TECHNICAL SPECIFICATION

ELECTRICAL TRACE HEATING

DEP 33.68.30.32-Gen.

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DESIGN AND ENGINEERING PRACTICE

USED BY

COMPANIES OF THE ROYAL DUTCH/SHELL GROUP

PREFACE

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The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

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1. INTRODUCTION

1.1 SCOPE

This DEP is a revision of DDD 33.68.30.32-Gen. "Electrical Heat Tracing", dated October 1988. It gives the minimum requirements for winterizing and heat loss compensation systems for piping and equipment, by means of electrical heating, with regard to design, material selection, installation and testing.

1.2 DISTRIBUTION, APPLICABILITY AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIPM, the distribution of this DEP is confined to companies forming part of or managed by the Royal Dutch/Shell Group or managed by a Group company, and to Contractors and Manufacturers/Suppliers nominated by them (i.e. the distribution code is "F", as defined in DEP 00.00.05.05-Gen.).

This DEP is intended for use in oil refineries, chemical plants, gas plants, supply/marketing facilities and production installations.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this document as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies electrical heat trace equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project work and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorized to act for the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Technical definitions

- Cable loop

  A single trace heating cable doubled back along a surface in order to obtain multiple tracing or to trace a short length of pipe, without branching from the main traced pipe.

- Certificate

  Document issued by a recognized authority certifying that it has examined a certain type of apparatus and, if necessary, has tested it and concluded that the apparatus complies with the relevant standard for such apparatus.

- Certificate of conformity

  Certificate stating that the electrical apparatus complies with the relevant standards for apparatus for potentially explosive atmospheres.

- Cold lead

The end part of a heating cable in which no heat is generated.

- Constant wattage cable

  A heating cable with a constant thermal output per metre/section of cable regardless of its temperature.

- Declaration of compliance

  Document issued by the Manufacturer declaring that the electrical apparatus complies with the requirements of IEC 79-15.

- Heat loss compensation

  Trace heating installed on piping and equipment, to compensate for the heat losses through the thermal insulation and heat sinks, in order to maintain a certain product temperature under varying climatic and operational conditions.

- Heat sink

  A spot in the installation where additional energy losses are likely to be causing reduced temperatures (such as flanges, valves, pumps, pipe supports, thermowells etc).

- Hot spot

  A spot in the heater with an unacceptably high temperature, resulting from insufficient dissipation of heat and involving risk of damage to the heater.

- Parallel heating cable

  A heating cable consisting of one or more heating elements between two parallel conductors.

- Piping (and pipe)

  Includes pipe used in piping systems as well as pipe used in transmission pipelines. If a requirement is intended to apply only to transmission pipelines then the term 'pipeline' is used.

- Power output

  The (thermal) power output of a heating cable is the electrical consumption measured in watts per metre of cable.

- Rated value, 05-41-010, IEC 50

  Qualifying term, applied to a quantity which is used in the specification of a machine or an apparatus.

- Self-regulating/self-limiting heating cable

  A parallel heating cable with a semi-conductive element, which responds to temperature variation by adjusting its thermal output to finally reach an equilibrium.

- Series heating cable

  A heating cable with one or more insulated resistive conductors forming the heating elements of the cable.

- Temperature controller

  A device which monitors a preset temperature range and automatically switches the power supply of the heater off and on, depending on the sensed temperature.

- Temperature limiter

  A device which monitors the temperature of a heater and switches the power off when the maximum set temperature is reached.

- Test report

  Document prepared by the Manufacturer indicating in detail the tests and verifications to which the electrical apparatus has been subjected and their results.

- Winterizing

Trace heating installed on piping and equipment containing liquid, in order to prevent freezing or solidification due to external low temperatures.

1.4 CROSS-REFERENCES

Where cross-references are made, the number of the section or sub-section referred to is shown in brackets.

All publications referred to are listed in (9).

2. GENERAL DESIGN REQUIREMENTS

2.1 CONTRACTOR RESPONSIBILITIES

The basic design of, and the calculations for, the heating system shall be the responsibility of the Contractor.

The design shall be based on the specific requirements stated on the process data specifications, drawings and isometrics. The Contractor is considered to be aware of all process data which may be essential for the correct design of the trace heating system. The Manufacturer should be involved in the design, or at least confirm that the design is sound; however, this does not relieve the Contractor of his responsibilities.

2.2 SAFETY

For safe and reliable application of electrical heating systems, the climatic, environmental and operating conditions shall be taken into consideration.

As far as practical, the electrical equipment should be located in non-hazardous areas or in the least-hazardous areas. It shall not be located in Zone 0 areas.

2.2.1 Hazardous Areas

When installed in a hazardous area, the construction of electrical equipment shall comply with the requirements of the relevant parts of IEC 79 or CENELEC documents EN 50.014 to 50.020 inclusive, 50.028 and 50.039. Equipment complying with standards different from the above may only be used with specific approval from the Principal.

For installations in Zone 1 and Zone 2 areas, the following types of protection shall be used:

- Connection boxes : Ex "e" enclosure
- Local switches : Ex "d" or Ex "m" switches, or a combination of these two, with Ex "e" terminals and enclosure
- Thermostats : Ex "d" or Ex "m", or a combination of these two, with Ex "e" terminals and enclosure
- Temperature control systems : Ex "i" for e.g. PT 100 connections

For the above-mentioned electrical apparatus, a Certificate of Conformity shall be obtained from the Manufacturer.

2.2.2 Non-Hazardous Areas

In non-hazardous areas, industrial type equipment may be used subject to approval by the Principal.

NOTE: For standardization, material as specified for Zone 1 and 2 areas may also be used in non-hazardous areas.

2.3 SITE CONDITIONS

The parts of a heating system installed outdoors shall be suitable for outdoor use in a relative humidity of 100%, and exposed to direct sunlight, without protective shelter. The atmosphere shall be considered saliferous, sulphurous and dusty as commonly encountered in petrochemical installations located close to open water. The possibility of condensation, as experienced during large temperature fluctuations in a humid atmosphere, shall be taken into account.

Especially for offshore or similar locations, extremely corrosive and saliferous conditions shall be taken into consideration.

2.4 DEGREE OF PROTECTION

As a minimum, the enclosures shall have a degree of protection IP 55 in accordance with

IEC 529. The IP rating of the main and sub-distribution boards shall be in accordance with DEP 33.67.01.31-Gen.

2.5 ELECTRICAL SUPPLY SYSTEM

The AC supply to the heating system shall be either single phase or symmetrical three-phase, + neutral, with a nominal voltage and frequency as indicated in the requisition. The supply variations at the distribution board under steady-state conditions shall be limited to:

- nominal system voltage : plus and minus 10%
- nominal system frequency : plus and minus 2%

In addition to the above, input voltage variations may be subject to temporary voltage variations of +10% and -20% of the nominal voltage, caused by e.g. motor starts.

Transient high-frequency voltages of 2 kV peak may also be superimposed on the input voltage as a consequence of system switching operations, etc.

2.6 HEATING-UP REQUIREMENT

Apart from compensation heating, there may be a need to heat-up (to melt) the contents of a pipeline within a certain period of time. This may be required for example when the product is solid under ambient conditions (e.g. wax). Additional heating capacity would need to be installed to perform such a duty. This can be done by increasing the capacity of the compensation heating or by installing additional heaters dedicated for this duty, provided consideration is given to the maximum heat density allowed under those circumstances. The most economic solution shall be chosen.

2.7 PERFORMANCE REQUIREMENTS

The system (materials, components and assembly methods) shall have a design life of at least 20 years.

Heating equipment used for piping and equipment which will undergo periodic steam cleaning shall have a minimum withstand temperature of 190 °C, for a cumulative exposure time of at least 1000 hours.

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.

2.8 SPARE OR OVER-CAPACITY

The installation of initial spare or over-capacity of the heating system shall be considered if for critical applications the power output is not allowed to drop below the design values.

The safety factor used in the design shall be stated in the heat balance calculations (8.2).

2.9 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.

3. HEATER SELECTION

3.1 GENERAL

For winterizing and compensation heating the following heater types may be used, in order of preference:

- self-regulating/self-limiting heaters
- constant wattage parallel heaters
- mineral insulated heaters (M.I. cable)

In the case of welded pipelines (i.e. without flanges) the system of skin electric current tracing heaters shall be considered.

3.2 SELF-REGULATING/SELF-LIMITING HEATERS

Self-regulating/self-limiting heaters shall be utilized where possible, within the restrictions of heat output and operating temperatures. They can be used for all winterizing and the majority of compensation heating requirements. Heating tape shall consist of two parallel copper conductors, both being in contact with a self-regulating/self-limiting semi-conductive material. This basic element shall be insulated by one or more non-hygroscopic jackets, and shall be covered with a braided metal screen covering at least 70% of the surface and a fluor-polymer outer jacket. The braided metal screen shall have an electrical conductivity not less than the conductivity of one of the conductors.

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 e.g. overlapping, irrespective of the application.

3.3 CONSTANT WATTAGE PARALLEL HEATERS

Constant wattage parallel heaters may be utilized when the required heat output or the operating temperature is beyond the capabilities of self-regulating/self-limiting heaters. A constant wattage parallel heating cable shall consist of two insulated copper conductors. Heating elements (wires or other types of elements) are connected to the two conductors at certain distances, forming heated zones. The maximum length between two elements (unheated zone) shall not be more than 1 metre.

The conductor and the heating elements shall be provided with one or more layers of insulating material. All insulating material shall be heat resistant and non-hygroscopic, and shall be covered with a braided metal screen covering at least 70% of the surface together with a polymer outer jacket. The electrical conductivity of the braided metal screen shall be not less than the conductivity of one of the conductors.

A constant wattage heating pad shall consist of heating elements between two flat copper conductors, covered by one or more layers of insulating material which shall be heat resistant and non-hygroscopic.

The heating pad shall have a metal earth screen or foil at the outside over the entire surface for mechanical protection.

The heaters (both cables and pads) shall provide a constant power output regardless of the operating temperature. In the event of a hot spot the affected element(s) may burn-out leaving, however, the remaining part of the heater in operation.

3.4 MINERAL INSULATED HEATERS

Mineral insulated heaters should only be used if the required temperatures are beyond the capabilities of constant wattage parallel heaters, and shall only be used with the approval of the Principal.

Mineral insulated heating cable shall consist of a metal outer tube with a concentric heating conductor inside, insulated with compressed magnesium oxide powder.

The cable shall have a constant power output per metre, which shall be determined by the specific conductor resistance and the total length of the cable and the applied voltage.

The cable shall be prefabricated in the required length and provided at both ends with proper seals, cold connection leads and metal cable glands.

Heating pads with mineral insulated heating cable shall consist of a metal plate on which the cable is fixed, to guarantee heat transfer over the entire length of the heating cable.

The phenomenon of choride stress cracking shall be taken into account when selecting the outer sheath of the heater and of the cold lead connections (e.g. use Inconel sheathing rather than stainless steel).

3.5 SKIN ELECTRIC CURRENT TRACING

This type of heating system shall be considered for heating of all-welded pipelines without flanges.

NOTE: 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. 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. The heating system acts resistively with a power factor of approximately 0.9.

In view of the fact that the electrical continuity of the heating tube is of paramount importance, such a system shall not be used on pipelines with flanges incorporating disconnectable connections in the heat tube.

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.

4. TEMPERATURE CONTROL

4.1 GENERAL

The installation and selection of temperature control depend on the following criteria:

- energy saving;
- product requirements;
- temperature limitation for safety reasons;
- protection against overheating of the heating elements.

4.2 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 4 °C. One single device can control all winterizing heating circuits of an area (see Appendix 2, circuit B).

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

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.

4.3 TEMPERATURE CONTROL RESULTING FROM PRODUCT REQUIREMENTS

Piping carrying products which are sensitive to degradation due to overheating may require close temperature control.

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 temperature 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 m in length.

The control units[1)] should be installed in the switch house and shall control the heater circuits via contactors incorporated in the heater supply panel (see Appendix 2, circuit C). The control unit shall also provide high and low temperature signals to the control room.

NOTE 1) : PLC type units are preferred because they are easily adjustable, can be serially linked and need relatively less cabling.

4.4 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 switched off automatically, and remain switched off until the temperature limiter has been reset manually.

Alternatively, automatic reset may be used if the temperature limiter gives an alarm in a manned control room when the heater is switched off.

The decision as to which option is to be applied shall be made with the agreement of the Principal.

4.5 TEMPERATURE LIMITATION FOR PROTECTION AGAINST OVERHEATING

It is sometimes 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:

- the material used in the heater, and in particular the self-regulating/self-limiting semi-conductive material. Examples of this are highly insulated small bore-tubing and piping in which a product could flow with a temperature higher than the maximum exposure temperature of the heater when energised.

- the material used in the process piping or equipment (e.g. plastic).

- personnel, e.g. supply piping of safety showers which may contain water at a too high temperature.

NOTE: The maximum allowable temperature when the heater is de-energised, as stated by the Manufacturer, shall not be exceeded.

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

5. POWER SUPPLY AND DISTRIBUTION

5.1 DISTRIBUTION PANEL

The heating system shall be connected to a distribution board, which shall comply with DEP 33.67.01.31-Gen. and should be installed in the plant switch house.

It may be economically attractive to install the distribution panel or a sub-distribution panel nearer to the heater installation. For this, Principal's approval is required.

These panels shall be suitable for outside installation as defined in DEP 33.67.01.31-Gen. The incoming feeders of such panels shall be protected by short circuit limiting devices having a maximum nominal current of 355 A. These (sub-)distribution panels shall be installed in a non-hazardous area.

The outgoing panels of the distribution board shall consist of a number of three-phase fused main circuits, with an isolating switch which is padlockable in the off position. Fuse sizes shall be selected to limit the short circuit currents to the capabilities of the downstream circuit breakers.

Each main circuit shall be divided into a number of circuits, each provided with a padlockable miniature circuit breaker. The circuits may be single phase or three phase, + neutral. In the case of single phase, they shall be equally divided over the three phases. If the heating system is not controlled by local thermostats but via an ambient temperature device or via a process control system, contactors shall be incorporated either in the main circuit or in each of the circuits (Appendix 2, circuits B, C and D).

5.2 CIRCUIT PROTECTION

Miniature circuit breakers in the circuits shall be either double pole for single-phase circuits or four pole for three-phase circuits, and shall have trip characteristics corresponding thermally and electromagnetically to IEC 947-2, Category B or C.

The maximum rating of the circuit breakers for parallel type heaters shall be 25 A, the minimum short circuit breaking capacity shall be 10 kA with current limiting capabilities.

The circuit breakers shall be equipped with a residual current protection device. Residual current protection devices for mineral insulated heaters shall have a maximum rated trip current of 300 mA; for all other heaters the maximum rated trip current shall be 30 mA. Auxiliary contacts wired up together for one common trip signal to a manned control room shall be provided.

It shall be ensured that the protective devices will operate effectively regardless the location of a possible fault in the heating cable. The breaker shall be suitable for the inrush current of the heating elements. The type and rating of the circuit breakers shall be approved by the heater manufacturer.

In the case of a three-phase heater cable, an unbalanced protection relay shall be provided with a trip setting of maximum of 20% of the nominal current with a maximum of 5 A.

5.3 FIELD DISTRIBUTION

The supply cabling between the distribution board and the heaters shall have a cross section adequately rated for the maximum load, and restricting the voltage drop over the cable under full load conditions to maximum 5% of the nominal voltage. The cables shall have copper conductors and a steel wire armouring or braiding and, if required, lead sheathing.

The connections of cabling and heaters shall be made via connection boxes. Individual heaters or groups of heaters on the same pipeline shall be provided with a local switch, padlockable in the 'off' position and installed in the vicinity of the supply point of the heater(s). Heaters integrated in instruments along the pipelines shall also be connected to a heater supply circuit.

6. INSTALLATION

6.1 HEATER DISTRIBUTION

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 (see Appendix 3).

Heating systems of duplicated process control instruments shall not be connected to the same circuit.

Heater circuits shall be loaded with maximum 20 A for single-phase circuits and 3 x 20 A for three-phase circuits.

For the current rating of self-regulating/self-limiting heaters, the minimum operating temperature shall be taken into account.

To prevent overloading of the heater conductors, the maximum length of a parallel heating cable shall be limited in accordance with the specification of the Manufacturer. Some heating cables are available with additional power supply conductors integrated in the tape. This will allow extended heater lengths without using separate power feeding points.

Through connections or 'tee offs' shall not be made underneath the pipe insulation; only end-seals and 'cold-lead' connections may be used. All other connections shall be made in connection boxes. Sufficient heater capacity shall be installed to ensure that, towards the end of the heating cable, the output does not drop below the minimum design value owing to the voltage drop in the heater conductors.

6.2 LOCAL SWITCHES

Local switches shall have a minimum switching capacity of 16 A and shall be double pole for a single phase circuit and four pole for a three phase, + neutral, circuit.

The switch shall not be loaded with more than 75% of its nominal rating.

The switches shall have a clear 'ON - OFF' indication. The 'OFF' position shall be padlockable.

Local switches shall be installed in the direct vicinity of the associated heating equipment in an easily accessible position and have the cable glands in the bottom.

6.3 LOCAL THERMOSTATS

Local thermostats shall be of the capillary type. The capillary shall be no more than 5 metres long. The contacts of thermostats used for direct switching shall have a minimum rated capacity of 16 A, which may be obtained by an integrated local contactor. The contacts shall not be loaded with more than 75% of its nominal rating. The temperature setting accuracy shall be no worse than ± 5 percent of the set value, with a maximum of ± 10 °C. The switching hysteresis shall be between 5 and 10% of the actual setting or between 4 and 10 °C, whichever 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.

6.4 CONNECTION BOXES

Connection boxes shall be used for:

a) the connections between supply cable and heater cable

b) The distribution of supply of one circuit of the distribution board (see 6.1) to sub-circuits. Only the supply of one circuit of the distribution board shall be allowed in a connection box.

NOTE: Combinations of a) and b) are also possible.

c) Splitting of a three-phase circuit into three single-phase circuits.

Connection boxes shall contain sufficient terminals for all the connections to be made. Individual terminals shall be provided for each conductor. The terminals shall be of non-loosening construction and of the wedge type, obviating the use of cable lugs and constructed in such a way that direct contact between screw and conductor is avoided. Terminals shall be identified in accordance with the related 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.

6.5 HEATER INSTALLATION

Extreme care shall be taken to prevent heater cables and pads absorbing water during transport as well as during and after installation. During transportation from the supplier to the site, the ends of the cables or the connection leads shall be suitably sealed by heat shrinkable adhesive end-seals, which shall remain fitted until the final connection is made in the junction box, switch, etc.

The heater cables or the cold leads shall be terminated in the junction boxes, switches, etc. in such a manner that any ingress of water through the cores, braiding or in between insulation layers due to the capillary effect is excluded.

Heaters shall be installed in accordance with the Manufacturer's instructions. All heaters shall be fixed to ensure continuous and permanent contact with the surface to be heated over the entire (hot) 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 heating cable has the tendency to rewind, and this can be used to improve the contact with the heated surface by unrolling the drum in a certain direction (see Appendix 4, Fig. 4).

Heating cables shall normally run straight along the lower quadrant of the pipes (see Appendix 4, Fig. 1). If spiralling of tapes is necessary, this shall be done as shown in Appendix 4, Fig. 2, in order to ensure that the cable can easily be removed. There shall not be any overlapping or touching of constant wattage output heaters. Where heaters run close together, special retaining fixings shall be used to prevent the heaters from touching. Overlapping of self-regulating/self-limiting heaters shall be avoided as much as possible.

Entry kits shall be used where heating cables, 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.

For details of the insulation reference is made to DEP 30.46.00.31-Gen.

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 cable fixed to pumps, valves, flanges etc. shall allow easy removal of the equipment without damaging the cable. 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 pumps, valves, flanges, etc. 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 continuous and permanent contact between heater and heated surface. They shall be 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-fibre tape shall be used. For heaters with a stainless steel outer sheath, stainless steel straps or bands shall be utilized.

6.6 IDENTIFICATION

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 metres apart and positioned on alternate sides of the sheathing.

Traced branch pipes, instruments, etc. shall carry individual signs.

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 pipe lines or equipment.

7. TESTING AND COMMISSIONING

7.1 FACTORY TESTING

The testing of the distribution board shall be done in accordance the requirements of DEP 33.67.01.31-Gen.

On request, the Manufacturer shall supply type test certificates of the heaters quoted, based on the requirements as summarized in Appendix 1.

If Manufacturer's testing is based on other codes, this shall be stated in the quotation. Before leaving the Manufacturer's works, each length of cable or panel shall be inspected and tested for performance.

Results shall be recorded in test reports, which shall be distributed as specified in the purchasing documents.

7.2 COMMISSIONING

The commissioning schedule for the heating system shall be prepared in accordance with DEP 63.10.08.11-Gen.

The heating system shall be inspected and tested before installing the thermal insulation.

If no process temperature measuring system is installed on the traced pipeline, temperature test points shall be installed at crucial points (for example near heat sinks) for checking the performance of the trace heating system.

8. DOCUMENTS

8.1 GENERAL

Documents, including drawings, required for the installation shall form an integral part of the design. The documents shall be distributed as specified in the purchasing documents. The documents shall show the relevant order and item numbers and the Manufacturer's reference number. Documents shall be updated when alterations to the design are made.

8.2 DOCUMENTS TO BE SUBMITTED

As well as any additional instructions in the requisition/purchase order, the following documents shall be submitted.

- General arrangement drawings and isometrics, showing the configuration of the heating system.
- Bill of material both per pipeline and for the total installation.
- Technical data of heaters, electrical equipment and other materials used.
- Heat balance calculations used for design.
- Schematic and connection diagrams covering the complete heating installation.
- Manufacturer's installation manual.
- Manufacturer's test reports, certificates of conformity, declarations of compliance.

8.3 DATA BASE

As part of the detailed design a data base, in the format specified by the Principal, shall be submitted to the Principal for inclusion in a (computerized) management system.

This data base shall contain as a minimum the following information for each individual heater circuit:

- type of heating system (winterizing, compensation, heating-up, etc.)
- length of the heating cable(s) and number of circuits
- type of the heating cable
- maximum, minimum and maintaining temperature
- power demand per circuit at maintaining temperature
- type and thickness of the insulation
- list of lines selected for steam cleaning
- list of switches and junction boxes, cross-referenced with the marking of the installation at site
- data on thermostat(s) and or temperature control system, also indicating for what purpose they are installed (5.1)

9. REFERENCES

In this DEP, reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP.00 00 05 05-Gen.
Thermal insulation for hot services	DEP 30.46.00.31-Gen.
Low voltage AC switchgear and control gear assemblies	DEP 33.67.01.31-Gen.
Field inspection of electrical installations and equipment	DEP 63.10.08.11-Gen.

BRITISH STANDARDS

Specification for electric surface heating devices	BS 6351: Part 1

Issued by:
British Standards Institution
2 Park Street
London W1A 2BS
England
United Kingdom.

EUROPEAN STANDARDS (CENELEC)

Electrical apparatus for potentially explosive atmospheres	EN 50.014 through EN 50.020 EN 50.028 and EN 50 039

Issued by:
European Committee for Electrotechnical Standardization
Brederodestraat 2
P.O. Box 5
B-1000 Brussels
Belgium.

INTERNATIONAL STANDARDS

International electrotechnical vocabulary	IEC 50
Electrical apparatus for explosive gas atmospheres	IEC 79
General guidelines for ageing procedure and evaluation of test results	IEC 216-1
Classification of degrees of protection provided by enclosures	IEC 529
Mineral insulated heating cables with a rated voltage not exceeding 750 V	IEC 702
Heating cables with a rated voltage of 300/500 V for	IEC 800

comfort heating and prevention of ice formation	
Common test methods for insulating and sheathing material of electric cables	IEC 811-4-2
Low voltage switchgear and controlgear, Part 2: Circuit breakers	IEC 947-2

Issued by:
Central Office of the IEC
(Sales Department)
3, Rue de Varembé
1211 Geneva 20
Switzerland.

10. APPENDICES

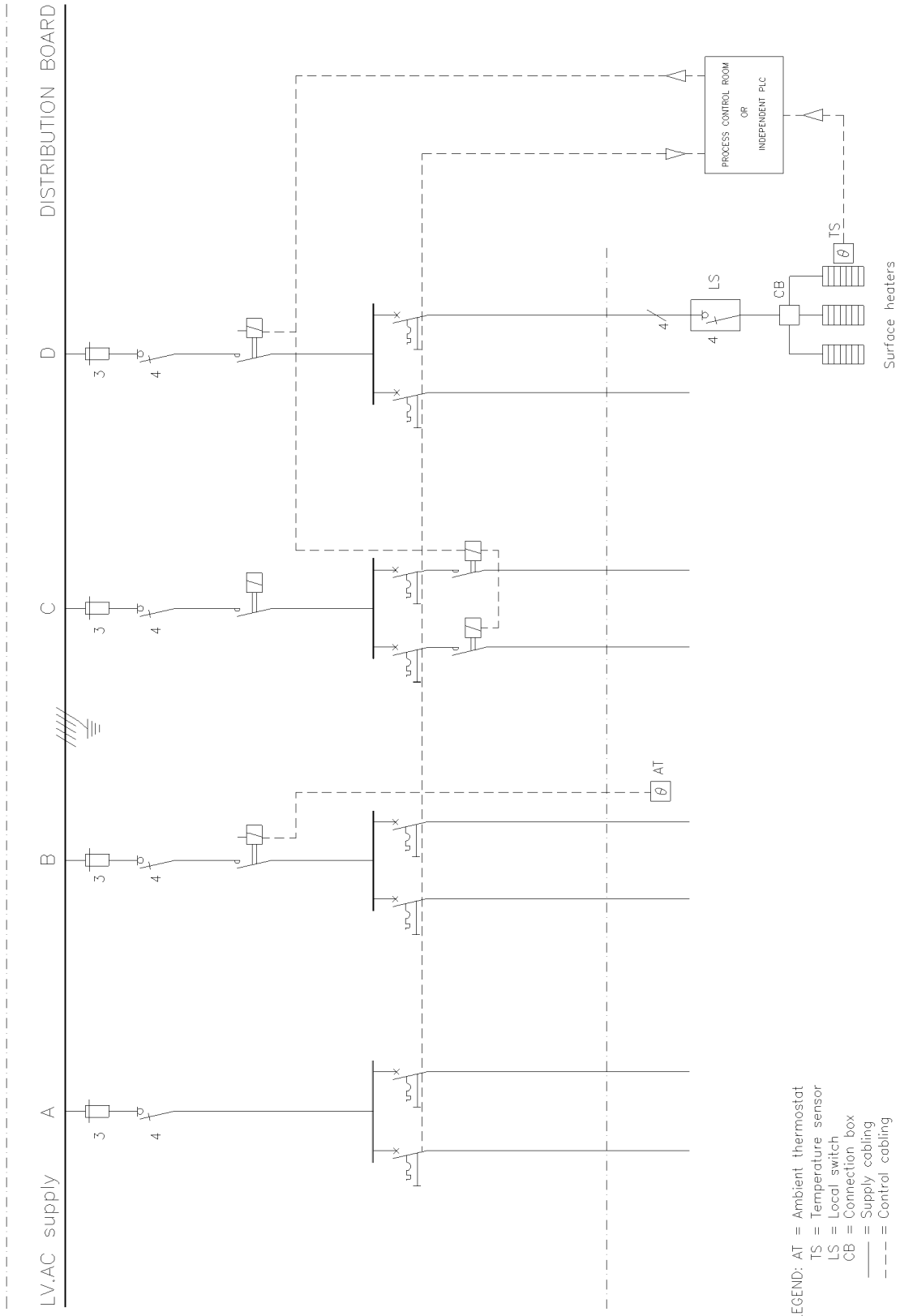
Appendix

1. Summary of tests and requirements for heat tracing cables and pads
2. Typical power supply and distribution diagram
3. Typical example of heater distribution
4. Trace heating installation examples

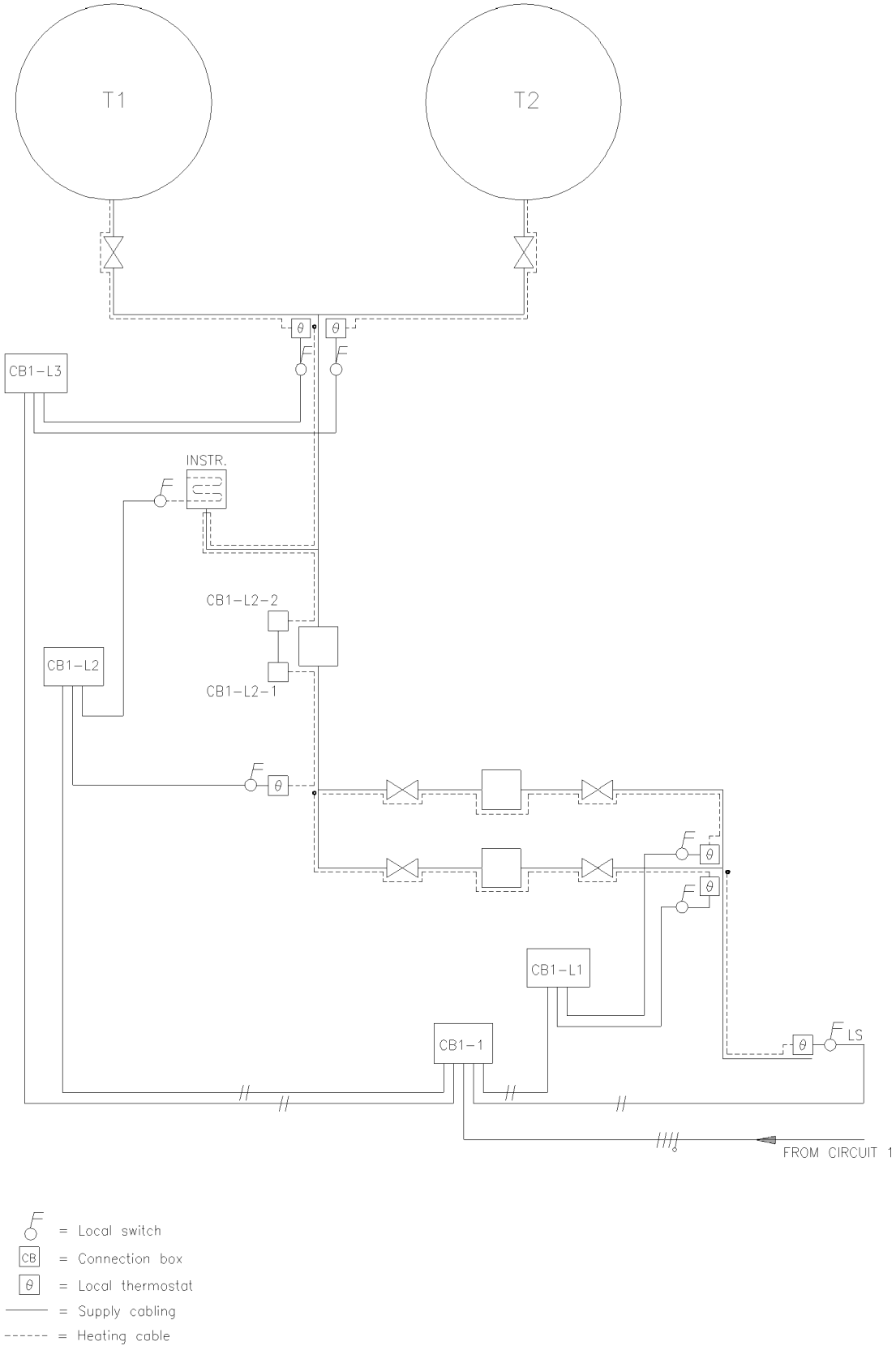
APPENDIX 1 SUMMARY OF TESTS AND REQUIREMENTS FOR HEAT TRACING CABLES AND PADS

TEST	IN ACCORDANCE WITH	EVALUATION CRITERIA
Dielectric withstand	IEC 702 BS 6351:Pt.1 (clause 8.1.6)	Withstand specified test voltage for specified duration
Insulation Resistance	IEC 702 BS 6351:Pt.1 (clause 8.1.6)	Greater than the specified value
Resistance of Metallic Braid	IEC 800 Pt.1 BS 6351:Pt.1 (clause 8.1.12)	Less than the specified value
Metallic Braid Penetration	IEC 800 Pt.1	As specified
Thermal Output (Power Output)	BS 6351:Pt.1 (clause 8.1.4)	Not less than the specified values
Start-up Current	BS 6351:Pt.1 (clause 8.1.4)	+40%, -0% tolerance on specified valves
Maximum Self-Generated Temperature	BS 6351:Pt.1 (clause 14.3) IEC 79.0	Not exceed the specified values
Thermal stability	IEC 216:Part 1	Percentage power retention not less than specified value
Cold bend	BS 6351:Pt.1 (clause 8.1.11) IEC 702 Pt.1	No cracks, withstand specified voltage for specified duration
Impact Resistance	BS 6351:Pt.1 (clause 8.1.10)	No cracks, withstand specified voltage for specified duration
Deformation Under Load	IEC 702 Pt.1 BS 6351:Pt.1 (clause 8.1.9)	No cracks, withstand specified voltage
Jacket Ageing	IEC 811-4-2	No cracks, withstand specified voltage for specified duration
Voltage withstand at Elevated Temperature	BS 6351:Pt.1 (clause 8.1.7)	While at specified temperature, withstand test voltage for 1 min.
Water Immersion	BS 6351:Pt.1 (clause 8.1.6)	No splitting or cracking Insulation resistance of base tape/cable not less than specified value. Braided and Jacketed tape withstand specified voltage for specified duration.
Chemical Resistance	Principal's approval	No cracks; retains specified value of mechanical strength and tensile strength
Composition of Insulation (M.I. cable)	IEC 702 Pt.2	Not less than specified

APPENDIX 2 TYPICAL POWER SUPPLY AND DISTRIBUTION DIAGRAM



APPENDIX 3 TYPICAL EXAMPLE OF HEATER DISTRIBUTION



APPENDIX 4 TRACE HEATING INSULATION EXAMPLES

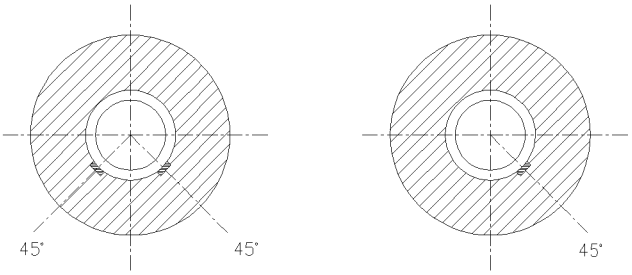


FIG. 1

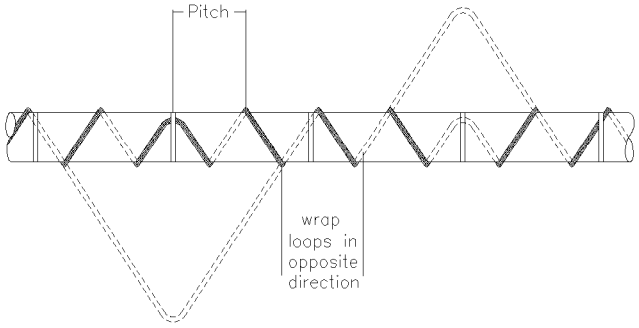
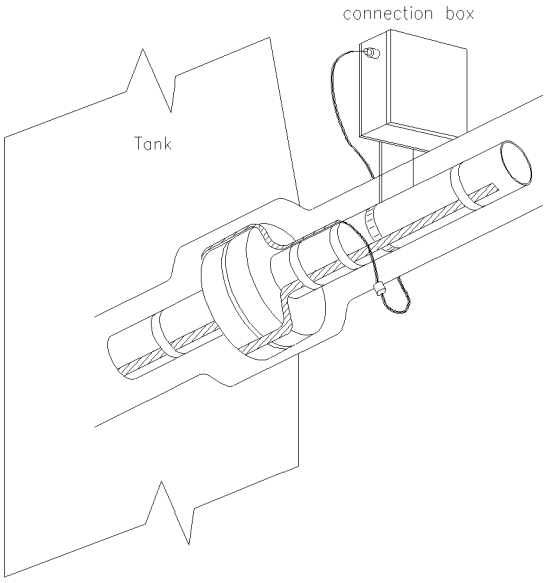


FIG. 2



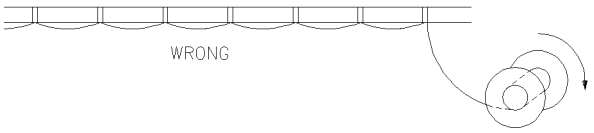


FIG. 4

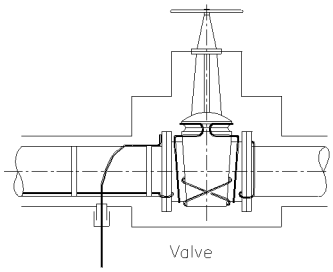


FIG. 3