



NATIONAL PETROCHEMICAL COMPANY
STANDARDS

ENGINEERING STANDARD
FOR
ELECTRICAL HEAT TRACING DESIGN

NPCS-ES-EL-03

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SCOPE

This standard describes the general characteristic and special requirements for design and installation of electrical heat-tracing in petrochemical plants.

STANDARDS AND CODES

The design and installation shall be in accordance with the standards and recommendations issued by the following:

- a) International Electrotechnical Commission (IEC).
- b) Cenelec Standards.

ABBREVIATIONS AND TERMS

The following abbreviation and terms are used in this engineering standard:

- ETL : Tracing and Calculation List.
- P&ID : Piping and Instrument Diagram.
- ISO : Isometric Drawing.
- PPS : Piping Plan Drawing.
- ESH : Electrical Surface Heating.
- HP : Heat-tracing Panel.
- JB : Junction Box.
- PLS : Pipeline Schedule.
- MCB : Miniature Circuit Breaker.
- SQR : Square Root.

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GENERAL DESIGN REQUIREMENTS

- 1.1 A complete electrical heating system shall be provided for temperature maintenance or to prevent freezing for the services specified in the P&IDS'.
- 1.2 The design shall be based on continuous and reliable service, safety to personnel and equipment, ease of maintenance and interchangeability of equipment. As far as possible, the design shall be standardized on one cable output rating.
- 1.3 Consideration shall be given but not limited to environmental conditions, pipe material, pipe size and length, fitting, type and thickness of insulation, lowest ambient design temperature, fluid flow conditions, type of control required such as thermistors, thermostats and area classification.
- 1.4 Electric tracing used underground shall be designed to allow maintenance without any requirement for excavation.
- 1.5 As far as practical, the control equipment shall be located in non-hazardous areas or in the least hazardous areas.
- 1.6 Distribution panels, junction boxes and installation materials shall be standardize as much as possible.
- 1.7 Maximum circuit length shall be limited to manufacturer's recommendation.
- 1.8 Consideration shall be given to high heat loss areas at pump bases, supports, manholes, and additional heat-tracing shall be provided as required.

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5 TEMPERATURE CONTROLS

- 5.1 For freeze protection, ambient sensing thermostats may be utilized to switch on groups of heating circuits. All ambient sensing thermostats shall be exposed to the same environmental conditions as the pipe or vessel begin electrically traced.
- 5.2 In classified areas, the sheath temperature shall not be higher than 80% of the ignition temperature of the vapour present as what will be indicated on the hazardous area classification drawings and detailed in the requisition. Where the sheath temperature can exceed this 80% figure, individual pipe sensing thermostats shall be used for freeze protection.
- 5.3 An individual thermostat shall be used for each heating circuit provided for maintaining a process temperature and for over temperature protection. The number and location of the thermostats shall be selected to ensure that the heating requirements of all piping equipment involved will be maintained under all process conditions.
- 5.4 Overlimit thermostats shall be used with all constant wattage heaters.
- 5.5 All thermostats shall be factory calibrated, non-indicating type, equipped with internally adjustable set-point contact for every circuit.
- 5.6 Thermostats shall not be loaded to more than 75% of their nominal current rating. Where this rating is exceeded, the circuit shall be controlled via a suitably rated contactor.
- 5.7 When constant wattage heaters are used separately controlled heating circuits shall be provided for closed by-passes and dead end flow.
- 5.8 A heating circuit shall not extend more than 30 cm (1 ft) beyond the point where two pipes join such as optional flow/non-flow paths may occur. IN such cases, separate thermostats shall be used.

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POWER DISTRIBUTION

From the motor control center (MCC) in the substation, feeder shall be provided to a local panel 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 outgoing circuits may be single phase or three phase plus neutral. In case of single phase circuits, they shall be equally loaded over the three phases.

The panel outgoing circuits shall be provided with current monitoring relay and indication lamp. The panel shall be equipped with a sun/rain canopy.

When the panel designed for freeze protection only, it shall be provided with a main four pole isolator switch and a thermostatically controlled contactor of incoming.

When the panel designed for process heating and freeze protection together, it shall be provided with split bus section, couples by a thermostatically controlled contactor (see figure 15.1).

The contactor operation shall be monitored by means of auxiliary contacts of contactor and thermostats. Following shall be controlled:

- a) Temperature above 5°C : contactor open.
- b) Temperature below 5°C : contactor closed.

The panel shall preferably be located in a nonclassified area, if possible.

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7 INSTALLATION

- 7.1 The installation of all heaters and associated equipment and controls shall be in accordance with NPCS-SD-EL-79 to NPCS-SD-EL-86, this engineering standard and vendor's instructions.
- 7.2 All heaters shall be fixed to ensure a good and permanent contact with the surface to be heated over entire hot length.
- 7.3 Heating cables shall be spiralled or installed on the lower portion of the pipe.
If installed on the lower portion, it shall be more than 60 degrees from the horizontal centerline to allow for the best heat transfer upward from the tracer and to utilize the pipe for mechanical protection.
- 7.4 Self-limiting heating cables shall be cut-to length.
- 7.5 Heating circuits shall not be installed until all pipes and equipment have met all required tests.
- 7.6 External thermal insulation shall be applied without delay after cables have been properly installed to prevent cable damage.
- 7.7 All entry and exit points for power, controls and thermostat capillaries should be enclosed in seamless tubes and shall be located 60 degree or more below the horizontal centerline to avoid water entry into thermal insulation. The entry and exit points shall be sealed with suitable epoxy compound.
Vendor's standard cable entries may be used instead of seamless tubes. However, this is subject to client's approval.
All junction boxes mounted direct to heat-traced pipes shall be located underneath pipes to avoid water entry into thermal insulation.
- 7.8 Cables shall be formed and bent to conform to flanges and fittings, except that type MI cable must not be bent on less than six times cable diameters.
- 7.9 Heaters and controls shall be carefully located and meticulously installed to preclude subsequent damage coincident with normal operations and maintenance.

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- 7.10 Overlapping or touching of constant wattage output heaters 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.
- 7.11 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.
- 7.12 The elements of a circuit such as thermostats, connection boxes and heaters shall be provided with permanent labels which shall consistently indicated 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 sheating of the associated pipe lines or equipment.
- 7.13 Signs shall be permanently fixed to the outside of the finished external thermal insulation for visibility from ground level. The sign shall read "Electric Traced" and shall be spaced at a maximum of 6 m and at any change of direction.
- 7.14 Thermostat sensing bulbs, when installed on pipe, shall be placed approximately 60 degree from the heating cable. Capillary runs outside of thermal insulation shall have mechanical protection, such as conduit or approved armored tubing.
- 7.15 Thermostat sensing bulbs in process maintenance service shall be located in the vicinity of the downstream end of the pipe being controlled.
- 7.16 Mineral insulated heater cables should not used on plastic piping when the two are in direct contact. When heating tapes are used, they shall be of the foil type construction of self-limiting type so as to give the greatest possible area for heat transfer. Prior to the installation of the electric heating tapes on the plastic pipes, an Aluminium foil of 0.5 mm thickness and of minimum width equal to twice that of the heating tapes shall be wrapped on the plastic pipes to assist heat transfer and to detect earth-leakage fault.



INSULATION

8.1 External thermal insulation shall be in accordance with NPC-ES-TP-02.

8.2 Insulation material shall be Calcium Silicate or other approved type which does not contain chemicals or materials that will corrode heaters and/or pipes.

HEATING EQUIPMENT

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

- a) Self-regulating heaters.
- b) Constant wattage parallel heaters.
- c) Mineral insulation heaters.

9.2 For internal heating of metallic tanks, electric heating "pads" or "blankets" may be considered, based on technical/economical criteria.

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10 TRACING OF INSTRUMENTS

10.1 Heating of instruments shall be done by self-limiting heating codes.

10.2 Heating of in-line instruments shall be done by means of the heating cables applied for the pipe where the instrument is mounted on. If the pipeline, where the instrument is mounted on, is not traced, a heating cable is to be selected for both instrument and instrument pressure piping in accordance with **Clause 12.1.**

10.3 Heating of level gauges and displacer type instruments shall be done by means of self-limiting cables. Selection of ESH device shall be done as outlined in section 13.

10.4 Heating of transmitters shall be done by means of the heating **cable** applied for the pressure piping. The additional cable length required for the transmitter shall be included in the length of the instrument pressure piping. Selection of ESH device shall be done as outlined in section 13.

11 DETAIL DESIGN PROCEDURE

For design of electrical heat-tracing, follow the below steps:

- a) Determine heat losses as per section 12.
- b) Select ESH device as per section 13.
- c) Determine the required length for tracing of each equipment as per section 14.
- d) Design electrical circuit and protection as per section 15.

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12 HEAT LOSS DETERMINATION12.1 PIPING SYSTEMS12.1.1 Pipe Heat Loss

Pipe heat loss is determined by conduction through the insulation layer. Conduction losses are primarily dependent on the insulation, thermal conductivity and overall diameter. The driving force for conduction heat transfer is the temperature difference between the inner and outer surfaces of the insulation formula 12.1.

$$Q_{\text{conduction}} = \frac{T_p - T_a}{\frac{\ln(d_2/d_1)}{2\pi K}} \quad (\text{W/m}) \quad (12.1)$$

Where :

$Q_{\text{conduction}}$ = Conductive heat loss (W/m)
 T_p = Pipe temperature ($^{\circ}\text{C}$)
 T_a = Minimum ambient air temperature ($^{\circ}\text{C}$)
 d_2 = Diameter over insulation (m)
 d_1 = Diameter under insulation (m)
 $\ln$ = Natural logarithm function
 π = 3.1415
 K = Insulation mean thermal conductivity (W/m. $^{\circ}\text{C}$)

The thermal conductivity is a function of the mean insulation temperature, $(T_p + T_a)/2$. Values for thermal conductivity shall be consistent with the American Society of Testing Materials (ASTM) or British Standard (BS) published data.

Note: Formula 12.1 considers an unit length of pipe (m). $Q_{\text{conduction}}$ is thus expressed in W/m.

The heat loss safety factor shall then be applied to increase the heat loss its a general engineering practice. The safety factor shall be 20%.

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