

DEP SPECIFICATION

**ELECTRICAL PROCESS HEATERS FOR NORTH
AMERICAN APPLICATION**

DEP 33.68.30.35-Gen.

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DESIGN AND ENGINEERING PRACTICE



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TABLE OF CONTENTS

1.	INTRODUCTION	4
1.1	SCOPE.....	4
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	4
1.3	DEFINITIONS	4
1.4	CROSS-REFERENCES	5
1.5	SUMMARY OF MAIN CHANGES.....	5
1.6	COMMENTS ON THIS DEP	5
1.7	DUAL UNITS.....	6
1.8	NON NORMATIVE TEXT (COMMENTARY).....	6
1.9	LOW POWER HEATERS	6
1.10	REQUISITION/DATA SHEETS.....	6
2.	GENERAL REQUIREMENTS	7
2.1	GENERAL	7
2.2	POWER CONTROL.....	7
2.3	MAXIMUM ALLOWABLE HEAT FLUX.....	8
2.4	MAIN ELECTRICAL SUPPLY.....	9
2.5	SERVICE CONDITIONS.....	9
3.	PERFORMANCE REQUIREMENTS.....	10
3.1	RATING.....	10
3.2	NOISE LIMITS	10
3.3	RELIABILITY AND AVAILABILITY	10
4.	CONSTRUCTION REQUIREMENTS.....	11
4.1	GENERAL	11
4.2	PROCESS HEATER.....	11
4.3	POWER AND CONTROL ASSEMBLY.....	13
4.4	POWER TRANSFORMER.....	18
4.5	NAMEPLATES.....	18
4.6	ACCESSORIES	18
4.7	SPARE PARTS	18
5.	MEASUREMENT, PROTECTION AND CONTROL EQUIPMENT.....	19
5.1	GENERAL	19
5.2	MEASUREMENT	19
5.3	PROTECTION AND ALARMS.....	19
6.	INSPECTION AND TESTING.....	20
6.1	GENERAL	20
6.2	QUALITY ASSURANCE	20
6.3	FACTORY ACCEPTANCE TESTS	21
6.4	SITE ACCEPTANCE TESTING.....	22
7.	DOCUMENTATION	22
7.1	GENERAL	22
7.2	DRAWING AND DATA REQUIREMENTS	23
8.	PREPARATION FOR SHIPMENT.....	24
9.	REFERENCES	25

APPENDICES

APPENDIX A	SUPPLY CONFIGURATIONS	26
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1. INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for the design, material selection, construction, installation and testing of electrical process heaters and associated thyristor power controllers. It is applicable to electrical process heaters that are supplied by a three phase LV system.

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

This DEP is intended for North American application.

1.2 DISTRIBUTION, INTENDED USE 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. Any authorised access to DEPs does not for that reason constitute an authorisation to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall 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 could 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 with regards to the 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 of a facility. The Principal may undertake all or part of the duties of the Contractor.

NOTE: The Contractor may also be referred to as Purchaser or Buyer.

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

NOTE: In this DEP, the term **Vendor** shall be understood to mean the Manufacturer/Supplier.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Term	Definition
availability	$\frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}}$

Term	Definition
bite coupling	Hydraulic fitting used for the mechanical fixing of a metal sheathed electric heating element to a tube sheet.
burst firing control	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
CSA	Canadian Standards Association
driver unit	Control device providing the input to the thyristor circuit incorporating soft start and auto/manual control
HTRI	Heat Transfer Research, Inc.
mean time between failure (MTBF) (hours)	$\frac{\text{operating time}}{\text{number of faults that have resulted in outages}}$
mean time to repair (MTTR) (hours)	$\frac{\text{total time spent on repairs and restoration to service}}{\text{number of faults that have resulted in outages}}$
point of coupling (PC)	Point in the electrical network at which the heater is connected to that network The PC is normally at the incoming terminals of the power and control assembly. If a unit transformer is installed, the PC is at the primary terminals of the transformer
single cycling control (cycle syncope)	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	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 or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (9).

1.5 SUMMARY OF MAIN CHANGES

This is a new DEP.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
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DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://www.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (Other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

1.9 LOW POWER HEATERS

For low power, thyristor-controlled, resistance heaters, less stringent requirements than those specified in this DEP may be applied. This is applicable for 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.

The clauses in this DEP where less stringent requirements may be applied to low power heaters are identified with a bullet (●) in the margin of the DEP.

1.10 REQUISITION/DATA SHEETS

The following Requisition/Data Sheets are intended to be used with this DEP:

- DEP 33.68.30.96-Gen. gives the specific electrical requirements.
- DEP 31.21.00.93-Gen. gives the specific mechanical/process requirements.

2. GENERAL REQUIREMENTS

2.1 GENERAL

This DEP is applicable to electrical process heaters that are supplied by a three phase LV system.

1. Each component of the process heater assembly shall be suitably rated for the climatic conditions specified in the electrical Data Sheet.
2. Unless otherwise specified on the electrical Data Sheet, the power and control assembly shall be located indoors, in a climate controlled substation, and the process heaters shall be located outdoors without shelter.
3. The process heaters shall be suitable for use in a saliferous, sulphurous, and dusty atmospheres. Condensation and solar radiation shall be taken into account.
4. Equipment to be installed in hazardous (classified) locations shall be certified by a Nationally Recognized Testing Authority as suitably rated with respect to the class, division or zone, group, and temperature rating as indicated on the electrical Data Sheet.
5. The Manufacturer shall provide a system that prevents problems during start-up when flow rates are low, e.g., on fuel gas heaters with large turn down ratios.
6. Equipment on mobile and fixed offshore facilities shall not be affected by vibration and shock as defined in API RP 14F.
 - a. Additional requirements may be required by the Classification Society and these will be stated in the Requisition.
 - b. Where testing of immunity against vibration and shock is required, this will be stated in the Requisition.

2.2 POWER CONTROL

1. 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 utilized) with a controlled output power range down to 3 % (single cycle control).
2. Burst firing control may be used when specified on the electrical Data Sheet.
 - a. For large loads attached to relatively weak supply systems that are susceptible to electrical disturbances, single cycling control should be used.
 - b. The load should be configured in either four-wire star or delta, with three-leg control using thyristor pairs adapted for the star configuration and two-leg control for the delta configuration.
3. Large loads shall be split into smaller banks, i.e. <400kW banks.
 - a. The smaller banks shall be controlled either via a thyristor step controller or a combination of step control and thyristor controlled banks.
 - b. The staging shall be selected according to the process and turndown condition.
 - c. Based on the mechanical/process and electrical data provided on the Data Sheets, the Manufacturer shall propose a suitable mode of control in the quotation.
4. Unless otherwise specified on the electrical Data Sheet, parallel thyristors shall not be applied. If parallel operation is necessary, current balancing shall be applied.

2.3 MAXIMUM ALLOWABLE HEAT FLUX

1. The maximum allowable average heat flux for electric process heaters shall not exceed the values indicated in Table 1. For fluids not listed in Table 1, the Principal shall be consulted.

Design heat fluxes may be required to be less than the maximum values specified in Table 1 in order to comply with the specified maximum fluid exposure temperature or maximum sheath temperature requirements.

2. The maximum fluid exposure temperature shall be specified by the Principal.
3. The maximum allowable sheath temperature is primarily a function of the sheath material, and may be specified by the Principal or otherwise recommended by the Manufacturer.
4. The Manufacturer shall provide the calculated average design heat flux, maximum local fluid exposure temperature and maximum local sheath temperature in the proposal,
5. Supporting calculations for item 4, above shall be provided after purchase order award.
6. The maximum heat flux shall cause no deterioration of the heated fluid (e.g., no coking, cracking or similar).

Table 1 Maximum watt density for electric heaters

Fluid	Maximum allowable watt density (W/cm ²)	Maximum allowable watt density (W/in ²)
Water		
Potable	9.3	60
Deionized	9.3	60
Demineralized	9.3	60
Process	7.4	48
Steam		
Maximum Operating Temp. Less than 150 °C (300 °F)	2.0	13
Maximum Operating Temp. > 150° but < 370°C (> 300 °F but < 700 °F)	1.6	10
Maximum Operating Temp. above 370°C (700 °F)	0.9	6
Fuel Oils		
Grades 1 and 2	3.6	23
Grades 4 and 5	2.0	13
Grade 6 and Bunker C	1.2	8
Lubricating Oils		
SAE 10	3.6	23
SAE 20	3.6	23
SAE 30	3.6	23
SAE 40	2.0	13
SAE 50	2.0	13