

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 1 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

Technical Specification for Electrical Heat Tracing

04	03/11/2025	Issued For Final				
03	01/20/2024	Issued For Final				
02	12/31/2023	Issued For Approval				
01	11/05/2023	Issued For Approval				
00	09/07/2023	Issued For Review				
Rev.	Date	Description	Prepared	Checked	Approved	Authorized

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 2 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

Tabulation of Revised Page

Sheet	Revisions							Sheet	Revisions						
	00	01	02	03	04	05			00	01	02	03	04	05	
1	x	x	x	x	x			36							
2	x	x	x	x	x			37							
3	x	x	x	x	x			38							
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8	x	x	x	x				43							
9	x	x	x	x	x			44							
10	x	x	x	x				45							
11	x	x	x	x	x			46							
12	x	x	x	x	x			47							
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14	x	x	x	x				49							
15	x	x	x	x				50							
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17	x	x	x	x	x			52							
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22	x	x	x	x				57							
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29			x					64							
30								65							
31								66							
32								67							
33								68							
34								69							
35								70							

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 3 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

Table of Contents

1. General.....	5
1.1 Introduction	5
1.2 Scope	5
1.3 Definitions	6
2. Codes and Standards	6
3. Conflicting Requirements.....	7
4. Site Condition and Utilities.....	8
4.1 General Site Location	8
4.2 Site description	9
5. Technical Specification	10
5.1 General	10
5.2 Power supply and distribution system	11
5.3 Design.....	12
5.4 Piping and Process Data	12
5.5 PERFORMANCE	12
5.5.1. Heating-up Requirement.....	12
5.5.2. Performance Requirements	13
5.5.3. Spare or Over Capacity.....	13
5.5.4. Operation and Maintenance	13
5.6 CONSTRUCTION.....	13
5.6.1. Type of Protection of Enclosure	13
5.6.2. Explosion-Protected Construction.....	14
5.6.3. Heater Selection	14
5.6.4. Self-regulating Heaters.....	14
5.6.5. Skin Electric Current Tracing	15
5.7 Temperature Control & Limitation	16
5.7.1. General.....	16
5.7.2. Temperature Control for Energy Saving	16
5.7.3. Temperature Control Resulting from Product Requirements	17
5.7.4. Temperature Limitation for Safety Reason	17
5.7.5. Temperature Limitation for Protection Against Over Heating.....	17
5.8 INSTALLATION	18
5.8.1. Heater Design.....	18
5.8.2. Distribution Panel	19
5.8.3. Local Thermostats	20
5.8.4. Power junction boxes / Power Connection Kits	20
5.8.5. Heater Installation.....	21
5.8.6. Identification.....	23
6. NAMEPLATES AND PAINTING.....	23
6.1 Indication of Type of Explosion-protection	23

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 4 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

6.2

Indication of ID Number.....

23

6.3

Painting

23

6.4

Labeling.....

24

7.

SPARE PARTS AND SPECIAL TOOLS

24

8.

PREPARATION FOR SHIPMENT

25

9.

QUALITY CONTROL, INSPECTION AND TESTING

26

9.1

General.....

26

9.2

Tests.....

26

10.

GUARANTEE

27

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 5 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

1. General

1.1 Introduction

The plant will be referred to as “phase 3” and “phase 4” in the rest of the report.

“Nominal” and “Design” capacity of the project is equal to 2340 dtph and 2700 dtph fresh ore feed conditions respectively. The plant is “Designed” to accommodate the “Maximum” conditions.

1.2 Scope

This specification covers the minimum technical requirements, design, procurement, manufacture, quality control, testing, inspection, spare parts engineering and transportation of Technical Specification for Electrical Heat Tracing to the site location. It is basically a performance-type specification and covers only those general aspects that are considered minimum quality and performance requirements by the purchaser. More detailed and specific data are contained in the drawings, data sheets and other documents that form the tender.

Standard design and models from bidders manufacturing program will be accepted in case they meet the requirements of this specification and serve the intended purpose. If a substantial improvement of any or all of the specified requirements expressed or implied herein is available from bidder, and this improved design offers economic advantages to purchaser, this should be proposed as an alternative together with basic proposal that conforms to this specification.

All equipment described in this specification are intended for continuous duty at the specified ratings under specified service conditions.

Compliance of the manufacturer with the provisions of this specification does not relieve him of the responsibility of furnishing Technical Specification for Electrical Heat Tracing and accessories of proper design electrically and mechanically suited to meet the operating guarantees at the specified service conditions.

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 6 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

1.3 Definitions

Throughout this document the following words and expressions shall have the meanings hereby assigned to them except where the context otherwise requires:

- **"CLIENT" &/OR OWNER"**
- **"BUYER &/OR PURCHASER"**
- **"BUYER REPRESENTATIVE"**
- **"SUPPLIER &/OR CONTRACTOR &/OR VENDOR"** means the firm or company which the contract will be made with.
- **"SUB-SUPPLIER"** means any person or company (other than the supplier) named in the contract for any part of the works.
- **"WORKS"** means all obligations of the Contractor described in the "scope of works" of this document.
- **"PLANT"**
- **"APPROVE"** means approval in writing letter confirmed by buyer.

2. Codes and Standards

The equipment covered by this Specification, including all components and auxiliaries shall be designed, manufactured and tested in accordance with the latest IEC Standards wherever they may apply, and in particular: unless otherwise specified, the design, equipment, materials, installation, inspection and testing shall be conformed to the requirements of the latest edition of the followings:

- IEC 62395-1 Electrical resistance trace heating systems for industrial and commercial applications - Part 1: General and testing requirements.
- IEC 62395-2 Electrical resistance trace heating systems for industrial and commercial applications - Part 2: Application guide for system design, installation and maintenance.

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 7 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

04

IEC 60519-10 Safety in electro-heating installations - Part 10: Particular requirements for electrical resistance trace heating systems for industrial and commercial applications.

IEC 60079-30-1 Explosive atmospheres - Part 30-1: Electrical resistance trace heating - General and testing requirements.

IEC 61439 Low-voltage switchgear and controlgear assemblies.

NEC Article 427 Fixed electrical heating equipment for pipe lines.

BS 5501 Electrical Apparatus for Potentially Explosive Atmospheres.

BS 5970 Thermal insulation of pipework, ductwork, associated equipment and other industrial installations in the temperature range of -100°C to +870°C.

BS 6351 Electric surface heating-Specification for electric surface heating devices.

IEEE 515 Recommended practice for the testing, design, installation and Maintenance of electrical resistance heat tracing for industrial Application.

Note: Electrical equipment shall be designed, manufactured, erected, and installed according to the latest editions of the IEC (International Electro technical Commission) standards.

Minimum requirement for installation shall be follow local codes and norms. In lack of them normal European industrial practice is followed. Other standards that can use in reference, but shall be equivalent with IEC standard, are as below:

BS-IEEE-ANSI-VDE -DIN -ISO -NEMA-NFPA-NACE-API-ISA-NACE

3. Conflicting Requirements

In the event of conflict, actual or implied, among documents relating to an enquiry or order, following order of precedence shall govern, unless agreed in writing by Buyer.

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 8 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

1. Material Requisition
2. Data sheet
3. Drawings
4. Specification
5. Design Criteria
6. Code and standards
7. In any case the vendor shall inform purchaser and obtain clarification before proceeding with any work.

The Vendor shall notify the Buyer of any apparent conflict between this specification, the Codes and Standards and any other specification noted herein. Resolution and/or interpretation of precedence shall be obtained from the Buyer in writing before proceeding with the design/manufacture.

Alternatives proposed by the Supplier will receive careful consideration if they improve performance and reliability.

4. Site Condition and Utilities

4.1 General Site Location

4-1-1 Site Location:

- Elevation: about 2500 meters above sea level.

4-1-2- Temperature:

- Max. (Summer): 35° C
- Design Max (indoor and outdoor) 40° C
- Min. (Winter): -25° C
- Design Min.(outdoor) -25°C

4-1-3- Relative Humidity:

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 9 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

- Humidity: 30 % @ 33°C
- Max.: 70 %
- Min.: 23 %

For specific indoor area (above open sumps and flotation cells and above thickeners) due to special condition (water evaporation and water spraying) relative humidity shall be considered 100 %.



4-1-4- Wind Condition:

- Max. Wind Velocity already recorded: 130 Km/h
- Prevailing Wind Direction:
- Winter: Between South and South West
- Summer: Between North and North East
- Stormy days per annum: 10

4-1-5- Rainfall:

- Average: 500 mm/a
- Design: 500 mm/a
- Rainfall Intensity: 76 mm/h

4-1-6- Snowfall:

- Average: 100 mm/a (as water)
- Design Intensity: 150 mm/a (as water)
- Frost Line: 1200 mm below grade

4.2 Site description

4-2-1- Lithology:

The Site lithology consists of colluviums or slope wash overlying a deep volcanic weathering profile.

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 10 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

The Site lithology is summarized in below table:

Unit	Description	Top of Unit (m)	Approx. thickness (m)
1	Colluvium/ Slope wash	Surface	1-3
2	Residual Solids	3	5-10
3	Volcanic Rocks	10	>10

4-2-2- Seismicity:

SITE is classified as a high hazard zone and the above standard shall be considered during design of all foundation, structures and buildings.

5. Technical Specification



5.1 General

The heat tracing system used in the project is for anti-freezing, anti-condensation, winterizing, and maintaining the process fluid temperature within metal pipes, valves, flanges, elbows, etc., on specific lines designated in the PID and on certain measuring instruments that is mentioned in EHT summary pipe line list.

This project shall use Seft-Regulated heat trace cable thermostatically controlled to provide freeze protection. It is sensitive to temperature changes and adjusts its power consumption (watts) accordingly, increasing or decreasing it based on temperature variations. Due to the variable temperature of heat tracing cables throughout the year, using self-regulated heat trace cable, compared to constant wattage heat trace cable, leads to reduced energy consumption and, consequently, lower electricity costs. Its flexibility and easy installation and the ability to operate with standard voltage are considered key features.

There are some temperatures that is defined here. (Applicable for the heat loss calculation and selection of heating cable type)

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 11 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

Max. operating Temperature: The highest temperature of the heat-traced fluid during normal process operating conditions which the heating cable will be exposed continuously.

Maintain Temperature: The desired temperature at the minimum ambient temperature which you want to maintain the pipe by the use of heat tracing.

Max. Exposure Temperature (Design Temp.): The highest anticipated pipe or fluid temperature to which the heating cable may be exposed intermittently.

To provide freeze protection the design requires that;

- Pipelines are insulated
- The system is temperature controlled.
- After the pipeline has been designed, the heat trace parameters can be established.

Sizing calculations require information on the following:

- Pipeline size and type
- Insulation type and thickness
- Process fluid type
- Temperature differential

With this knowledge in hand, the manufacturer would normally perform the calculations to recommend cable rating and control.

5.2 Power supply and distribution system

- Nominal voltage level: 400/230VAC from emergency bus
- Nominal Frequency: 50Hz
- Voltage fluctuation: $\pm 10\%$
- Frequency fluctuation: $\pm 5\%$ (Stationary: $\pm 2\%$ / Instantaneous: $\pm 5\%$)
- Power distribution system: TNS (3PH+N+PE) solidly earthed



	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 12 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

5.3 Design

Scope of this document shall be designed based on all “engineering document” and submitted to client for review and approval by contractor.

It should be noted that Procurement and Construction activities of this equipment must be done based on approved engineering document. All equipment shall be supplied based on approved TBE documents.

Contractor should be assured about using last revision of all documents.

5.4 Piping and Process Data

In this project propose of electrical heat tracing is anti-freezing, except otherwise mentioned for process proposes such as maintenance temperature for specific gas or fluid. The following information on piping and process fluid requiring electrical heat tracing will be given in the related data sheets or tables as design information:

- Line no. or instrument tag no.
- Piping size
- Piping length
- Piping material specification
- Insulation type and thickness
- Fluid limit temperature (low and high)
- Fluid data (operation temperature, coming temperature and specific heat)

5.5 PERFORMANCE

5.5.1. Heating-up Requirement

Apart from compensation heating, there may be a need to heat-up (to melt) the

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 13 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

content of a pipeline within a certain time limit. This may be required for example when the product is in a solid state under ambient condition. Additional heating capacity needs to be installed to comply with this requirement. This can be done by increasing the capacity of the compensation heating or by installing additional heaters dedicated for this duty. Due consideration shall be given to the maximum heat density allowed under those situations.

5.5.2. Performance Requirements

Heating equipment shall be designed to withstand the highest possible temperature, which can occur under all process conditions.

The heat density of the heating elements shall be such that the temperature limits for pipe, heaters or product are not exceeded.

5.5.3. Spare or Over Capacity

The installation of initial spare or over capacity shall be considered when for critical application the power output is not allowed to drop below the design values.

5.5.4. Operation and Maintenance

All electrical equipment subject to operating and maintenance activities shall be easily accessible and shall allow for safe and convenient performance of such activities. System components shall be standardized as much as possible.

5.6 CONSTRUCTION

5.6.1. Type of Protection of Enclosure

The type of protection of enclosures shall be as follows depending on the installation place (indoor, outdoor or explosive area as per area classification) which shall be specified during detail design.

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 14 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

- For indoor installations: enclosed type (IP42 as minimum)
- For outdoor installations: Water proof type (IP55 as a minimum)

Electrical heat tracing installed in an area where harmful corrosive chemicals exist, or near sea coast where damage by saline wind is possible, shall be of corrosion-proof type suitable for use in the atmospheric condition specified in this document as well as of the type of protection stated in above clause.

Electrical heat tracing installed in a hazardous location shall be of explosion-protected type suitable for use in the atmospheric condition specified in the related data sheets (during detail design) as well as of the type of protection stated in above clause.

5.6.2. Explosion-Protected Construction

The type of explosion-protection of explosion-protected type electrical heat tracing components shall be specified during detail design as per area classification.

5.6.3. Heater Selection

For winterizing and compensation heating, self-regulating heaters shall be used. In case of all welded pipelines without flanges, the system of skin electric current tracing (S.E.C.T) heaters shall be considered.

5.6.4. Self-regulating Heaters

Self-regulating heaters shall be utilized, unless otherwise specified, within the restrictions of heat output and operating temperatures. They can be used for all winterizing and the majority of compensation heating requirements.

A self-regulating Heating tape shall consist of two parallel copper conductors, both being in contact with a self-regulating semi-conductive material.

This basic element shall be insulated by one or more non-hygroscopic jackets, and

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 15 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

shall be covered with a braided metal screen covering at least 80% of the surface and a polymer outer jacket. The braided metal screen shall have an electrical conductivity not less than the conductivity of one conductor.

A self-regulating heating tape shall consist of a semi-conductive material between two copper conductors and covered by one or more layers of polymer insulation. A metal earth screen or foil shall be provided at the outside over the entire surface for mechanical protection and covered by a polymer outer jacket.

The heaters shall vary the power output in response to the sensed temperature at every point of the surface. As the temperature increases, the heater output shall decrease automatically and vice versa. The natural reduction in heat output by increasing temperatures shall be at least so much that the heater will not be damaged due to overheating as result of overlapping, irrespective of the application.

5.6.5. Skin Electric Current Tracing

For heating of all welded pipelines without flanges and valves, the 'SECT' heating system shall be considered. The principle is based on a heat resistant single core cable running in a tube of ferromagnetic material (heat tube), which is welded to the pipeline to be heated. At the end of the pipeline, the cable is connected to the tube. At the beginning of the pipeline, a voltage with a frequency of 50 or 60 Hz is applied between tube and cable. The current flowing through the tube does not flow uniformly through the cross section of the tube, but concentrates near the inner surface because of the proximity effect. Heat is effectively generated in the tube because its resistance is increased by concentrating the current path at the inner skin portion. A SECT heating system acts resistively with a power factor of approximately 0.9.

Owing to the fact that the electrical continuity of the heating tube is of paramount

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 16 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

importance, the use of such a system on pipelines with flanges incorporating disconnect able connections in the heat tube is not recommended.

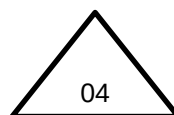
Since there is no electrical leakage from the heat tube, the tube can be earthed at any point. The system shall be ordered as a package unit, including the design and all materials.

5.7 Temperature Control & Limitation

5.7.1. General

The installation and selection of temperature control & limitation depends on the following criteria:

- Energy saving
- Product requirements
- Safety reasons
- Protection Against Over Heating



5.7.2. Temperature Control for Energy Saving

In a winterizing installation, an ambient temperature sensing device shall be used to activate the heating installation when the temperature drops below 5°C. One single device can control all winterizing heating circuits of an area.

Pipelines with compensation heating normally do not require heating when the line is in operation. Only under no or low flow condition, the heating system will be used to compensate for the heat losses. Consequently, the heating system shall only be activated when required and local thermostats shall control it.

The number and location of the thermostats shall be selected to ensure that the heating requirements of all piping and equipment involved will be maintained under all process conditions.

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 17 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

5.7.3. Temperature Control Resulting from Product Requirements

Pipelines carrying products which are sensitive to degradation due to overheating may require a more sophisticated control system than local thermostats.

Temperature control for the compensation heating shall under these conditions be obtained from the process temperature measuring system. If such a system is not available, an independent control system with thermocouple devices or resistor element type devices (e.g., PT100 elements) shall be provided.

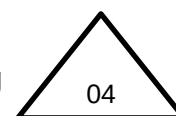
The sensors shall be of the sealed type and shall be hooked up to separate connection boxes. The wiring between a sensor and its associated connection box shall not be more than 5 meters in length.

5.7.4. Temperature Limitation for Safety Reason

When heaters are installed in a hazardous area (Zone 1 or 2) which is classified with a more stringent temperature classification than that of the heater, independent temperature limiters shall be installed to monitor the surface temperature of the heaters.

When the maximum allowable temperature has been reached, the associated heater shall be tripped automatically, and remain switched off until the temperature limiter has been reset manually.

5.7.5. Temperature Limitation for Protection Against Over Heating



Sometimes it is required to install thermostats, which monitor the surface temperature of the heaters and disconnect the system from the supply in case of too high a temperature.

This high temperature could be damaging to:

- a) The material used in the heater and in particular the self-regulating/self-limiting semi conductive material.

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 18 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

b) The material used in the process piping or equipment (e.g., plastic)

c) Personnel, e.g., supply piping of safety showers, which may contain water at a too high temperature.

The maximum allowable temperature when the heater is de-energized, as stated by the Vendor, shall not be exceeded.

The requirement of such temperature limiters shall be discussed with the Vendor in the detailed design stage.

5.8 INSTALLATION

5.8.1. Heater Design

- Heaters shall be distributed and grouped logically in order to minimize the number of switches, thermostats and power cabling required. In installations where the process flow can follow different routes (for example, manifolds and A/B pump lines), each independent part of the system shall be controlled separately. Where in a pipeline the same conditions apply, the heater shall be controlled from one point unless the applied heaters are connected to different circuits.
- The input cable should have 20% extra capacity. The distribution panel should have 10% spare feeder.
- Heater circuits shall be loaded with maximum 20 A for single-phase circuits and 3x20 A for three-phase circuits.
- For the current rating of self-limiting heaters, the minimum operating temperature shall be taken into account.
- Sufficient heater capacity shall be installed to ensure that the output does not drop below the minimum design value owing to the voltage drop in the heater conductors, at the end of the heater cable.

To prevent overloading of the tape conductors, the maximum length of a parallel heating tape shall be limited in accordance with the specification of the manufacturer. Some heating tapes are available with additional power supply

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 19 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

conductors integrated in the tape. This will allow extended heater lengths without using separate power feeding points.

No through connections or 'tee offs' shall be made underneath the pipe insulation. Only 'cold-lead' connections are permitted. All other connections shall be made in connection boxes. Sufficient heater capacity shall be installed to ensure that, towards the end of the tape, the output does not drop below the minimum design value owing to the voltage drop in the tape conductors.

5.8.2. Distribution Panel



From the motor control center (MCC) in the substation room, feeder shall be provided to a local distribution panel (LDP) in the field for heat-tracing purposes.

The panel shall comprise with a main incoming isolator switch and outgoing ways which will generally consist of a number of circuit breakers to be selected to protect the outgoing circuits.

The local panel shall consist of a main incoming circuit breaker (MCCB-TM/ 4pole) and number of circuit breakers to be selected to protect the outgoing circuits.

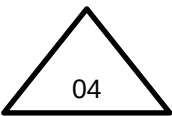
In order to protect of outgoing circuits, they will be equipped by single phase miniature circuit breaker (RCBO/2 pole-30mA) to protect the heating cables. RCBO's provide both residual current protection and overcurrent protection for outgoing circuits.

The Minimum & maximum rating of the outgoing circuit breakers for parallel type heaters shall be 16A and 25A respectively. They shall be suitable for the inrush current of the heating elements. So, they shall be considered type C. The switches shall have a clear 'ON - OFF' indication.

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 20 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

Outdoor local distribution panels shall be installed in the direct vicinity of the associated heating equipment at field in an easily accessible position and shall be equipped with sun/rain canopy.

5.8.3. Local Thermostats



For freeze protection ambient sensing thermostat may be utilized to switch on groups of heating circuits.

On pipe thermostats shall be of the capillary type. The maximum capillary length shall be not more than 5 meters.

The ambient thermostats shall be microprocessor based electronic type with digital display. The ambient temperature controller shall be installed in the local distribution panel and shall control the heater circuits via PT100 sensors and contactors incorporated in the heater supply panel.

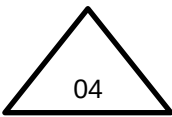
The contacts of thermostats used for direct switching shall have a minimum rated capacity of 16A, which may be obtained by an integrated local contactor. The contacts shall not be loaded with more than 75% of its nominal rating. Where this rating is exceeded, the circuit shall be controlled via a suitably rated contactor.

For capillary thermostats, the temperature setting accuracy shall be at least 95% of the set value and the maximum difference shall not be more than 5°C. The switching hysteresis shall be between 5 and 10% of the actual setting or between 5°C and 10°C, whatever is more stringent.

Local thermostats shall only be adjustable with the use of tools. Thermostats installed as temperature limiters for safety reasons shall be of the fail-safe type.

5.8.4. Power junction boxes / Power Connection Kits

Connection boxes shall be used for:



- The connections between supply cable and heater cable

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 21 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

- Distribution of supply of one circuit of the distribution board to sub circuits.
Only the supply of one circuit of the distribution board shall be allowed in a connection box.
- NOTE: Combinations of above-mentioned items are possible
- Splitting of a three-phase circuit into three single-phase circuits

Connection boxes shall contain sufficient terminals for all the connections to be made. Connection boxes should have 20% extra terminal. Individual terminals shall be provided for each conductor. The terminals shall be clamp type. Terminals shall be identified in accordance with the related connection diagram. In addition, sufficient earth terminals or an earth bar with sufficient earth connection points shall be provided to earth the metal screens of all cables and heaters.

All cables connected to the box shall enter the box through the bottom or the sides. not the top. Sufficient cable glands suitably sized for the associated cables shall be installed.

5.8.5. Heater Installation

Heaters shall be installed in accordance with the manufacturer's instructions. All heaters shall be fixed to ensure a good and permanent contact with the surface to be heated over the entire length.

Especially when constant output heaters are used, this shall receive special attention since lack of contact will cause hot spots, which may damage the heater. Unrolled tape has the tendency to rewind. This can be used to improve the contact with the heated surface by unrolling the drum in a certain direction.

Heating tapes shall normally run straight along the lower quadrant of the pipes. If spiraling of tapes is necessary, this shall be done in order to ensure that the tape can easily be removed. Overlapping or touching of constant wattage output heaters

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 22 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

is not allowed. Where heaters run close together, special retaining fixings shall be used to prevent the heaters from touching. Overlapping of self-regulating heaters shall be avoided as much as possible.

Entry kits shall be used where heating tapes, cold leads or temperature leads enter the thermal insulation, to prevent damage and to ensure weatherproofing.

The entry kits may consist of special entry brackets, cable glands or conduit type entries. Cable glands or conduit type entries shall be fixed to the bottom part of the pipeline. The design and the installation of the entry brackets shall be such that ingress of water is excluded.

Cold-lead joints including a small portion of the cold-lead shall be fixed to the heated surface to ensure a good contact of the heater.

Heating tape fixed to pumps, valves, flanges etc. shall allow easy removal of the equipment without damaging the tape. To obtain good contact between heater and heated surface, additional metal tape or foil can be used. Additional fixing straps shall be provided on both sides of the fitting to avoid loosening of the heater from the associated pipes. Special measures shall be taken to prevent damage to the heaters from sharp edges or rough surfaces.

Fixing materials for heaters shall ensure good and permanent contact between heater and heated surface. They shall be of sufficient mechanical strength, non-corrosive, suitable for the relevant operating temperature, and shall not damage the heater mechanically or chemically.

In general, for heaters with a polymer outer jacket self-adhesive plastic or glass fiber tape shall be used. For heaters with a stainless-steel outer sheath, stainless steel straps or bands shall be utilized.

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 23 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

5.8.6. Identification

Electrical heat traced pipes and equipment shall be clearly identified with suitable durable weatherproof caution signs, visible from all sides. Signs on traced pipelines shall not be more than 5 meters apart and positioned on alternate sides of the sheathing.

Traced branch pipes, instruments, etc. shall carry individual signs. Caution signs shall be yellow with black lettering.

The elements of a circuit such as local switches, thermostats, connection boxes and heaters shall be provided with permanent labels, which shall consistently indicate the number of the circuit to which the elements are connected.

The labels shall be fixed on a non-removable part, for heaters the labels shall be fixed on the sheathing of the associated pipelines or equipment.

6. NAMEPLATES AND PAINTING

6.1 Indication of Type of Explosion-protection

The explosion-protected type of the elements such as local switches, thermostats, connection boxes and heaters shall have indication of the “symbols concerning explosion-protection”.

6.2 Indication of ID Number

CONTRACTOR’s ID No. (Identification Number) shall be indicated on the side of the connection boxes.

6.3 Painting

General requirements for painting and its color shall be specified in the painting procedure prepared by vendor and sent to the EMPLOYER for approval.

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 24 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

All metallic surfaces, except machined, plated or stainless-steel surfaces, shall be shop painted. Prior to painting, surface treatment for rust prevention shall be given. Enclosure shall be given a minimum of two coats of paint. Material and method for painting is left to the discretion of Vendor unless otherwise specified, but shall withstand satisfactorily the use in the specified corrosive atmosphere.

6.4 Labeling

- 1) Electrically heat traced piping and equipment shall be clearly identified with suitable durable weatherproof caution signs, visible from all sides. Signs on traced pipelines shall not be more than 5 meters apart and positioned on alternate sides of the sheathing. Traced branch pipes, instruments, etc. shall carry individual signs.
- 2) The elements of a circuit such as local switches, thermostats, junction boxes and heaters shall be provided with permanent labels, which shall consistently indicate the number of the circuit to which the elements are connected. The labels shall be fixed on the sheathing of the associated pipe lines or equipment.
- 3) Nameplates and labels shall be in the English language.
- 4) The labels shall be of non-corrodible laminated material with black letters not less than 3mm of height on white ground, but warning and danger notices shall have white letters on a red ground. Labels shall be fixed with Corrosion resistant screws or rivets.

7. SPARE PARTS AND SPECIAL TOOLS

The contractor shall provide all special tools that may be necessary to enable equipment to be erected, commissioned and maintained. These tools will become the property of the buyer.

For the commissioning of the equipment, the contractor shall provide a complete

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 25 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

set of spare parts, which in his opinion and experience are necessary during this period. These spares shall be in addition to those spare parts as below bought by buyer for the running of the equipment after commissioning.

Spare parts for 2 years operation shall be supplied as specified separately. Vendor shall recommend any other spare parts for 2 years operation in addition to the spare parts specified by CONTRACTOR.

Special tools necessary for assembling, installation and maintenance of the electrical heat tracing shall be supplied.

These are spares, which the contractor recommends shall be held in stock in order to maintain the equipment in operation for a period of two years normal operation after setting to work. These spares will not be available for use by the contractor during commissioning of the plants.

8. PREPARATION FOR SHIPMENT

Before packing, the elements of electrical heat tracing shall be thoroughly cleaned for removal of foreign matters and the part which is likely to become rusted shall be properly treated for rust prevention after drying. All openings, such as cable entrances, shall be properly covered or plugged to prevent foreign matters from entering during transit and subsequent storage.

The elements of electrical heat tracing shall be packed in accordance with the best modern practice consistent with destination and method of transport employed. Fragile components such as measuring instruments and indicating lights shall be especially protected to prevent mechanical damage.

The elements of electrical heat tracing shall be wrapped with plastic sheet taking care to prevent ingress of water, and the package shall be adequately secured to

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 26 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

prevent damage during transportation. Especially for export, the plastic wrapping shall be sealed with silica gel dryer put inside. Total weight and CONTRACTOR's ID No. shall be clearly marked on the package.

The contractor is responsible for proper and safe transport and delivery of the equipment to site location.

9. QUALITY CONTROL, INSPECTION AND TESTING

9.1 General

The contractor shall have a comprehensive quality control procedure. Inspection and testing shall be based on the related standards.

Vendor shall submit a QC plan prepared based on the related standards and the template QC plan shall be sent to the buyer for approval, it shall be included at least the following items:

- Quality control procedure
- Type test certificate
- Routine tests

Approved QC plan will be the base of quality control, inspection and testing.

The supplier shall issue the buyer the QCTM (including QC plan and approved Inspection and testing report) eventually.

Important Notes: The QC plan does not relieve the contractor of his duties of quality control, inspection and testing of the equipment complete with all accessories necessary for proper operation.

9.2 Tests

Vendor shall submit valid type test certification or the company, which the equipment license is from. In addition, routine tests shall be carried out in vendor

	Document Number: 12002-D-EL-SPC-303-GNL-020	Rev		Date: 03/11/2025
Class: FA	Library Code: 303-E03-0200-00-EL-SPC-020-4	Client	Vendor	Page 27 of 27
	Document Title: Technical Specification for Electrical Heat Tracing	04	00	

factory as per related standards minimum as follow:

- Temperature control system functions test
- Confirmation of equipment test functions
- Visual check of equipment

All equipment shall be tested in presence of EMPLOYER.

10. GUARANTEE

The supplier shall replace any damaged equipment resulting from poor workmanship and/or faulty design. The supplier shall also replace any equipment failed under the following conditions:

- Failure under startup and commissioning tests performed according to IEC recommendations.
- Satisfactory and trouble-free operation of equipment under specified conditions generally shall be guaranteed for a period of 12 months from starting to operation.

The supplier shall guarantee to support any spare parts for a period of 10 years.