

DEP SPECIFICATION

WELDED PLATE-BLOC HEAT EXCHANGERS – APPLICATION, DESIGN AND FABRICATION

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DESIGN AND ENGINEERING PRACTICE



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TABLE OF CONTENTS

PART I	INTRODUCTION	6
1.1	SCOPE.....	6
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	6
1.3	DEFINITIONS	6
1.4	CROSS-REFERENCES	7
1.5	SUMMARY OF CHANGES.....	7
1.6	COMMENTS ON THIS DEP	8
1.7	DUAL UNITS.....	9
1.8	NON NORMATIVE TEXT (COMMENTARY).....	9
PART II	SELECTION AND APPLICATION	10
1.	THERMAL AND HYDRAULIC DESIGN CONSIDERATIONS.....	10
1.1	SCOPE.....	10
1.2	TEMPERATURE AND PRESSURE LIMITATIONS.....	10
1.3	SIZE LIMITATIONS	10
1.4	FLOW RATE	10
1.5	MINIMUM TEMPERATURE APPROACH	10
1.6	MAXIMUM TEMPERATURE DIFFERENTIAL.....	10
1.7	THERMAL FATIGUE	10
1.8	PERFORMANCE MONITORING.....	11
1.9	CORROSION	11
1.10	PARTICULATES.....	11
1.11	FOULING	11
1.12	FLUID VELOCITIES	12
1.13	DEPRESSURISATION	12
2.	MECHANICAL DESIGN CONSIDERATIONS	12
2.1	GENERAL	12
2.2	DESIGN PRESSURE AND TEMPERATURE	12
2.3	PRESSURE AND THERMAL CYCLING	12
2.4	STRUCTURAL INTEGRITY.....	12
2.5	VENTS AND DRAINS.....	13
2.6	INTERSTREAM LEAKAGE	13
PART III	DESIGN AND FABRICATION.....	14
1.	GENERAL.....	14
1.1	DOCUMENT HIERARCHY AND SUBMITTALS.....	14
1.2	PRESSURE VESSEL CODE.....	15
1.3	CERTIFYING AUTHORITY	16
1.4	SCOPE OF SUPPLY	16
1.5	EQUIPMENT NUMBERING.....	16
2.	THERMAL AND HYDRAULIC DESIGN	16
2.1	INFORMATION REQUIRED FROM CONTRACTOR.....	16
2.2	PRESSURE DROP	16
2.3	INFORMATION SUPPLIED BY THE MANUFACTURER	17
2.4	OPTIMISATION OF PLATE GEOMETRY	17
2.5	THERMOSYPHON REBOILER.....	17
2.6	FOULING MARGIN.....	17
2.7	STRAINER.....	19
2.8	TWO-PHASE FLOW INLET DISTRIBUTORS.....	19
3.	MECHANICAL DESIGN	19
3.1	GENERAL	19
3.2	DESIGN PRESSURE AND TEMPERATURE	19
3.3	DESIGN CONDITIONS AND CALCULATIONS	20
3.4	CORROSION ALLOWANCE	20
3.5	LOAD CASES	20
3.6	ALLOWABLE STRESSES.....	20

3.7	PLATES IN THE PLATE PACK	21
3.8	PANELS, GIRDERS AND LINING	21
3.9	UPPER AND LOWER HEADS	21
3.10	BAFFLES (OR PASS PARTITION PLATES)	21
3.11	BOLTS AND NUTS	22
3.12	CONNECTIONS	22
3.13	NOZZLE LOADS	23
3.14	SUPPORTS	23
3.15	EARTHING	23
3.16	INSULATION	23
3.17	VENTS AND DRAINS	23
3.18	THREADED CONNECTIONS	23
3.19	CLEANING CONNECTIONS	23
3.20	INSTRUMENT CONNECTIONS	24
3.21	SAFETY/RELIEF VALVE NOZZLE CONNECTIONS	24
3.22	LIFTING LUGS	24
3.23	DIMENSION AND TOLERANCES	24
3.24	SPARE AND REPLACEMENT PARTS	24
3.25	PANEL BOLT TIGHTENING	24
4.	MATERIALS OF CONSTRUCTION	24
4.1	GENERAL	24
4.2	MATERIALS SELECTION	25
4.3	NON-PRESSURE PARTS	25
4.4	GASKETS	25
4.5	NAMEPLATE	26
4.6	MATERIALS CERTIFICATION AND TRACEABILITY	26
5.	WELDING	26
5.1	GENERAL	26
5.2	PROCEDURE APPROVAL	26
5.3	PROCEDURES AND QUALIFICATIONS	26
5.4	WELD MAP	26
5.5	WELD PREPARATION	26
6.	NON-DESTRUCTIVE EXAMINATION	27
6.1	GENERAL	27
6.2	RADIOGRAPHY	27
6.3	ULTRASONIC EXAMINATION	27
6.4	MAGNETIC AND LIQUID PENETRANT EXAMINATION	27
6.5	OTHER NON-DESTRUCTIVE EXAMINATION	27
7.	INSPECTION	27
7.1	QUALITY CONTROL	27
7.2	MATERIALS INSPECTION	28
7.3	ASSEMBLY INSPECTION	28
7.4	WELD INSPECTION	28
7.5	DIMENSIONAL INSPECTION	28
7.6	NON-CONFORMANCES	28
8.	TESTING	29
8.1	LEAK TESTING	29
8.2	PRESSURE TESTING	29
9.	PREPARATION FOR SHIPMENT	30
9.1	PREPARATION	30
9.2	SURFACE FINISH	31
9.3	PACKING	31
9.4	MARKING	31
PART IV	REFERENCES	32

APPENDICES

APPENDIX A REQUISITIONING AND DOCUMENT SUBMITTALS 34

PART I INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the selection, application, design and fabrication of Welded Plate-Bloc Heat Exchangers (WPBHEs) with an integral welded core of alternating stream corrugated plate flow channels and removable cover panels on both stream sides. Other types of welded plate type heat exchangers are excluded.

Part II of this DEP addresses selection and application of welded plate-bloc heat exchangers.

Part III of this DEP addresses design and fabrication of welded plate-bloc heat exchangers.

This is a revision of the DEP of the same number dated February 2012, Amendment A01; 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 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 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

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 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 word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Abbreviations

Term	Definition
BPVC	Boiler and Pressure Vessel Code
ERW	Electric Resistance Welded
ICA	Independent Certifying Authority
ITP	Inspection and Test Plan
PEFS	Process Engineering Flow Schemes
PMI	Positive Material Identification
PTFE	Polytetrafluoroethylene
QA	Quality Assurance
UT	Ultrasonic Testing
WPBHE	Welded Plate-Bloc Heat Exchanger
NDE	Non-Destructive Examination

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 (Part IV).

1.5 SUMMARY OF CHANGES

This DEP is a minor revision of the DEP of the same number dated February 2012. The following are the main, non-editorial changes.

Section	Change
Part II, 1.2	Deleted last paragraph of clause.
Part II, 1.3.2	Added the following abbreviations: ERW, ICA, ITP, PEFS.
Part II, 1.5	Deleted last sentence of clause.
Part II, 1.8	Added reference to DEP 32.31.09.32-Gen.
Part II, 1.11	Revised the first paragraph.
Part II, 1.12	Added velocity head limits.
Part II, 2.1	Revised clause in its entirety.
Part II, 2.3	Deleted clause as the requirements are covered under Part III, 3.5.
Part II, 2.4	Deleted first sentence of clause.
Part II, 2.5	Revised the clause to specify helium leak test to be carried out first followed by pressure test. Deleted last sentence of clause.
Part II, 2.8	Deleted clause as the requirements are covered under Part III, 8.1 and 8.2.
Part III, 1.1.4	Added requirement for weight certificate at the end of the clause.
Part III, 2.1	Deleted last paragraph of clause as the requirement is covered under Part II, 2.1.
Part III, 2.2	Deleted last sentence of clause as the requirement is covered under Part III, 2.7.
Part III, 2.4	Added sub-clause c)

Section	Change
Part III, 2.6	Revised clause in its entirety. Revised shear stress and allowable pressure drop values in Table-2. Added shear stress equation under Note-5. Added pressure drop requirements after Table-2. Added reference to DEP 20.21.00.31-Gen.on bulk and wall temperature limits for cooling water service.
Part III, 2.7	Deleted second paragraph of clause as the requirement is covered under Part II, 1.10.
Part III, 3.1	Revised clause in its entirety.
Part III, 3.2	Deleted last paragraph of clause as the requirements are covered under Part II, 1.2, 1.7.
Part III, 3.4	Revised clause in its entirety.
Part III, 3.5	Deleted last paragraph of clause.
Part III, 3.8, Item 2	Added requirement for Manufacturer on NDE for lining connection.
Part III, 3.9	Revised clause to clarify requirement for corrugated end plates.
Part III, 3.10	Deleted first sentence of clause. Added new requirement in the last paragraph.
Part III, 3.12, Item 7, 8	Revised clause to clarify the lining and weld overlay requirements for nozzles in hydrogen and wet hydrogen sulphide service.
Part III, 3.13	Revised clause referring to Part II, 2.5.
Part III, 3.17	Revised first sentence of clause referring to clause 3.12.
Part III, 3.25	Added new clause on panel bolt tightening requirements.
Part III, 4.1, Item 1	Revised first sentence and deleted last sentence of the paragraph.
Part III, 4.4	Deleted reference to gasket brands. Revised clause to consult Principal for the list of approved gasket materials.
Part III, 4.5	Revised clause in its entirety.
Part III, 8.1	Revised the clause to specify helium leak test to be carried out first followed by pressure test.
Part III, 8.2	Added new requirement for seepage leak during pressure test.
Part III, 8.3	Deleted clause. Weight certificate requirement covered under Part III, 1.1.4

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.

PART II SELECTION AND APPLICATION

1. THERMAL AND HYDRAULIC DESIGN CONSIDERATIONS

1.1 SCOPE

1. The heat transfer and pressure drop correlations and methods required for a satisfactory thermal and hydraulic design shall reside with the Manufacturer.

1.2 TEMPERATURE AND PRESSURE LIMITATIONS

1. The Manufacturer should be consulted at an early stage of the process design to determine the highest pressure and temperature that is feasible for the applicable welded plate-bloc heat exchanger (WPBHE(s)).

The maximum design pressure and temperature that can be accommodated in a WPBHE can vary and is dependent on the Manufacturer specific design configuration.

2. A minimum differential pressure of 1 barg (15 psig) should be maintained between the operating pressures of each stream to prevent pressure inversion/fluctuations which may create fatigue and damage the plate-pack and cause leaks between the plates.

1.3 SIZE LIMITATIONS

1. The Manufacturer should be consulted at an early stage of the process design to determine the largest size and highest heat transfer area that can be accommodated in a single heat exchanger.

1.4 FLOW RATE

1. Cold circuit flow stoppage which may lead to partial vaporization and recondensation should be prevented.

Such frequently repeated operation can damage the exchanger.

1.5 MINIMUM TEMPERATURE APPROACH

1. For demanding applications, temperature approaches down to 3 °C (5°F) can be obtained in a WPBHE. However, a close temperature approach such as this should be applied with caution.

Small upsets in process conditions, changes in process stream physical properties or non-linearity in heat release curves could prevent achieving the required thermal duty. This caution is especially important for two-phase flow applications.

1.6 MAXIMUM TEMPERATURE DIFFERENTIAL

1. The maximum temperature difference of process streams between adjacent plates in any point in the heat exchanger should typically be limited to 80°C to 100°C (144°F to 180°F). Should higher temperature differences be required, the Manufacturer should be consulted for limitations in operation, e.g., in warm-up and cool-down rates.

1.7 THERMAL FATIGUE

The highest thermal stresses due to temperature differentials are likely to occur during start-up, shutdown or upset conditions.

1. The Contractor shall inform the Manufacturer of the number of anticipated start-up, shutdown and identified upset conditions to be considered, along with a definition of the operation under each case, so that the Manufacturer may consider this in the mechanical design of the WPBHE.

2. Care should be taken to avoid excessive flow fluctuations as these might cause thermal fatigue. If flow of one or both streams will be intermittent or not in a steady state, the Manufacturer should be consulted for limits in operation.
3. WPBHE shall not be used for high cyclical heat duties having sudden temperature changes exceeding 60°C/hour (108°F/hour).

High cyclical temperature and/or pressure conditions can create fatigue leading to a reduced lifetime of the exchanger.

4. The Manufacturer should be consulted at an early stage of the process design to determine the suitability of selecting WPBHE for expected or potential cyclic conditions.

1.8 PERFORMANCE MONITORING

1. To ensure continued, trouble-free performance of WPBHE, as outlined in the DEP 32.31.09.32-Gen. for performance monitoring, the following instrumentation should be installed and monitored:
 - a. pressure drops across the heat exchanger for both streams;
 - b. inlet and outlet temperatures of both streams;
 - c. flow rates of both streams;
 - d. pressure drop across the strainers for both streams.

1.9 CORROSION

1. The plate material shall be selected based on nil corrosion rates, unless otherwise approved by the Principal.

1.10 PARTICULATES

1. If particulates of a size greater than 50 % of the gap between plates are likely to be present in the process stream, upstream straining of the process stream shall be provided by the Contractor unless otherwise approved by the Principal. In general, a filter or strainer of mesh size 2 mm to 3 mm (0.08 in to 0.12 in) should be installed at the inlets of process streams.
2. During commissioning, to prevent construction debris (mill scale, rust, welding electrode etc.,) from accumulating in the WPBHE, a temporary filter strainer of mesh size 1 mm (0.04 in) or below should be installed.
3. The use of instrumentation to measure differential pressures across the filter to give an early indication of blockage should be considered. Otherwise, the collapse of the filter would pass additional debris to the WPBHE.
 - a. Two parallel filters should be installed so that one is always online, and have a pressure drop measurement [typically with a range of 0.1 bar (1.5 psi) to 0.5 bar (7.0 psi)] across the filters so they can be cleaned at proper intervals.

1.11 FOULING

1. Conventional fouling-resistance values used with shell-and-tube heat exchangers should not be used in the thermal design of WPBHEs. In the absence of fouling data, a minimum fouling margin as per Part III, 2.6 Table-2 should be applied.
2. Fouling streams could be tolerated if the fouling is not likely to be rapid enough to block flow channels and the fouling can be removed relatively easily either by hydro-blasting or with chemical solvents that are compatible with both the process and the materials used for the construction of the WPBHE. For minimum wall shear stress to minimize fouling refer to (Part III, 2.6, Table-2).