

ELECTRICAL PROCESS HEATERS

DEP 33.68.30.33-Gen.

November 2006

DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design, material selection, construction, installation and testing of resistance heaters and associated thyristor power controllers used in oil and gas, petrochemical and utility facilities. The mechanical design and construction aspects of the shell side of the heater assembly shall conform to the relevant parts of DEP 31.21.01.30-Gen.

This DEP is a revision of the DEP of the same number dated October 2001; see (1.5) for a summary of the main changes.

Requisition DEP 33.68.30.93-Gen. gives the specific electrical requirements.

Requisition DEP 31.21.00.93-Gen. gives the specific mechanical/process requirements.

For low power, thyristor-controlled, resistance heaters less stringent requirements than those specified can be accepted. This is applicable to heaters where the nominal current of the short circuit protection device (fuse or circuit breaker) in the supply to the power and control assembly is 100 A or less. These less stringent requirements are stated in ***bold italic text*** under the specific headings, with a reference to this clause for the above definition.

This DEP does not apply to small resistance heater applications without thyristor control such as HVAC, drum heaters, etc.

1.2 DISTRIBUTION, APPLICABILITY AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them.

This DEP is intended to be used in new construction projects for, and in the retrofitting, operation and maintenance of exploration and production facilities, oil refineries, chemical plants, gas plants and supply/marketing installations.

When DEPs are applied, a Management of Change (MOC) process should be implemented; this is of particular importance when existing facilities are to be modified.

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, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project, or operation or maintenance of a facility.

The Principal may undertake all or part of the duties of the Contractor.

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

The **Principal** is the party that initiates the project 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 authorised to act for, and on behalf of, the Principal.

The **Purchaser** is the party that buys the heater unit. The Purchaser may be either the Contractor or the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Availability

Availability is defined as :
$$\frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}}$$

Bite coupling

A hydraulic fitting used for the mechanical fixing of a metal sheathed electric heating element to a tube sheet.

Burst firing control

A firing mode of the thyristor circuits whereby a finite number of complete mains cycles are applied to the load and power control is achieved by regulating the percentage of "on" cycles.

Driver unit

A control device providing the input to the thyristor circuit incorporating soft start and auto/manual control.

Mean time between failure - MTBF

Mean time between failure is defined as:

$$\frac{\text{operating time}}{\text{number of faults that have resulted in outages}} \quad (\text{hours})$$

Mean time to repair - MTTR

Mean time to repair is defined as:

$$\frac{\text{total time spent on repairs and restoration to service}}{\text{number of faults that have resulted in outages}} \quad (\text{hours})$$

Point of Coupling of the heater (PC)

The point in the electrical network at which the heater is connected to that network.

NOTE: The PC is normally at the incoming terminals of the Power and Control Assembly. Where a unit transformer is installed the PC is at the primary terminals of the transformer.

Requisition

This is DEP 33.68.30.93-Gen., Data/requisition sheet for Electrical Process Heaters.

Single cycling control (cycle syncopation)

A form of thyristor firing where the required power is applied in a minimum period of mains cycles, so that half power is given by one cycle on and one cycle off.

Watt density

Power per unit of heated surface of a metal sheathed heating element.

Zero crossover operation

A point in a sinusoidal mains waveform where the voltage or current is zero. To minimise interference, the thyristors controlling resistive loads are always switched on at the heater voltage zero crossover and switched off at the heater current zero crossover.

1.4 CROSS REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced in this DEP are listed in (8).

1.5 SUMMARY OF CHANGES SINCE PREVIOUS EDITION

This DEP is a revision of the DEP of the same number dated October 2001. The following are the main, non-editorial changes.

Section	Change
General	References to other DEPs (Electrical Engineering Guidelines and LV switchgear DEP) deleted. The specific requirements are now included in this DEP revision.
1.1	Introduction of less stringent requirements for low-power, thyristor-controlled heaters up to 100 A.
2.3	Total Harmonic Distortion (THD) specified in line with IEC TR 61000-3-6.
3.3	EMC requirements updated.
4.2	'Control panel' renamed as 'power and control assembly'.
4.2	Requirements for power and control assembly made more stringent to increase reliability and safety to personnel.
General	A new data/requisition sheet has been introduced.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the DEP Administrator at standards@shell.com. Shell staff may also post comments on this DEP on the Surface Global Network (SGN) under the Standards folder.

2. GENERAL REQUIREMENTS

2.1 BASIS OF DESIGN

This specification is applicable to electrical process heaters that are supplied by a three phase LV system. The requirements for single phase heaters shall be specified by the Principal and agreed with the Manufacturer in the quotation stage.

The heater power and control assembly and associated heater shall be designed to provide continuous operation at rated output for six years at the process conditions stated in the Requisition, allowing for periodic minor maintenance, e.g. filter cleaning.

Additionally, the equipment shall be designed to function in continuously operating petrochemical process units, production facilities or utility installations and shall have a design life of at least 20 years. The design shall ensure minimum mechanical stress and fatigue on the heater elements.

The power of each heater shall be controlled by thyristors fired according to the zero crossover mode, i.e. phase angle control shall not be utilised, with a controlled output power range down to 3 % (single cycle control).

Burst firing control shall not be utilised for large loads attached to relatively weak supply systems susceptible to electrical disturbances; single cycling control should be used instead. The load should be configured in either four-wire star or delta, with three-leg control using thyristor pairs adopted for the star configuration and two-leg control for the delta configuration.

Large loads should be split into smaller banks. These banks shall be controlled either via a thyristor step controller or a combination of step control and thyristor controlled banks. The staging shall be selected according to the process and turndown condition. Based on the process and electrical data provided in the Requisition, the Manufacturer shall propose a suitable mode of control in the quotation.

Parallel thyristors should not be applied. If parallel operation is necessary, current balancing shall be applied.

Thyristor protection shall include over-current protection by means of ultra rapid fuses and voltage transient suppressers. Where deemed necessary by the Manufacturer, di/dt limiting reactors and dv/dt protection networks shall be provided.

The input signal to the control circuit (provided by others) shall be a 4 to 20 mA d.c. signal with a linear relationship from 0 to 100 % power. The maximum allowable output impedance of this equipment shall be 500 Ω . The input signal shall be galvanically separated from the driver unit and its power supply.

If specified by the Principal the input signal will be digital via e.g. Profibus, Fieldbus or Modbus communication links. In this case the Principal shall provide a detailed specification in the quotation stage.

The Manufacturer shall provide a system to prevent problems during start-up and when flow rates are low, e.g. on fuel gas heaters with large turn down ratios.

Over-temperature protection with pre-alarm shall be provided and trip signals shall be either connected directly to the power and control assembly's main contactor in simple installations or via an instrument interface, as specified in the Requisition.

Over-voltage protection shall be provided to avoid damage to any analogue instruments from faults in the thyristor trigger circuit.

Manual/auto selection for output control shall be provided to allow control of the power output via a potentiometer in the manual position. A ramp unit shall prevent the heater being switched directly to full load. This potentiometer and associated switch shall be designed to be tamper proof.

The Power and Control Assembly shall have a compartmented enclosure, separating the incoming supply, the thyristors and the measurement and control systems. The enclosure shall be designed so as to provide a high degree of safety for personnel in case of an internal fault. Further details in (4.2.3).

2.2 MAXIMUM ALLOWABLE HEAT FLUX

The process heater shall be designed for a heat flux as indicated below, unless otherwise specified in the Requisition (form DEP 31.21.00.93-Gen.):

Medium	Maximum heat flux (W/cm ²)
Water	5.0 – 7.0
Hydrocarbons	1.7 – 2.2
Gases/vapours	1.5 – 2.0

The medium and the maximum allowable heat flux shall be specified by the Purchaser on the process data sheet. The Manufacturer shall confirm the heat flux of the heater under normal operating conditions and the maximum design heat flux.

2.3 MAINS ELECTRICITY SUPPLY

The heater shall be capable of operation within the nominal voltage and frequency as indicated in the Requisition.

During normal system operation and under steady-state conditions, the voltage at the Point of Coupling (PC) will not deviate from nominal voltage by more than 5 % and the system frequency will not deviate from the nominal frequency by more than 2 %.

The AC power supply to the heater will be symmetrical and sinusoidal, although the voltage at the PC may be subject to transients resulting in short term voltage excursions between 80 % and 110 % of nominal, and to voltage interruptions during system short circuits. Transient high frequency voltages of up to 2 kV may also be superimposed on the input voltage as a consequence of system switching operations. The Manufacturer shall include in his quotation special measures, if any, that he considers to be required to avoid failures due to these transient overvoltages.

Harmonic voltage distortion levels shall be as stated in IEC TR 61000-3-6.

For equipment installed in existing installations compatibility levels as stated in Table 1 of IEC TR 61000-3-6 shall be applied. The Total Harmonic Distortion (THD) shall not exceed 8 %.

For equipment to be installed in new projects, planning levels as stated in Table 2 of IEC TR 61000-3-6 shall be applied. The Total Harmonic Distortion (THD) shall not exceed 6.5 %.

The Requisition shall indicate which of the two options is applicable.

The above is applicable for voltages up to 35 kV.

NOTE: IEC TR 61000-3-6 uses the term MV for voltages up to 35 kV.

The neutral of the supply system shall be assumed to be solidly earthed, unless otherwise stated in the Requisition.

The Principal shall advise characteristics of the power supply in the quotation if these are different from what is stated above.

NOTE: This may be applicable for installations on e.g. fixed or mobile offshore facilities.

2.4 SHORT CIRCUIT RATING

The Requisition states the maximum prospective short circuit current at the Point of Coupling of the heater (PC).