

## DEP SPECIFICATION

# PRINTED CIRCUIT HEAT EXCHANGERS – DESIGN AND FABRICATION

DEP 31.21.01.33-Gen.

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(DEP Circular 44/11 has been incorporated)

ECCN EAR99

## DESIGN AND ENGINEERING PRACTICE

### DEM1



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## 1. INTRODUCTION

### 1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design and fabrication of printed circuit heat exchangers (PCHes).

Selection and application of PCHes is covered by DEP 31.21.01.11-Gen.

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual DEM 1 – Application of Technical Standards

This is a revision of the DEP of the same number dated January 2005; see (1.5) regarding the changes.

### 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.

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 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 with regard 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

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.

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 lower-case word **shall** indicates a requirement.

The capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

### 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 by this DEP are listed in (12).

### 1.5 SUMMARY OF CHANGES

The previous edition of this DEP was dated January 2010. The changes made in this revision have been the separation of the DEP into this DEP-Specification and a companion

DEP-Informative, as well as some updates. As this revision was a major overhaul it is impractical to summarise all of the changes here.

#### 1.6 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the Administrator at [standards@shell.com](mailto:standards@shell.com), using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of “DEPs on the Web”, available through the Global Technical Standards web portal <http://www.shell.com/standards> and on the main page of the DEPs DVD-ROM.

#### 1.7 DUAL UNITS

**Amended per  
Circular 44/11**

**Dual units have been incorporated throughout this DEP.**

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.

## **2. GENERAL INFORMATION**

### **2.1 DOCUMENT HIERARCHY AND SUBMITTALS**

#### **2.1.1 Hierarchy**

In case of conflict between documents relating to an order, the following hierarchy shall apply:

1. the Purchase Order
2. this DEP

#### **2.1.2 Document submittals**

See Appendix A.

### **2.2 PRESSURE VESSEL CODE**

Printed circuit heat exchangers SHALL [PS] be considered to be pressure vessels.

Unless otherwise specified by the Principal, the pressure vessel code shall be ASME VIII, Division 1, as amended/supplemented by DEP 31.22.20.31-Gen.

### **2.3 CERTIFYING AUTHORITY**

The Manufacturer shall seek confirmation from the Contractor whether the design and construction of the PCHE are subject to the approval of an Independent Certifying Authority, and if required the Manufacturer shall be responsible for obtaining the necessary design approvals and meeting the inspection requirements.

### **2.4 SCOPE OF SUPPLY**

Unless otherwise specified, the scope of supply shall be as specified on the data/requisition sheets.

The Contractor shall assure that all features necessary for reliable and safe operation will be provided. These should include, where applicable, adequate means of control to maintain mechanical and operational integrity throughout the specified variations in operating conditions.

With regard to safety and reliability, unspecified but self-evident conditions may occur during start-up, shut-down, power failure or interruption of the process flow. These conditions shall be reflected in the Principal's PCHE data sheets and supporting specifications and SHALL [PS] be taken into account and satisfied by the Contractor and Manufacturer. Fatigue analyses shall be performed as needed to confirm design adequacy.

### **2.5 UNITS OF MEASUREMENT**

The SI unit system has been applied in this DEP but, where considered necessary, the metric sizes are followed by their imperial equivalents in brackets.

All pressure references shall indicate either an absolute pressure or gauge pressure basis. The unit of pressure should be qualified as bar (abs) or bar (ga), whichever is applicable.

### **2.6 EQUIPMENT NUMBERING**

Heat transfer equipment shall be identified by a specific equipment number in accordance with DEP 31.10.03.10-Gen.

### 3. THERMAL AND HYDRAULIC DESIGN

#### 3.1 INFORMATION REQUIRED FROM CONTRACTOR

The Contractor shall specify the heat transfer duty, allowable pressure drop, flow rates, terminal bulk temperatures, inlet pressures, stream compositions and physical properties of the fluids passing through the heat exchanger.

The Manufacturer shall be responsible for acquiring all the design requirements on the data sheets from the Contractor.

The design shall satisfy all operating cases and design conditions specified by the Contractor on the data sheets and supporting specifications.

#### 3.2 PRESSURE DROP

For potentially fouling fluid streams, as specified by the Principal, the pressure drop for the clean printed circuit heat exchanger shall be less than 90 % of the allowable.

In calculating the pressure drop, losses shall include all those occurring in nozzles, header tanks, bends, fittings, manifolds, distribution and thermal sections.

For two-phase streams, the pressure drop shall include frictional, static head, acceleration, and momentum recovery components.

The Contractor shall verify strainer requirements with the Principal. If a strainer is specified, the Contractor shall integrally assess the design of the heat exchanger, strainer and intermediate piping to optimize the overall design. The pressure drop for the strainer is additional to the stated printed circuit heat exchanger allowable pressure drop and usually the strainer is not provided by the heat exchanger Manufacturer.

#### 3.3 INFORMATION SUPPLIED BY THE MANUFACTURER

The Manufacturer shall provide completed data/requisition sheets and outline drawings for the Principal's review. This shall include sufficient information for the Principal to assess the thermal and hydraulic performance and mechanical integrity of the unit.

The Manufacturer SHALL [PS] indicate any operation limitations in the operations manual, e.g. maximum number of thermal cycles the PCHE could sustain basis the results of a fatigue analysis.

#### 3.4 OPTIMISATION OF PLATE GEOMETRY

Within the mechanical, thermal and hydraulic constraints detailed in the requisition, the manufacturer shall optimise the design of the printed circuit heat exchanger by selecting suitable geometry to balance the following objectives:

- minimise cost of heat exchanger;
- minimise size and weight of heat exchanger.

#### 3.5 THERMOSYPHON REBOILER

For thermosyphon reboilers, the Manufacturer shall verify that the calculated flow circulation for the applicable system flow loop (e.g. piping configuration, equivalent piping lengths, installation of pressure reducing valve in reboiler inlet piping ) are consistent with the data/requisition sheet requirements. The Contractor shall confirm that suitable control provisions are provided to ensure reliable operation for all specified operating conditions. The Manufacturer shall inform the Principal or Contractor of any conflicts and resolve accordingly.

For vaporizing streams provided by thermosyphon action the effective mean temperature difference shall consider the effect of boiling point elevation due to the liquid static head.

The Contractor should ensure that thermosyphon reboiler outlet piping is routed vertically from the reboiler to the column with only one 90° elbow and one horizontal part