

DEP SPECIFICATION

BRAZED ALUMINIUM PLATE-FIN HEAT EXCHANGERS (AMENDMENTS/SUPPLEMENTS TO ISO 15547-2:2005)

DEP 31.21.01.34-Gen.

February 2017

ECCN EAR99

DESIGN AND ENGINEERING PRACTICE

DEM1



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PART I INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design and fabrication of vacuum brazed aluminium plate-fin heat exchangers for use in services that are not very toxic.

Part IV of this DEP provides amendments and supplements to ISO 15547-2:2005. For ease of reference, the clause numbering of ISO 15547-2 has been used throughout Part IV of this DEP. Clauses of ISO 15547-2 that are not mentioned remain valid as written.

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 February 2013; 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. 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 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 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.

NOTE: In ISO 15547, the term **Vendor** is used. 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 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.

NOTE: In ISO 15547, the term **Purchaser** is used. In this DEP, the term **Purchaser** shall be understood to mean 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.

The word **may** indicates a permitted option.

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 (Part V).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated February 2013. The following are the main non-editorial changes:

Section/Clause	Change
All	Restructured and clarified requirements, enforced use of shall/should/may for normative statements.

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.
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.

PART II GENERAL

1.1 DESIGN RULES

1. The design, engineering and fabrication of vacuum brazed aluminium plate-fin heat exchangers shall be based on this DEP.
2. In the event of conflict between documents relating to an order, the following hierarchy shall apply:
 - a. the purchase order;
 - b. this DEP;
 - c. ISO 15547-2.
3. In the event of any conflict regarding the design rules, the Principal shall be consulted.

1.2 DOCUMENT SUBMITTALS

See (Part IV, Annex C).

1.3 SCOPE OF SUPPLY

1. The scope of supply shall be as specified on the data/requisition sheets.
2. The Manufacturer shall include all special features necessary for reliable and safe operation.

Special features include, where applicable, adequate means of control, as specified by the Principal, to cope with the specified variations in operating conditions.

Atypical and/or transient conditions during start-up, shutdown, power failure or interruption of the process flow could have an impact on the reliable and safe operation of the plate-fin heat exchanger"
3. Contractor SHALL [PS] specify on the Principal's data sheets any atypical and/or transient conditions that could occur during start-up, shutdown, power failure or interruption of the process flow on the Principal's data sheets.

1.4 UNITS OF MEASUREMENT

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

1. Use of absolute pressure or gauge pressure shall be clearly identified on documentation.
2. The unit of pressure should be qualified as bar (abs) or bar (ga), whichever is applicable.

1.5 EQUIPMENT NUMBERING

1. Plate-fin heat exchangers shall be identified by a specific equipment number in accordance with DEP 01.00.09.10-Gen.

1.6 GENERAL PLATE-FIN HEAT EXCHANGER INFORMATION

Background information on thermal design of plate-fin heat exchangers can be derived from the standards of the brazed aluminium plate-fin heat exchanger manufacturer's association (ALPEMA) at <http://www.alpema.org>.

PART III BASIC REQUIREMENTS

1 THERMAL AND HYDRAULIC DESIGN

1.1 SCOPE

1. The Manufacturer shall be responsible for the performance design of the heat exchanger.
2. Manufacturer's fin data sheets shall include F and J factors for all fin types proposed by the Manufacturer,
 - a. Refer to clause (Part IV, 4.7) for fin selection.

1.2 INFORMATION REQUIRED FROM THE PRINCIPAL

1. The Manufacturer shall be responsible for acquiring all the design requirements on the data sheets from the Principal.
2. The design shall satisfy all operating cases and design conditions specified by the Principal on the data sheets and supporting specifications.

1.3 PRESSURE DROP

1. For potentially fouling systems, as advised by the Principal, the pressure drop for the clean plate-fin heat exchanger shall be restricted to 90% of the specified maximum allowable value.
2. In calculating the pressure drop, losses shall include all those occurring in nozzles, headers, bends, fittings, manifolds, distribution and thermal sections.
3. For two-phase streams, the pressure drop shall include frictional, static head and acceleration components.
4. The Contractor shall verify strainer requirements with the Principal.
 - a. 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 with respect to plot layout and cost.

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.

1.4 INFORMATION SUPPLIED BY THE MANUFACTURER

1. The Manufacturer shall provide completed data/requisition sheets and outline drawings for the Principal's review.
 - a. Data/requisition sheets and outline drawings shall include sufficient information for the Principal to assess the thermal and hydraulic performance and mechanical integrity of the unit.
2. The Manufacturer SHALL [PS] indicate any start-up or shutdown operation limitations in the operations manual.

Examples include temperature, pressure, and flow transients, including in and out of phase transients amongst multiple streams.
3. Maximum permissible temperature gradient per minute and hour shall be specified by the Manufacturer.
4. The maximum allowable pressure transient/pulse shall be provided by the Manufacturer, along with guidelines on maximum permissible combinations of pressure pulsations and frequency.

1.5 OPTIMISATION OF PLATE-FIN HEAT EXCHANGER GEOMETRY

1. The Manufacturer shall optimise the design of the plate-fin heat exchanger by selecting suitable geometry to balance the following objectives:
 - a. minimise cost;
 - b. minimise size and weight.
2. Plate-fin heat exchanger distribution fins shall be of an industry proven design to minimize maldistribution.
3. The effective heat transfer surface area of a passage shall exclude:
 - a. the portion in its own distributor section;
 - b. heat transfer surface which is opposite the distributor finning of primary counter-flow streams.
4. The design of the plate-fin heat exchanger shall account for:
 - a. the effects of longitudinal conduction;
 - b. actual stacking plan;
 - c. the effects of heat transferred by conduction between non-adjacent layers;
 - d. minimizing flow maldistribution across the width of each passage and amongst the numerous passages of individual streams.
5. Flow maldistribution shall not exceed $\pm 5\%$ of the average flow rate per passage without the approval of the Principal.

1.6 THERMOSYPHON REBOILER

1. For thermosyphon reboilers, the Manufacturer shall verify that the calculated flow circulation for the applicable system flow loop (e.g., piping configuration, equivalent lengths) is in accordance with the data/requisition sheet requirements.
2. The Manufacturer shall inform the Contractor of any conflicts per verification (1.6 item 1)
3. The Contractor shall ensure that the conflicts per verification (1.6 item1) are resolved.
4. The Manufacturer shall confirm that control provisions be installed to provide reliable operation for all communicated design operating conditions.
5. For vaporizing streams provided by thermosyphon action, including submerged plate-fin heat exchangers in a vessel, the effective mean temperature difference shall account for the effect of boiling point elevation due to the liquid static head.
6. The Contractor should ensure that thermosiphon reboiler outlet piping is routed vertically from the reboiler to the column with only one 90° elbow and one horizontal part

1.7 STRAINER

1. The Contractor shall ensure that the plate-fin heat exchanger is equipped with a strainer during commissioning/start-up that meets the Manufacturers requirements.
2. Maximum strainer size shall be 177 μm (80 Tyler mesh).
 - a. Use of Strainer sizes higher than 177 μm (80 Tyler mesh) will be subject to approval by the Principal.
3. The Contractor shall verify the requirements with the Principal concerning removal timing and procedures for temporary start-up strainers.

4. The Contractor shall ensure that permanent strainers are provided to remove particles that exceed 30% of the nominal fin height and fin gap.
5. If serrated fins are utilized, the fin gap shall be taken as 50% of the actual fin gap.
6. The Contractor shall obtain Principal's approval for all instances where there is no foreseen strainer requirement for an applicable stream.

1.8 TWO-PHASE FLOW INLET DISTRIBUTORS

1. The design of the separator vessel shall be included in the scope of the Manufacturer.
2. The design of alternative two-phase flow distributors shall be subject to approval by the Principal.
3. The Manufacturer shall also guarantee the performance of the distribution system at 50% turndown from the normal flow rates for all operating cases unless a higher turndown requirement has been specified.
4. The Manufacturer shall obtain Principal's approval for the following:
 - a. the final design layout of the separator vessel;
 - b. the liquid static head to be used for the design.
5. The Manufacturer shall ensure that the design of the distributor section provides less than 10% flow maldistribution of either fluid phase amongst the plate fin heat exchanger channels over the full range of turndown.

1.9 DESIGN MARGINS

1. A minimum of 10% excess surface area shall be provided in addition to the heat transfer surface area required to satisfy the specified thermal duty requirements using the clean overall heat transfer coefficient, unless any specified fouling margin already accounts for more than 10% of the total heat transfer resistance

2 MECHANICAL DESIGN

2.1 GENERAL

1. If a number of operating cases and design conditions are specified, the Manufacturer shall select the most stringent case (e.g., pressure drop, temperature) so that all design conditions are met.
2. In addition to the steady state design operating condition(s), the mechanical design SHALL [PS] satisfy all operating conditions, including transient conditions.

Transient conditions could impose significant stresses on the plate-fin heat exchanger.
3. In case a Mercury Resistant design has been specified by the Principal, the Manufacturer shall take into account the following:
 - a. effects of aluminium metallurgy;
 - b. mechanical details of plate-fin heat exchanger drainability.
4. In case 5000-series aluminium alloys are used, the Manufacturer SHALL [PS] include a proven method of heat treatment to eliminate grain boundary precipitation and prevent sensitization to mercury induced cracking.