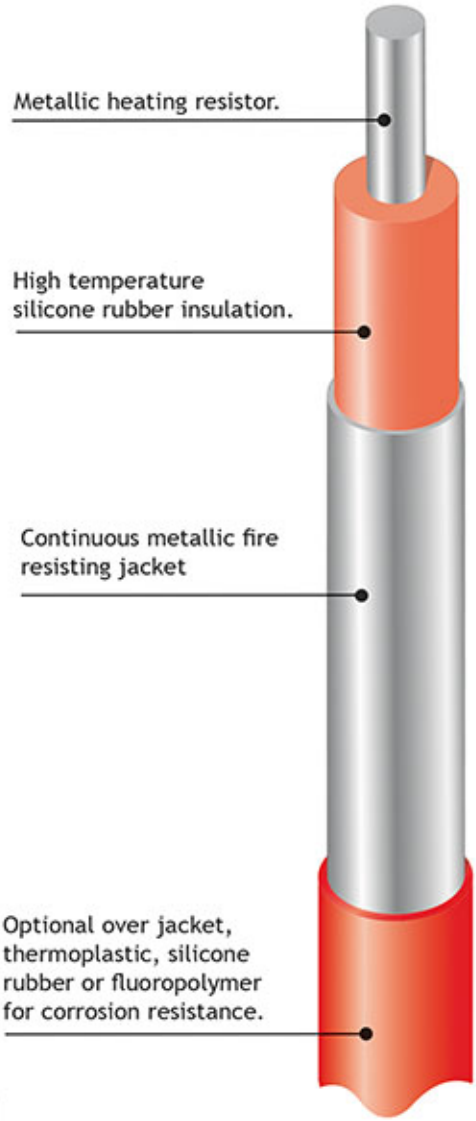
LONGLINE R-HV round heating cables are high performance series resistance heaters for multi km pipelines where temperature maintenance or freeze protection is required.

Circuit lengths of up to a hundred kilometre are possible from a single electrical supply point.

LONGLINE R-HV provides constant power per unit length without voltage drop along the length. The cables may be applied at voltages up to 6.6kV 3 phase to maximise circuit lengths.

The continuous metal jacket is able to withstand high mechanical forces to prevent external damage during installation, whilst also providing superior fire-resisting properties compared with most heating cables.

LONGLINE R-HV cables may be used in safe and hazardous classified locations.



SPECIFICATION

MAXIMUM CONTINUOUS EXPOSURE TEMPERATURE (Power OFF): 230°C (446°F)

MINIMUM INSTALLATION TEMPERATURE: 60-°C (76-°F)

RATED VOLTAGE: up to 6.6kV/3.81kV 1/3 phase

DIMENSIONS/ELECTRICAL RESISTANCE:

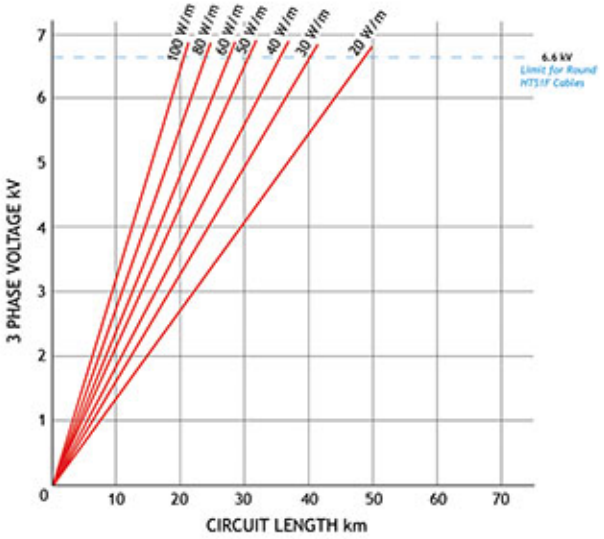
Type Ref	Diameter (mm) 'D'	Nominal Res.@ 20°C Ω/km
HTS1F 7.0A	0.75	14.6
HTS1F 9.0A	0.45	16.6

LongLine LLR & LLR-HV Cable

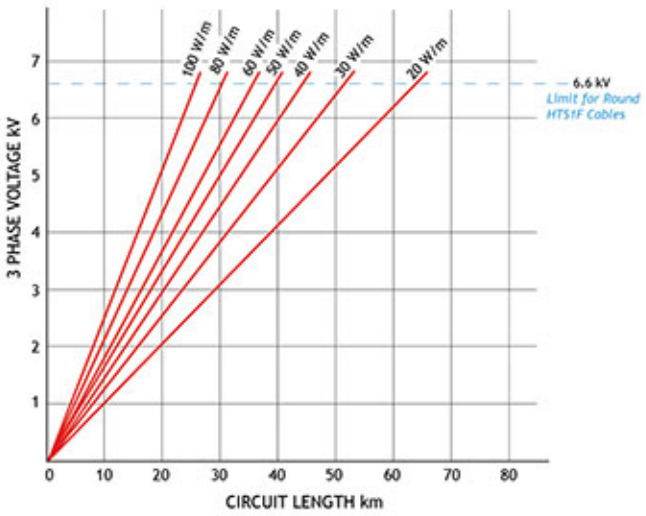
Screw connection kit

for splice or power connection of HTS1F-AR-A heating cables

TYPE: HTS1F / 7A



TYPE: HTS1F / 9A



Termination Components

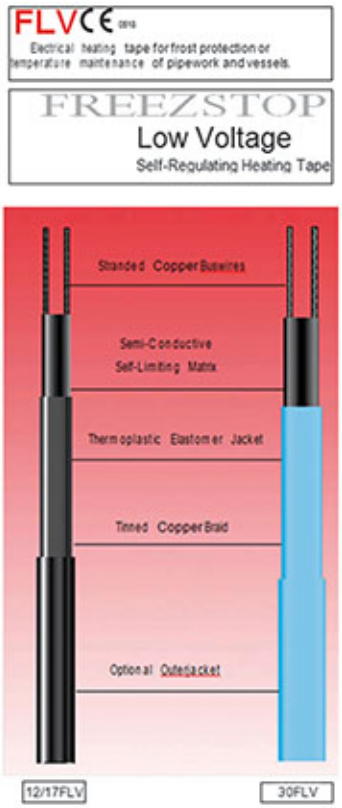
Terminations – power end

Heat Trace have three different methods for the termination of its parallel heat tracers at the power supply. All methods are available for both safe and hazardous locations:-

- **Direct Entry Sealed Termination Unit (DESTU)** – This is an improved method, where the junction box is connected to the DESTU, which is mounted onto the pipe surface. The tracer passes through the DESTU into the junction box, avoiding the possibility of damage to the tracer where it exits the thermal insulation.

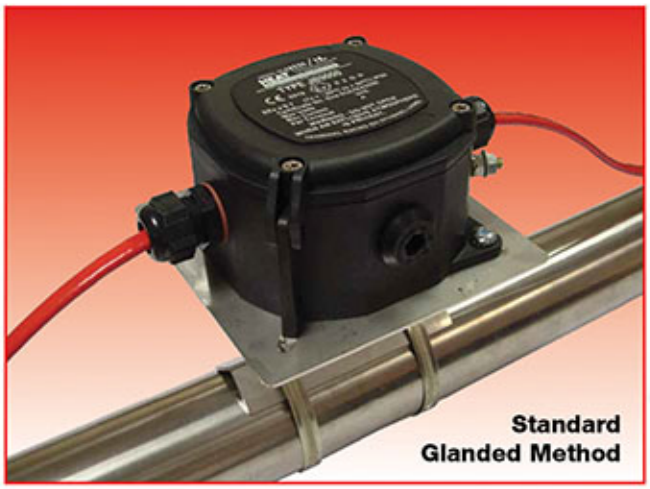
- **StripFree Unit** – The StripFree connection box has been specially developed by Heat Trace to reduce installation time and component costs. Tracers can be terminated without the need to strip the ends of self-regulating tracers. StripFree units are available for connection to the power supply and also for series and tee connections. StripFree boxes are particularly useful for small diameter instrument lines which cannot support large junction boxes.

- **Standard Method** – This uses tracer termination gland components and a junction box. To avoid the possibility of damage to the tracer where it exits from the thermal insulation, a separate lagging entry kit is required.



DESTU

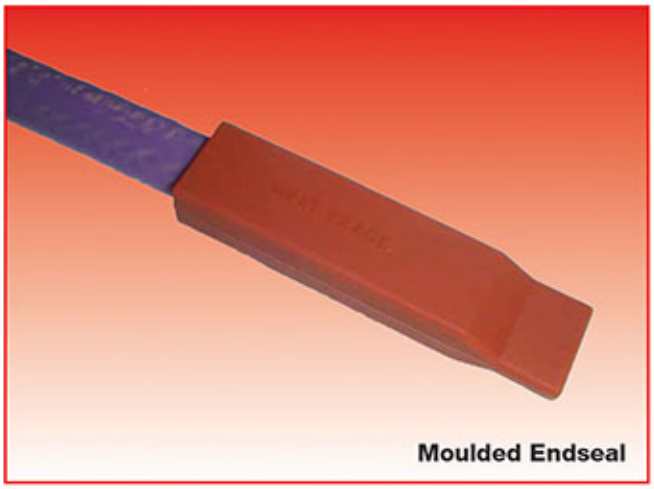

StripFree


Standard Glanded Method

Terminations – remote end

Heat Trace have three different methods for the termination of its parallel heat tracers at the remote end. All methods are available for both safe and hazardous locations:-

- **Moulded end seal** – The silicone rubber end seal is fixed with an adhesive. It is a simple and low cost form of sealing.
- **StripFree end seal** – The StripFree end seal has been specially developed by Heat Trace to reduce installation time. The end of the tracer is simply pushed into the end seal which immediately seals. It cannot be removed without a tool, and therefore provides additional safety. This seal is considered to be the best form of end-sealing.
- **Heat Shrink seal** – The fitting of shrink seals require the use of a hot air gun. This may not be practical in a hazardous area.



Moulded Endseal

StripFree

Heatshrink Endseal

TEMPERATURE CONTROL – Selection Guide

The selection of an appropriate temperature control system is dictated by its purpose or objective. This guide to selection considers two forms of control:-

- **Air-sensing**, where the air temperature is monitored and the heating load is either:

a) fully applied at a set temperature, as traditionally used for freeze protection installations, or,

b) varied with changes in ambient temperature, and hence heat losses *(called PowerMatching)*.

- **Pipe or surface sensing**, where the controller sensor is located directly on the pipe or equipment surface. This method has been traditionally employed for all temperature maintenance duties.

The purpose or objective of the temperature control system may be any one or more of the following:-

1. Ensuring temperature safety

It has already been stated in Section 2 (page 12) that **temperature control to ensure temperature safety is the least favoured option** – inherently temperature safe self-regulating heaters, or a stabilised design provide greater safety. But where necessary for ensuring temperature safety, pipe or surface sensing is almost always required. Care is required to ensure that all pipes which can experience differing flow conditions are controlled independently – this may result in a large number of heating circuits.

2. Process temperature accuracy

The three levels of process temperature accuracy defined in IEC heat tracing standards, types I, II, and III, are explained in Section 3 (page 18). The approach to selecting the best control system for each type of process is described on page 47.

3. Energy efficiency

The highest levels of energy efficiency have usually required a pipe or surface sensing form of control system. This again often results in multiple heating circuits to accommodate the many permutations of flow conditions. In this case, sections of pipe having differing flow conditions need to be controlled independently.

The degree of energy efficiency is also influenced by the accuracy of the controller – electronic devices are often more accurate than mechanical types.

4. Low capital costs

The lowest capital costs will usually result from a temperature control system having the fewest number of heating circuits. This is normally achieved by an air-sensing form of temperature control system.

Type I process control – maintaining above a minimum temperature level

It should be recognised that a Type I control system will be extremely energy wasteful. For example, a freeze protection installation controlled by an air-sensing thermostat will be 100% energised at all times when the ambient temperature falls below the thermostat setting (typically 2 or 3°C). However, the average heating requirement over the number of winter hours that the system is energised is likely to be less than 20%, i.e. ***over 80% of the delivered heat will be wasted.***

Most of this waste heat can be avoided by upgrading the system to a Type II process, achieved at a very modest cost, where energy savings recover the additional cost in a very short period of time.

FOR THIS REASON, HEAT TRACE RARELY RECOMMEND A TYPE I TEMPERATURE CONTROL SYSTEM.

Type II process control – maintaining within a broad temperature band

This has traditionally been achieved by means of mechanical capillary thermostats, having their sensors located on the pipe surface.

However, in-plant piping systems are often complex, having multiple flow permutations. To control all possible permutations, a separate thermostat is required for each section of pipe having differing flow conditions. This results in many heating circuits within an expensive distribution system.

To meet the requirements of a Type II process, whilst at the same time reducing to a minimum the number of heating circuits, and hence, distribution and control panel costs, Heat Trace is able to recommend a heat tracing system where:-

a) the tracers are spiralled to the pipes to just compensate for heat losses at the minimum ambient design temperature.
b) the controller is Heat Trace's unique PowerMatch unit. This monitors the ambient temperature and varies the heat delivered by the tracer according to changes in ambient temperature, and hence, heat losses.

By monitoring the air rather than the pipe surface temperature, only one controller is needed for each different 'maintain' temperature. The system can be used equally for either freeze protection of process temperature maintenance.

This system may occasionally result in heat being delivered unnecessarily to some sections of pipe having flow conditions. However, the system is an excellent balance of process temperature accuracy, energy efficiency, and low capital costs.

Type III process control – maintaining within a narrow temperature band

To control all sections of a piping system within a narrow temperature band of 2°C, as required for temperature sensitive materials (e.g. chocolate), has traditionally required the use of numerous high accuracy electronic controllers, controlling several sections of pipe which may have differing flow conditions. This has necessarily been provided at a high capital cost.

However, Type III process temperature accuracy can now be achieved with the same PowerMatching control system described for Type II systems above, but with the addition of a fine tuning temperature control.

Again, the heating load delivered at any time is matched to losses according to the ambient conditions. To ensure a narrow band process accuracy, a further sensor is located on a short heated 'dummy' line incorporated into the piping system.

SUMMARY

Type I process control – maintaining above a minimum temperature level

- is very energy wasteful. Not recommended – upgrade to Type II process control

Type II process control – maintaining within a broad temperature band

- can be achieved by air-sensing PowerMatch control to provide good energy efficiency from the fewest number of heating circuits i.e. least capital cost

Type III process control – maintaining within a narrow temperature band

- can be achieved by air-sensing PowerMatch control plus fine-tune line control to provide good energy efficiency from the fewest number of heating circuits.

Type I Process Control - Maintain above a minimum point

Type	Description	Area Location	Air or pipe/ Equipment Sensing
AT-F AIRSTAT	**The AT-F AIRSTAT is a non-adjustable controller that energises the heating circuit when the sensor temperature falls to +2°C. The system then de-energises as the sensor temperature rises above +5°C. It has a MAINS ON and HEATER ON indication.**	Safe Areas	Air Sensing
CT CAPSTAT	**The CAPSTAT is a temperature adjustable ON-OFF thermostat comprising a liquid filled sensing bulb connected to an electrical switch via a capillary tube. Expansion of the liquid on rise in temperature causes the switch to open and on cooling, it closes. The CAPSTAT sensing bulb may be positioned to sense the air temperature.**	Safe Areas	Air Sensing
CT-FL CAPSTAT	**The CAPSTAT CT-FL and CT-FL/DUAL are temperature adjustable ON-OFF thermostats but for use in Zone 1 and Zone 2 hazardous areas, with enclosures suitable for Gas Groups IIA, IIB and IIC . The sensing bulb may be positioned to sense the air temperature.**	Hazardous Areas Zone 1 & Zone 2 Areas	Air Sensing

Type I Process Control - Maintain above a minimum point

Switch Rating	Comments	
8 amps direct switching, or via suitably rated contactor.	• AT-F AirStat is non-adjustable • Must be located indoors • Large blocks of heating may be switched from a single controller - fewer heating circuits are required • Least efficient form of control	
16 amps direct switching, or via suitably rated contactor.	• CT Capstat is adjustable in the range 0-40°C • Suitable for outdoor use • Large blocks of heating may be switched from a single controller - fewer heating circuits are required • Least efficient form of control	
16 amps direct switching, or via suitably rated contactor.	• CT-FL Capstat is adjustable in the range 0-40°C • Suitable for outdoor use • Large blocks of heating may be switched from a single controller - fewer heating circuits are required • Least efficient form of control	

Type II Process Control - Maintain within a broad band

Type	Description	Area Location	Air or pipe/ Equipment Sensing
POWERMATCH Micro+	**The POWERMATCH Micro+ is an electronic digital controller that senses changes in air temperature and then automatically adjusts the ratio of the periods in which the heaters are energised and switched off so that the heat delivered matches heat losses.**	Safe Area - For hazardous areas protection is required.	Air Sensing.
IRE168	**The IRE168 is a single point electronic temperature controller. When connected to RTD's will energise trace heating circuits at the desired set point.**	Safe Area - For Hazardous areas, appropriate Ex protection is required. (consult Heat Trace Ltd)	Air or Surface Sensing by PT100 sensor.
CT CT-FL CT-FL/Dual	**The CAPSTAT is a temperature adjustable ON-OFF thermostat comprising a liquid filled sensing bulb connected to an electrical switch via a capillary tube. Expansion of the liquid on rise in temperature causes the switch to open and on cooling, it closes. The CAPSTAT sensing bulb may be positioned to sense the line temperature or surface temperature of a vessel.**	Safe Area Hazardous Area Zones 1 & 2.	Line Sensing.

Type II Process Control - Maintain within a broad band

Switch Rating	Comments	
8 amps direct switching, or via suitably rated contactor.	• Unit located in control panel • Powermatching is significantly more efficient than conventional air sensing thermostats • Large blocks of heating may be switched from a single controller - fewer heating circuits are required • May be used with self regulating heating cables • Temperature range -50 to +80°C	
Internal 16A or external switching via contactors, solid state relays or Thyristor drives.	• Unit located in control panel • DIN Rail Mounting • Digital display • Accurate temperature control (0.5% scale range) • Temperature range -200 to +800°C • Pt100 three wire sensing • 4-20mA temperature control output	
16 amps direct switching, or via suitably rated contactor.	• CT and CT-FL are adjustable thermostats with 3 temperature ranges: **Type A** 0–40°C **Type B** 20–110°C **Type C** 20–300°C • Suitable for outdoor use • One thermostat is required for each pipeline - more heating circuits may be required	

Type III Process Control - Maintain within a narrow band

Type	Description	Area Location	Air or pipe/ Equipment Sensing
POWERMATCH Micro+	**The POWERMATCH Micro+ is an electronic digital controller that senses changes in air temperature and then automatically adjusts the ratio of the periods in which the heaters are energised and switched off so that the heat delivered matches heat losses.** **A separate line sensing controller provides fine tune control. This sensor may be located on a "dummy" heated pipe section having no flow (dead leg).**	Safe Area - For hazardous areas protection is required	Air Sensing and line sensing
IRE168	**The IRE168 is a single point electronic temperature controller. When connected to RTD's will energise trace heating circuits at the desired set point.**	Safe Area - For Hazardous areas, appropriate Ex protection is required (consult Heat Trace Ltd)	Air or Surface Sensing by PT100 sensor
IRE8	**The IRE8 is a user friendly multi-channel (4 or 8) electronic PID temperature controller. Control parameters for each output can be preset independently and are automatically set by auto-tuning. For monitoring purposes, 3 different alarm outputs are provided. Each channel is connected to air or pipe sensing PT100 RTD's.**	Safe Area - For Hazardous areas, appropriate Ex protection is required (consult Heat Trace Ltd)	Air and Surface Sensing by PT100 sensor.
GUARDIAN ENERGY MANAGEMENT SYSTEM	**Guardian is an 8 channel, computer assisted energy management, control and auditing system for large / critical heat tracing installations. It may be provided as a stand alone system or integrated into the plant's SCADA or DCS system. Details of the auditing / monitoring facilities are provided on page 55.**	Safe Area - For hazardous areas protection is required	Line sensing

Type III Process Control - Maintain within a narrow band

Switch Rating	Comments	
16 amps direct switching, or via suitably rated contactor.	• Unit located in control panel • Powermatching is significantly more efficient than conventional air sensing thermostats. Type III accuracy is provided by the additional line sensing control • Large blocks of heating may be switched from a single controller - fewer heating circuits are required • May be used with self regulating heating cables • Temperature range -50 to +80°C	
Internal 16A or external switching via contactors, solid state relays or Thyristor drives.	• Unit located in control panel • DIN Rail Mounting • Digital display • Accurate temperature control (0.5% scale range) • Temperature range -200 to +800°C • Pt100 three wire sensing • 4-20mA temperature control output	
Internal 3A or external switching via contactors, solid state relays or Thyristor drives.	• Unit located in control panel • Fascia Mounted • Multi Digital display • Full navigation facilities • Accurate temperature control (0.5% scale range) • 3 alarm outputs • Temperature range -199 to +600°C • Pt100 three wire sensing • Output: relay or SSR; (optional: TRIAC, 0-20mA or 4-20mA) • RS485, RS422 & RS232 communication	
Internal 5A relays or suitably rated, contactors or solid state relays.	• Unit located in control panel, DIN rail mounted • Controls and monitors up to 8 individual heating circuits per Guardian • Precise temperature control • Full time surveillance of heating system integrity • Pt100 three wire sensing • Alarm Functions • Output by Relay or SSR • Local LCD Monitoring panel with full navigation (Optional) • RS485 Modbus Communication to remote PC with "Guardian Consultant" package • Trend analysis, Performance and Alarm Reports (Optional)	

Installation of heat tracers - General

Heat tracers should be attached to clean piping and equipment in accordance with the instructions. Care should be taken at flanges and fittings to position heaters so as to avoid damage. Check that the heater assembly can accommodate movement and vibration.

The installer should allow the appropriate amount of heater to compensate for additional heat losses from pipeline fittings, as allocated by the *Evolution* design software.

A heat tracer should be kept in as intimate a contact as possible to the heated surface. Where close contact is not possible, such as on valves, a heat-conductive covering of metal foil may be used.

It is recommended that the heat tracer is not folded, twisted, or allowed to overlap, cross or touch itself. Attention should be given to the minimum bending radius.

Where heat tracers cross possible sources of leaks, for example, flanges, they should be positioned to minimize contact with the leaking medium.

Only genuine Heat Trace components may be used or else the system certification will be invalidated.

Straight tracing runs on pipe

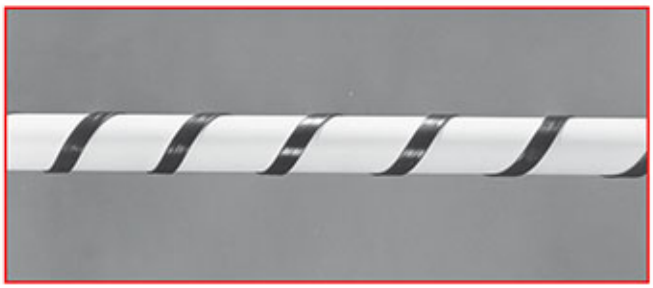
Single straight traced runs are usually positioned at the underside of the pipe, fixed at 300mm centres, using only the correct Heat Trace fixing tape.

Multiple straight heat tracers should be equally spaced around the circumference of the pipe. Extra lengths of heat tracer will have been provided for in the design to compensate for the additional heat losses at pipe fittings, valves etc..

Spiral tracing runs on pipe

The pipe and equipment should be marked at the design spiral pitch. Then apply the heat tracer in a uniform spiral from the power supply point maintaining slight tension in the tracer as it is applied. Fix at no more than 2 metre centres using only the correct Heat Trace fixing tape.

Spiral tracing runs should be applied in such a way that valves, etc.., can be easily removed or replaced.



Connections and terminations

It is essential that all heat tracers are terminated correctly with approved components to Heat Trace's instructions.

Longline heat tracers intended for site termination should be checked to ensure that the installed lengths correspond to the design length and loading.

Connection of the heat tracer to the power supply should be such as to prevent physical damage, and positioned to prevent the ingress of water.

Heat tracing circuits are connected into Heat Trace junction boxes specifically designed for connection of the tracer. The boxes provide appropriate protection and certification. Junction box lids should not be left open at any time.

The metallic braid or sheath of the heat tracer must be bonded to the earthing system to provide for an effective ground path.

Tracer end seals must be securely fitted to Heat Trace's instructions and protected to avoid mechanical damage and ingress of water.

Marking and tagging

After installation, all the circuits must be properly marked / tagged, as follows:-

a) Branch circuit breaker
b) Monitor and alarm apparatus
c) Heat tracer power connection
d) Circuit number and set point for each temperature controller

Marking shall be carried out for each heat tracing circuit, on the respective junction box.

Post installation testing

The pre-installation insulation resistance test described above shall be repeated on all heat tracer circuits after installation, using a minimum 500Vdc megger. The measured insulation resistance shall not be less than 20 M.Ohms.

Continuity and resistance checks shall be made for each circuit and the installed tracer load confirmed with the design load.

The type, length and electrical data of each heat tracer shall be noted for inclusion in the final documentation. The connection points shall be recorded for entry in the piping and instrumentation diagrams.

Installation of thermal insulation system

Precautions must be taken to protect tracers from mechanical damage and moisture intrusion after they have been installed and prior to the application of thermal insulation. The installation supervisor shall coordinate with the thermal insulation contractor, so that the thermal insulation is applied as soon as possible after the installation and testing of heat tracers.

It should be confirmed that the thermal insulation to be installed is of the size, specification and thickness used for the design of the heat tracing system.

When a tracer is installed onto the surface of a pipe, it's effective diameter is increased. The thermal insulation is usually provided in pre-formed sections. Thus a small gap may occur due to the addition of the tracer. In this case, 'filler' segments should be installed to ensure full insulation. Note that, if over-sized insulation is used (i.e. the next pipe size up), then heat loss calculations must be based on the over-sized pipe value.

The thermal insulation installation crew should be experienced /trained in fitting insulation over tracers, particularly with a view to avoiding mechanical damage, which is most likely when cutting and forming sheet metal cladding around flanges and other line equipment.

Warning labels must be fixed to the cladding at 6m intervals advising that electric tracers are installed beneath the thermal insulation and fitted to the cladding over each valve or item of equipment that may require periodic maintenance.

Field circuit insulation resistance test

The test procedure described above shall be conducted on all heat tracer circuits after lagging, with the requirement that the measured insulation resistance shall not be less than 20MΩ

Visual inspection

Carry out a visual inspection of the thermally insulated system to ensure that:

1. moisture cannot penetrate the insulation
2. screws used for fastening cladding are short enough to preclude any possibility of damage to tracers or temperature sensors.
3. entry cut-outs in the cladding for heat tracers, temperature sensors, etc.., are dimensioned so as to render contact impossible.
4. cladding joints and thermal insulation entries are properly sealed with an elastic, non-hardening sealant resistant to chemical attack.

Documentation

The thermal insulation material and its thickness shall be documented.

Commissioning & Documentation

Functional check and final documentation

The heat tracing system(s) shall be commissioned after the thermal insulation has been installed and the electrical distribution is completed. The heat tracer commissioning record given in Table 2 shall be completed and retained.

a) Close all branch circuits and verify proper current. A temporary bypass may be required for the temperature control device.
b) Verify that monitor or alarm circuits are operable. A bypass may be required at field contacts.
c) Fill out the heat tracer commissioning record (Table 2) for each circuit. This shall clearly document all testing and commissioning data.
d) Record the electrical insulation resistance values for each measurement taken.
e) Record the applied voltage and resulting current after five minutes of energization, and pipe temperature if required.
f) Verify that the alarm and monitor components operate as intended.
g) Verify that the calibration check at the temperature controller setpoint has been performed and the controller has been set at this value.

Final documentation

Adequate and uniform documentation of the electric heat tracing circuits is an essential precondition for economical maintenance of this equipment. This is especially important to facilitate rapid troubleshooting in the event of circuit problems. It also provides the basis for simpler, faster and less costly handling of any desired modifications and expansions by a specialist for electric heat tracing systems.

The documentation of each heating circuit of a heat tracing system shall include the following elements:

Design and testing documentation:

a) Table of contents
b) Piping diagram showing the heat tracing circuits and the location of power points, connections, splices, tees, end terminations, and temperature sensors for control and limitation
c) For vessels: layout of the heat tracing
d) Pipe and thermal insulation list
e) Individual circuit length of heat tracers
f) Calculation and dimensioning data
g) Material list
h) Heat tracer installation instructions
i) Heater cabling plan
j) Description of and installation instructions for temperature sensors
k) Heater commissioning record (Table 2)
l) Temperature profile measurement
m) Installation certificate

Circuit diagrams:

a) Wiring and circuit diagram
b) Terminal connection diagrams, switchgear with parts list
c) Installation instructions

Other:

a) Technical descriptions and instruction manuals for the individual pieces of equipment
b) Functional diagram as agreed to with the design engineer
c) Certificates or declarations of conformity from a certification agency for explosive gas atmosphere equipment, as required

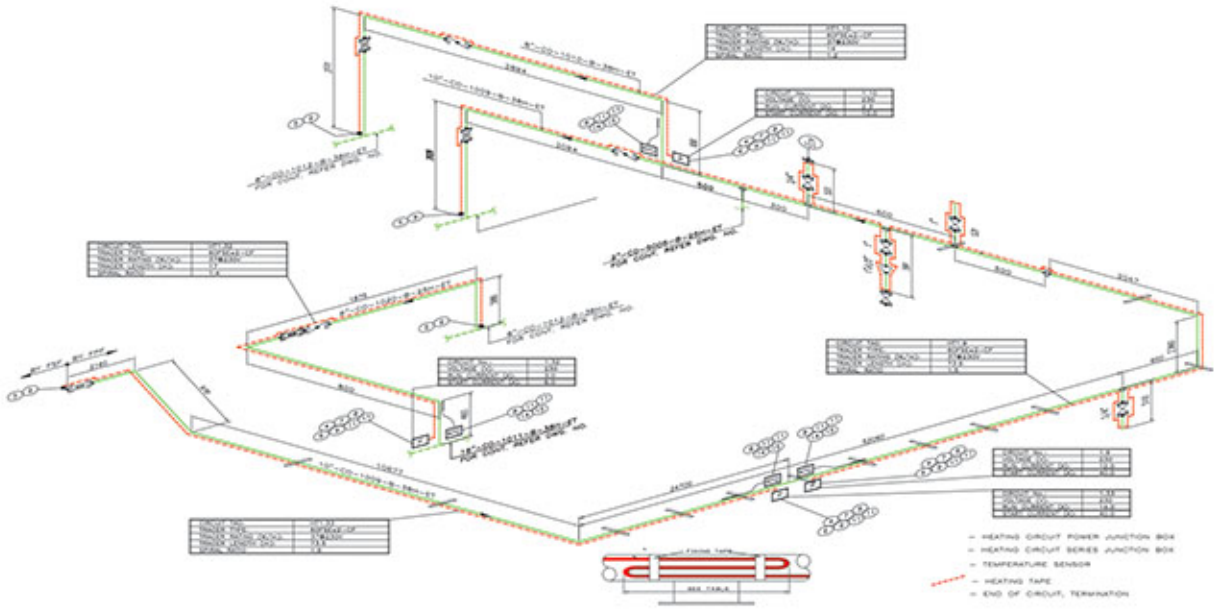


Table 2 - Heat tracer commissioning record

Location		System		Project number		Reference drawing(s)	
Line number		Heat Tracer number		Area classification		Temperature classification	
Panel number		Location		Circuit number		Circuit amp/voltage	
Heat Tracer manufacturer		Heat Tracer model		Heat Tracer wattage unit length/voltage rating			
Verify certification marking:							
HEAT TRACER INFORMATION:							
Heat Tracer total design length				Heat Tracer total installed length			
Thermal insulation type				Thermal insulation thickness			
Workpiece maintain temperature				Maximum workpiece temperature			
HEAT TRACER TESTING: (data from heat tracer installation record)							
Electrical resistance (continuity) test, in ohms							
Electrical insulation resistance test, in Megohms							
Test ambient temperature							
PERFORMANCE DATA:	Volts a.c.		Current in amperes				
	Panel	Field	Single-phase	Three-phase			
			Line	A phase	B phase	C phase	Neutral
Start-up							
After 5 min							
After 4 h							
Ambient temperature at time of test							
Pipe temperature at beginning of test			After 4 h				
Calculated watts per unit length (V x A/m)			After 4 h				
TEMPERATURE CONTROL: type							
Heat Tracer controller	**Ambient sensing**		**Workpiece sensing**			**Temperature setpoint**	
High limit controller	**Type**		**Location**			**Temperature setpoint**	
Heating controls calibrated							
Heating controls operation verified							
ALARMS/MONITORING: type							
Temperature	High setting		Low setting			Operation verified	
Heat Tracer current	High setting		Low setting			Operation verified	
Residual current			Setting			Operation verified	
Loss of voltage						Operation verified	
Other						Operation verified	
RCD PROTECTION: type							
Setting		Measured current		Tested in operation			
Performed by:				Company		Date	
Witnessed by:				Company		Date	
Accepted by:				Company		Date	
Approved by:				Company		Date	

Maintenance

General

It is recommended that the maintenance schedule given in Table 3 should be undertaken each year. All maintenance activities should be recorded in a maintenance log (such as that shown in Table 3) and retained in the system documentation.

Fault location

Specialised methods of fault location are necessary to find faults in electric heat tracing systems covered by thermal insulation and metallic cladding, and advice should be sought from the electric heat tracing system designer. Most commonly, faults are caused by mechanical damage, corrosion, overheating or ingress of moisture.

Fault rectification

When the fault has been located, the defective component should be replaced or repaired. Those parts of the installation that have been disturbed should be checked in accordance with Table 2 and recorded in accordance with Table 3.

Table 3 – Maintenance schedule and log record

Location system		System		Reference drawing(s)			
CIRCUIT INFORMATION							
Heat tracer number		Circuit length		Breaker panel no.			
Power connection		Design voltage		Breaker pole(s) no.			
Tee connection		Residual current protection (type)					
Splice connection		Residual current trip setting					
Process control type I, II or III		Heating controller type					
Circuit Monitoring	YES / NO						
VISUAL							
Panel no.	Circuit no.						
	Date						
	Initial						
Thermal insulation							
Damaged insulation/ lagging							
Water seal acceptable							
Insulation/lagging missing							
Presence of moisture							
Heating system components							
Enclosures, boxes sealed							
Presence of moisture							
Signs of corrosion							
Heat tracer lead discolouration							
Heating and/or high limit controller							
Operating properly							
Controller set point							
ELECTRICAL							
Insulation resistance testing (bypass controller if necessary)							
Test voltage							
Megger value, MΩ							
Heat tracer supply voltage							
Value at power source							
Value at field connection							
Heat tracer circuit current reading							
Amps reading at 2 to 5 min.							
Amps reading after 15 min.							
Ground-fault current							
Comments and actions							
Performed by:		Company		Date			
Approved by:		Company		Date			

DETAILS REQUIRED FOR HEAT TRACING PROPOSAL FOR PIPELINES

NAME OF PROJECT :

CLIENT INFORMATION:

SCOPE OF WORK

1	DESIGN & ENGINEEING	YES ☐ / NO ☐
2	SUPPLY OF HEAT TRACING CALE & ACCESSORIES	YES ☐ / NO ☐
3	SUPPLY OF HEAT TRACING DISTRIBUTION PANEL	YES ☐ / NO ☐
4	SUPPLY OF POWER & CONTROL CABLE	YES ☐ / NO ☐
5	SUPPLY OF THERMAL INSULATION	YES ☐ / NO ☐
6	SUPPLY OF START UP & COMMISSIONING SPARES	YES ☐ / NO ☐
7	SUPPLY OF 2YEARS NORMAL OPERATION SPARES	YES ☐ / NO ☐
8	INSTALLATION, TESTING & COMMISSIONING	YES ☐ / NO ☐
9	SUPERVISION OF INSTALLATION, TESTING & COMMISSIONING	YES ☐ / NO ☐

DOCUMENTS

1 SPECIFICATION OF ELECTRIC HEAT TRACING
2 SPECIFICATION OF THERMAL INSULATION
3 SPECIFICATION OF POWER & CONTROL CABLE (IF IN OUR SCOPE OF SUPPLY)
4 SPECIFICATION HEAT TRACING PANEL (IF AVAILABLE)
5 P&ID (PFS) DRAWINGS (IF AVAILABLE)
6 ISOMETRIC DRAWINGS OF PIPELINES (IF AVAILABLE)
7 INSTRUMENT HEAT TRACING REQUIRED (YES / NO)
8 INCASE INSTRUMENT HEAT TRACING IS REQYRED THEN INSTRUMENT HOOK UP DRAWINGS REQUIRED

DESIGN PARAMETER

MINIMUM AMBIENT TEMPERATURE	DEG. C
MAXIMUM AMBIENT TEMPERATURE	DEG. C
MAINTENANCE TEMPERATURE	DEG. C
MAXIMUM OPERATING TEMPERATURE	DEG. C
DESIGN TEMPERATURE	DEG. C
TYPE OF INSULATION	
INSULATION THICKNESS	MM
HAZARDOUS AREA CLASSIFICATION	
SUPPLY VOLTAGE (3PHASE / 1PHASE / 4WIRE / 3WIRE / HZ)	

LINE LIST

SN	LINE NUMBER	PIPE SIZE / OD	MATERIAL OF CONSTRUCTION OF PIPE	PIPE LENGTH	INSULATION THICKNESS	VALVE	FLANGE	SUPPORTS	MAINTENANCE TEMPERATURE	OPERATING TEMPERATURE	DESIGN TEMPERATURE
		(INCH)		(M)	(MM)		(NOS)	(NOS)	(DEG.C)	(DEG.C)	(DEG.C)

NOTE: PLEASE PROVIDE MAXIMUM AVAILABLE INFORMATION.

DETAILS REQUIRED FOR HEAT TRACING PROPOSAL FOR VESSEL / TANK

NAME OF PROJECT :

CLIENT INFORMATION:

SCOPE OF WORK

1	DESIGN & ENGINEEING	YES ☐ / NO ☐
2	SUPPLY OF HEAT TRACING CALE & ACCESSORIES	YES ☐ / NO ☐
3	SUPPLY OF HEAT TRACING DISTRIBUTION PANEL	YES ☐ / NO ☐
4	SUPPLY OF POWER & CONTROL CABLE	YES ☐ / NO ☐
5	SUPPLY OF THERMAL INSULATION	YES ☐ / NO ☐
6	SUPPLY OF START UP & COMMISSIONING SPARES	YES ☐ / NO ☐
7	SUPPLY OF 2YEARS NORMAL OPERATION SPARES	YES ☐ / NO ☐
8	INSTALLATION, TESTING & COMMISSIONING	YES ☐ / NO ☐
9	SUPERVISION OF INSTALLATION, TESTING & COMMISSIONING	YES ☐ / NO ☐

DOCUMENTS

1 SPECIFICATION OF ELECTRIC HEAT TRACING
2 SPECIFICATION OF THERMAL INSULATION
3 SPECIFICATION OF POWER & CONTROL CABLE (IF IN OUR SCOPE OF SUPPLY)
4 SPECIFICATION HEAT TRACING PANEL (IF AVAILABLE)
5 GA DRAWING OF VESSEL (IF AVAILABLE)

DESIGN PARAMETER

MINIMUM AMBIENT TEMPERATURE	DEG. C
MAXIMUM AMBIENT TEMPERATURE	DEG. C
MAINTENANCE TEMPERATURE	DEG. C
MAXIMUM OPERATING TEMPERATURE	DEG. C
DESIGN TEMPERATURE	DEG. C
TYPE OF INSULATION	
INSULATION THICKNESS	MM
HAZARDOUS AREA CLASSIFICATION	
SUPPLY VOLTAGE (3PHASE / 1PHASE / 4WIRE / 3WIRE / HZ)	

TANK / VESSEL DIMENSION

SN	TANK / VESSEL TAG NO	DIAMETER	HEIGHT / LENGTH	INSULATION THICKNESS FOR TANK / VESSEL SHELL	INSULATION THICKNESS FOR BOTTOM	MAINTENANCE TEMPERATURE	OPERATING TEMPERATURE	DESIGN TEMPERATURE	MATERIAL OF CONSTRUCTION OF TANK
		(INCH)	(M)	(MM)	(MM)	(NOS)	(NOS)	(DEG.C)	

NOTE: PLEASE PROVIDE MAXIMUM AVAILABLE INFORMATION.

NOTES

WORLDWIDE REPRESENTATION

Heat Trace is represented throughout the world in over 40 countries. Our network of Affiliate Offices, Partner Companies, Distributors and Agents work, both independently and jointly, with our Corporate Headquarters, resulting in an integrated team of heat tracing and surface heating specialists having a global capability.

For full details of overseas offices please contact
Heat Trace Limited direct.

HEAT TRACE™
SETTING THE STANDARDS LEADING THE WAY

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