

DEP SPECIFICATION

HEAT EXCHANGERS FOR PACKAGED EQUIPMENT – DESIGN AND FABRICATION

DEP 31.21.01.36-Gen.

February 2012

(Amendment A01 has been incorporated – February 2013)

ECCN EAR99

DESIGN AND ENGINEERING PRACTICE



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All administrative queries should be directed to the DEP Administrator in Shell GSI.

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1. INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for the design and fabrication of heat exchangers provided as part of packaged equipment. This may include heat exchangers provided as part of a licensed modular or skid-built process package (e.g., Air Separation Unit or Glycol Dehydration Unit), when specified by the Principal, as well as exchangers supplied as ancillary services on OEM packages (e.g., lubricating oil coolers supplied on gas compressor packages).

This DEP may also be applied to heat exchangers in general process services with limited design life when specified by the Principal. It is not intended to be applied to process heat exchangers except for non-critical services of limited design life.

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 authorization 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.

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 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 Abbreviations

Term	Definition
OEM	Original Equipment Manufacturer

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 (6).

1.5 SUMMARY OF CHANGES

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Section	Change
1.6	Updated DEP feedback process.
2.9	Reference to pressure vessel DEPs have been updated to the new pressure vessel DEP 31.22.00.31-Gen.
4.2.1.5	Reference to pressure vessel DEPs have been updated to the new pressure vessel DEP 31.22.00.31-Gen.
4.3.1.6	Reference to pressure vessel DEPs have been updated to the new pressure vessel DEP 31.22.00.31-Gen.
6.	Reference to pressure vessel DEPs have been updated to the new pressure vessel DEP 31.22.00.31-Gen.
6.	Added DEP feedback form - DEP 00.00.05.80-Gen.

1.6 COMMENTS ON THIS DEP

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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.
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.

2. GENERAL REQUIREMENTS

- 2.1 Unless a specific type of heat exchanger is specified for service by the Contractor, the Manufacturer/Supplier shall select the heat exchanger type with due regard to cost, operation, reliability, maintainability, plot space and weight.
- 2.2 The use of heat exchanger types other than shell-and-tube or air-cooled shall be approved by the Principal.
- 2.3 Gasketed or welded/semi-welded plate exchangers may be provided for utility (non-process) services when approved by the Contractor and if the Manufacturer/Supplier can demonstrate successful previous operation in similar service. Gasketed or welded/semi-welded plate heat exchangers are often preferred for water services, particularly for off-shore applications.
- 2.4 When provided for utility services, gasketed and welded/semi-welded plate exchangers may be provided in accordance with the Manufacturer/Supplier's standard design, to meet the intended service requirements. Sufficient design details shall be provided to the Contractor in order to ensure a fit-for-purpose design.
- 2.5 Gasketed or welded plate exchangers for process service shall only be used with the approval of the Principal. When used in process services they shall comply with DEP 31.21.01.32-Gen. or 31.21.01.13-Gen. as applicable.
- 2.6 The Manufacturer/Supplier shall indicate any exchangers subject to hydrogen service on the heat exchanger data sheet along with the hydrogen partial pressure. Hydrogen service is defined as any service in which the hydrogen partial pressure is greater than 700 kPa absolute (100 psia) at any temperature.
- 2.7 The Manufacturer/Supplier shall indicate any exchangers subject to very toxic service on the heat exchanger data sheet. Very toxic substances are those which are as specified in DEP 01.00.01.30-Gen.
- 2.8 Materials, fabrication, and testing of heat exchangers in sour or wet H₂S containing environments shall be in accordance with DEP 30.10.02.15-Gen. or DEP30.10.02.17-Gen., as may be applicable.

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- 2.9 Heat exchangers shall be considered as pressure vessels, and shall comply with the pressure vessel specification DEP 31.22.00.31-Gen. The applicable pressure vessel design code shall be specified by the Contractor.
- 2.10 The design pressure and temperature for both the hot and cold side circuits, as applicable, shall be determined in accordance with DEP 01.00.01.30-Gen. and shall be specified on the heat exchanger data sheet.
- 2.11 The design metal temperature of the bolting, including tie-rods and/or bolts for plate exchangers, shall be 100 % of the design temperature of the exchanger. Although flanges are not normally insulated, this allows insulation to be applied to the flanges at a later date without problems for most applications. Flanges in hydrogen service or in hydrocarbon services operating above their auto-ignition temperatures shall not be insulated. In addition, flanges in sour and/or wet H₂S service which utilize non-sour service bolting materials shall not be insulated.
- 2.12 The materials of construction for all parts of the heat exchanger shall be specified on the heat exchanger data sheet. Proposal documents and as-built data sheets shall include the complete ASME (or equivalent) specification designations.
- 2.13 All materials used for pressure retaining parts shall be traceable to the source of original manufacture, with all testing witnessed by a Manufacturer's representative who is independent of production, in accordance with the requirements of the applicable pressure vessel design code.
- 2.14 Dissimilar metal welds shall not be used for pressure boundary welds, unless approved by the Principal. Dissimilar metal welds shall not be used for pressure boundary welds of heat exchangers which are in hydrogen service.

- 2.15 For materials selection in hydrogen service, the maximum hydrogen partial pressure and maximum operating temperature shall be used as the basis for materials selection. This temperature and hydrogen partial pressure shall be at least 15 °C (27 °F) below and 170 kPa (25 psi) to the left of the applicable material curves of API RP 941, Figure 1.

3. THERMAL AND HYDRAULIC PERFORMANCE DESIGN

- 3.1 It is recognized that the Supplier may not be the Manufacturer of the heat exchanger. However, the Supplier shall be responsible for the thermal and hydraulic performance design and vibration analysis of the heat exchanger.
- 3.2 The thermal and hydraulic rating of the heat exchanger shall take into account all relevant environmental factors, particularly in the design of air cooled heat exchangers. Specific consideration shall be given to the mounting configuration and location with respect to adverse wind conditions and the possibility of unwanted hot air recirculation as well as the maximum and minimum expected ambient temperatures.
- 3.3 The supply pressure and temperature of available utility cooling streams (including cooling water) shall be specified by the Contractor.
- 3.4 The maximum and minimum ambient air temperatures to be considered in the design of air-cooled heat exchangers shall be specified by the Contractor.
- 3.5 Validation of thermal and hydraulic design of shell-and-tube heat and multi-tube hairpin exchangers shall be based on design methods which have been proven in practice. In this respect, the design procedures and computer programs published by Heat Transfer Research Inc.® (HTRI) or Aspen+®/UNISIM® (the former Heat Transfer and Fluid Flow Services (HTFS) software) shall be used. Discrepancies in the performance prediction results between different design methods shall be referred to the Principal's heat transfer specialist for resolution. The applicable versions of such computer programs used for thermal design shall be agreed upon between the Contractor and the Principal during the initial stage of the project. In the case of a proprietary design, the calculation method and the degree of responsibility shall be agreed between the Manufacturer/Supplier and the Principal.
- 3.6 Fouling resistances for common packaged equipment fluids and utility streams shall be in accordance with Table 1.

Table 1 Fouling Resistances

Fluid	Fouling Resistance, m²-°C/W (hr-ft²-°F/Btu)
Steam	0.00009 (0.0005)
Boiler Feed Water / Steam Generation	0.00009 (0.0005)
Clean Sea Water (once-through)	0.00026 (0.0015)
Dirty Sea Water (once-through)	0.00034 (0.002)
Brackish Water (once-through)	0.00034 (0.002)
Dirty Brackish Water (once-through)	0.00052 (0.003)
Fresh Treated Water (once-through)	0.00026 (0.0015)
Non-Treated Fresh Water (once-through)	0.00034 (0.002)
Open recirculating cooling water system (cooling tower)	See Note 1
Closed loop recirculating cooling water system (high quality treated tempered water cooling systems)	0.00018 (0.001)
Fluid	Fouling Resistance, m²-°C/W (hr-ft²-°F/Btu)
Closed loop recirculating glycol (in water) utility cooling streams	0.00026 (0.0015)
Lube and Seal Oils	0.00018 (0.001)
Jacket Coolant	0.00009 (0.0005)
Heat Transfer Fluids (Note 2)	0.00034 (0.002)

NOTE 1: For tube side velocities ≥ 1.8 m/s (6 ft/s) a fouling resistance of 0.00026 m²-°C/W (0.0015 hr-ft²-°F/Btu) shall be used. For tube side velocities < 1.8 m/s (6 ft/s) a fouling resistance of 0.00034 m²-°C/W (0.002 hr-ft²-°F/Btu) shall be used. When high-alloy and non-ferrous alloy tubes are used with tube side water allocation, these fouling resistances may be multiplied by a factor of 0.8.

NOTE 2: Heat transfer fluids (HTF) refer to specific hydrocarbon-based fluids that are available on the open market for use in heat transfer applications. Generally, this includes synthetic aromatic, silicone-based and a limited selection of specific HTF designated mineral oils. Glycol in water based heat transfer fluids used as utility cooling streams are indicated separately.

- 3.7 Fouling resistances for streams not shown shall be selected by the Manufacturer/Supplier based on previous experience, and shall be subject to the approval of the Contractor.
- 3.8 When plate type heat exchangers are used, a fouling margin in lieu of fouling resistance shall be applied in accordance with DEP 31.21.01.32-Gen. or DEP 31.21.01.13-Gen. as applicable.
- 3.9 For the purposes of hydraulic circuit design, the estimated fouled heat exchanger pressure drops shall be used. In order to estimate the fouled pressure drop, the calculated clean pressure drops through heat exchangers shall be increased by the margin specified in Table 2 to account for exchanger fouling.