MATERIAL STANDARD

FOR

ELECTRICAL HEAT TRACING

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1. SCOPE

Electric Surface Heating (ESH) system are designed to satisfy two distinct requirements:

1.1 Temperature Maintenance

Maintaining temperature requires the provision of heat to a surface equal to the rate of heat loss due to the temperature difference and its surrounding at the required surface temperature.

When starting from a lower temperature the time taken to achieve the required temperature will vary according to the ambient temperature and whether the pipe or vessel is empty, partially filled or completely filled under no flow conditions.

1.2 Process Heating

This requires the provision of sufficient heat to raise the temperature of surface and contained material within a stated time, change the state of material or to promote or control a chemical reaction. It may also be necessary to maintain material at the required raised temperature.

2. REFERENCES

Electrical heat tracing system shall be designed, manufactured, quality controlled, installed and tested to the requirement of the edition of following standards that are in effect at the time of publication of this Standards, the applicability of changes in standard shall be mutually agreed upon by the Company and the designer/supplier.

BSI (BRITISH STANDARDS INSTITUTION)

BS 476 (1984) Part 4	"Fire Test on Building Materials and Structures"
BS 1710 (1984)	"Specification for Identification of Pipelines and Services"
BS 4683 (1971)	"Classification of Maximum Surface Temperature"
BS 5345 (1976)	"Code of Practice for Selection, Installation and Maintenance of Part 1 Electrical Apparatus for Use in Potentially Explosive Atmospheres (other than Mining Applications or Explosive Processing and Manufacture)
BS 5501 (1977)	"Electrical Apparatus for Potentially Explosive Atmospheres"
BS 5422 (1977)	"Specification for the Use of Thermal Insulating Material"
BS 5970 (1981)	"Code of Practice for Thermal Insulation of Pipework and Equipment, in the Temperature Range -100°C to +870°C"
BS 6207 (1987)	"Specification for Mineral Insulated Copper Sheathed Cables with Copper Conductors"
BS 6351 (1981) Part 1	"Specification for Electric Surface Heating Devices"
BS 6351 (1983) Part 2	"Guide to the Design of Electric Surface Systems"

BS 6351 (1983) "Code of Practice for the Installations, Testing and Maintenance Part 3 of Electric Surface Heating Systems"

IEC (INTERNATIONAL ELECTROTECHNICAL COMMISSION)

IEC 540 "Test Methods for Insulations and Sheaths of Electric Cables and Cords" (Elastomeric and Thermoplastic Compounds)

IEEE (INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS)

IEEE 515 "Recommended Practice for the Testing, Design, Installation and Maintenance of Electrical Resistance Heat Tracing for Industrial Application"

NEC (NATIONAL ELECTRICAL CODE)

NEC Article 427 "Fixed Electrical Heating Equipment for Pipelines and Vessels"

ANSI (AMERICAN NATIONAL STANDARD INSTITUTE)

NFPA (NATIONAL FIRE PROTECTION ASSOCIATION) (NOW NATIONAL FIRE CODE)

ANSI/NFPA 70 "National Electrical Code"

3. UNITS

This Standard is based on International System of Units (SI), except where otherwise is specified.

4. ENVIRONMENTAL CONDITIONS

See Appendix A.

5. TYPE OF HEAT TRACING CABLE

For winterizing and compensation heating the following heater types can be selected accounting to maximum temperature required for the fluid:

1) Self regulating heaters.
2) Zonal constant wattage parallel heaters.
3) Mineral insulated cable (heaters).

5.1 Self Regulating Heaters

Self regulating heat tracing strip typically consists of a temperature dependent heating element, conductor, a jacket or electrical insulation.

Additional metal braids/and/or jacket may be used as required.

5.1.1 The heating element shall be a conductive polymeric material with a highly temperature dependent resistivity. Heat is generated by passing an electric current along the entire length of the parallel circuit heat tracing strip.

5.1.2 The conductors carry electrical current along the entire length of the parallel circuit heat tracing strip.

5.1.3 Jacket or electrical insulation

The heating element shall be electrically insulated with one or more dielectric materials having sufficient thickness and uniformity to provide mechanical and electrical integrity.

5.1.4 Metallic braid

The heat tracing strip to be surrounded by a metallic braid to:

I) Provide additional mechanical protection, and
II) Provide an earth path
Under normal conditions the braid shall carry no current.

5.1.5 Mechanical and chemical resistant outer jacket

The heat tracing strip shall be surrounded by a protective outer covering to provide added mechanical protection and to protect it from chemical environments (corrosives, solvents, water) which might affect its performance. This protective layer is the outer jacket.

5.2 Zonal Parallel Resistance Heating Tape (Constant Wattage)

The zonal parallel resistance heating tape can be utilized when the required heat output on the operating temperage is beyond the capabilities of self regulating heaters.

5.2.1 The zone heater consists of two insulated bus wires wrapped with a thin (38-40 American wire gage) Nichrome heating wire and covered with polymer insulation. The heating wire is connected to alternate bus wires at nodes every 30 to 120 cm.

The distance between nodes constitutes a heating zone. A metallic braid or outer jacket between nodes constitute a zone, a metallic braid or outer jacket or both are optional.

5.2.2 The main advantage of this tracer is that it can be cut to length in the field. However one must be aware of node location when cutting, because there will be no heating from the cut to be nearest node.

5.2.3 This tracing cable shall not be used where there is demand for service above 215°C.

5.3 Mineral Insulated Cable for Heat Tracing

Mineral insulated cable shall consist of an outer seamless sheet (of copper, stainless steel, ixonel or other approved metal. The insulation shall be magnesium oxide and one or more heating conductors inside. Temperature range shall be upto 850°C.

Precaution:

Mineral insulated cable chief disadvantage is that it can not be cut to length on spliced in the field. This makes design installation and maintenance more difficult with it than with other type of electric tracer. Because it is a series heater an entire circuit is lost if any section fail.

For more information on mineral insulated cable see BS 6207.

5.3.1 Mineral insulated cable shall be factory fabricated in the required length and load in section without splices for the entire length.

5.3.2 The cold section shall be enclosed in a flexible stainless steel conduit. Mineral insulation shall be seated from moisture by an epoxy compound.

5.3.3 The cable shall be provided on both ends with proper seals cold connection leads and metal cable glands.

5.3.4 Each cable shall be capable of field bending to an inside radius of six times the cable diameter without damage.

5.3.5 The connection box in which heating section and cold sections are connected shall be water proof.

5.3.6 Cable sheaths conductor and termination materials and cable support clamps shall withstand the design temperature of the pipe equipment, or instruments; and when applicable the steam out temperature.

Notes:

1) All type of heaters shall have at least 600 volt minimum dielectric withstand rating operating voltages will be 230 single phase, 230/400 - 3 phase 4 wire, 50 H_Z.

2) Temperature limit of selected cables shall not be exceeded by pipe being traced, under any normal, abnormal or maintenance conditions.

3) Heating cables shall be resistant to organic chemical.

6. MINIMUM SAFETY REQUIREMENTS FOR ESH DEVICE AND CONTROL

Minimum safety requirements for ESH devices and control equipment shall comply with the requirements of Clause 3 of BS 6351: Part 2.

7. THERMAL INSULATION*

7.1 General Requirements

7.1.1 The thermal insulation system should be generally in accordance with BS 6351: Part 3, Section 6.

7.1.2 Insulation systems and their installation should also comply with BS 5970 and BS 5422.

7.1.3 Thermal insulation for temperature above 230°C should be non-combustible as defined by the test in BS 476: Part 4 and for temperatures below 230°C Grade P of BS 476: Part 5 will apply unless there are special circumstances.

7.1.4 Where external metallic cladding is specified, care should be taken to ensure that bare edges of the metallic cladding cannot come into direct contact with the ESH device.

***Note:**

Calcium silicate insulation is most commonly used in oil industry for thermal insulation in heat tracing.

8. EXPLOSIVE ATMOSPHERE APPLICATIONS (BASIC REQUIREMENTS)

Applications in this category must satisfy a number of interrelated safety standards and codes of practice in the design, installation and maintenance of Electric Trace Heating Systems. Primarily, Section 3 of BS 6351: Part 1 1983 in addition to those specified in Section 2 of the same standard i.e., "Electrical Surface Heating", together with related requirements to BS 4683 "Electrical Apparatus for Explosive Atmospheres" and BS 5501 "Electrical Apparatus for Potentially Explosive Atmospheres" (in line with European Standards and eventually to replace BS 4683) covering the design, construction and installation of orthodox electrical apparatus, are the controlling standards. Related codes of practice are contained in BS 6351 and BS 5345, which describe, amongst other things, various categories of hazard. Unlike design practice applied in the specification and design of orthodox electrical apparatus, the design limits for electric surface heating units depend on a number of interdependent factors, including process temperature, the limiting temperature of the material or "T" classification (BS 4683: Part 1), and the method of installation.

9. FACTORY TESTS OF ESH DEVICES

Type tests and routine tests of ESH devices in factory shall be carried out according to requirements of Clauses 7 and 8 of Part 1 of BS 6351.

Note:

For Precommissioning test after installation and inspection see IPS-I-EL-115/1.

10. LABELLING AND IDENTIFICATION OF ESH SYSTEMS

10.1 General Requirements

10.1.1 Each ESH device should be identified by means of a non-deteriorating engraved label in accordance with Clauses 9 and 15 of BS 6351: Part 1.

10.1.2 In addition all components of an ESH system should be identifiable both individually and as part of a complete circuit or system.

Each power supply point, means of isolation, control equipment, junction box and each feeder or branch circuit should be legibly and durably marked to indicate its purpose.

BS 6351: Part 3 sub-clause 11.2.2 gives a recommended basis for equipment and service identification. In addition, however, it is recommended that a further indicator be added to indicate the line or vessel being heated. This could be the workpiece (line or vessel) reference used at the particular plant or site of installation.

10.1.3 Warning labels should also be attached at regular intervals to the cladding over each electrically surface heated workpiece to indicate the presence of concealed ESH equipment, in accordance with sub-clause 11.3.2 of BS 6351: Part 3. These should also give the reference to the ESH circuit involved so that during maintenance the requisite isolation point can be identified.

10.1.4 The labels should be of metals suitable for outdoor installation. The engraved marking and fixing should also be satisfactory for outdoor installation. These requirements are particularly important in saliferous atmospheres. The engraved symbols should not be on a black background.

10.2 Specific Requirements for Hazardous Areas

Electrical surface heating device for use in hazardous areas shall be marked in accordance with BS 4683 or BS 5501.

Approved components shall be marked with the following information in addition to that specified in Sub-clause 10.1 of this Standard.

a) Cables tapes and surface heaters:

1) Certificate number
2) Type of protection
3) Apparatus group

b) Cable units, tape units and surface heater units:

1) Manufacturer's type reference or identification
2) Certification mark and certificate number
3) Type of protection
4) Apparatus group
5) Temperature classification

11. DOCUMENTATION

11.1 General Requirements

11.1.2 The documentation which shall be made available to client shall include:

a) A compiled reference of each workpiece requiring heating.

b) Isometric diagrams of pipework indicating locations of flanges, valves and supports.

c) Details of insulation on each workpiece.

d) The required temperature for each workpiece.

e) The thermal capacity of each workpiece and its contents, if process heating is required.

f) The calculations of power requirements for each ESH circuit or zone.

g) The heating devices selected for each circuit or zone, including calculations of maximum temperature to assess suitability for hazardous area group and temperature classification, if applicable.

h) Power supply details for each circuit or zone.

i) The reference nomenclature of each item of equipment, e.g., supply cable, heating device, junction box, temperature controller, temperature sensor, circuit breaker, fuse-switch, contactor, etc., for each circuit or zone.

Note:

Any one piping circuit may be included in more than one heating zone.

j) Inspection and test certificates at each stage of assembly and installation, pre-commissioning and commissioning (where applicable).

k) As built drawings of the ESH systems.

11.2 Guidance Regarding Certification

For certification of ESH devices for use in a flammable (explosive) atmosphere the Certifying Autority will need to assess the devices for compliance with requirements of clauses referred to in Appendix A of BS 6351: Part 1 (1983).

APPENDICES

APPENDIX A
BASIC ENQUIRY INFORMATION

1) Pipework:

a) Pipe nominal bore (mm) and lengths (meters) .....
b) Pipe material .....
c) Number of flanges and valves .....

2) Vessels:

a) Vessel dimensions (meters) .....
b) Vessel material .....
c) Dry weight of vessel (kg) or wall thickness .....
d) Normal operating capacity (m^3) .....

3) General:

a) Maintain or raise to temperature. (°C) .....
b) Ambient temperature, (min./max. °C) .....
c) Maximum operating temperature, if different from "3d".....
d) Control temperature, tolerance +/- .....
e) Indoor or outdoor .....
f) Corrosive environment and hostile agencies .....
g) Hazardous area: temperature, classification .....
h) Thermal insulation material and thickness (mm) .....
i) Type of product .....
g) Temperature raise, heat up time (hrs) .....
h) Product density (kg/m^3) .....

APPENDIX B
ENVIRONMENTAL CONDITIONS

1) Site elevation: ---------- meters above seal level.

2) Maximum ambient air temperature: ---------- degree centigrade.
(Bare metal directly exposed to the sun can at times reach a surface temperature of ---------- degree centigrade.)

3) Minimum air temperature: ---------- degree centigrade.

4) Relative humidity: ---------- percent.

5) Atmosphere: saliferrous, dusty corrosive and subject to dust storms with concentration of 70 - 1412 mg/cubic meter, H_2S may be present, unless otherwise specified.

6) Lightning storm isoceraunic level: ---------- storm days/year.

7) Maximum intensity of earthquake ---------- richters.

Note:

Blanks to be filled by client.