

DEP SPECIFICATION

CENTRIFUGAL SUBMERGED MOTOR PUMPS AND ELECTRO SUBMERSIBLE HYDRAULIC TURBINES

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DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for centrifugal submerged motor pumps (column-mounted or pot-mounted) in refrigerated product or pressurised storage service.

This DEP also specifies requirements and gives recommendations for electro submersible hydraulic turbines, also referred to as liquid expanders.

If a term in this DEP is not applicable to the design, manufacturing, testing, or operation of submerged generator liquid expanders, then any related clause is not applicable.

This DEP is intended to be used in conjunction with API 610/ISO 13709 data/requisition sheets for centrifugal pumps.

This is a revision of the DEP of the same number dated February 2011; 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 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 as regards safety, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this document 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 with the object of obtaining agreement to follow this document 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.

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

1.3.2 Specific definitions

Term	Definition
Best efficiency point	The flow at which a pump achieves its highest efficiency
Column-mounted	The installation of a complete pump assembly in a storage tank column. <i>Not applicable for submerged generator liquid expanders.</i>
Guarantee point	The normal operating point as specified on the data/requisition sheet and the point at which the Manufacturer/Supplier certifies that performance of the pump is within the tolerances specified (ref. API Std 610, section 7.3.1.1).
Intermittent service	Operation, including intentional stops and starts, under the conditions specified for the guarantee point
Design pressure	The greatest pressure at the specified pumping temperature for which the pump casing and the vessel (for pot-mounted pumps) are designed. <i>This includes all intended operating conditions and possible upset conditions</i>
Maximum discharge pressure	The maximum suction pressure plus the maximum differential head that the pump would be able to develop when operating at the specified conditions of speed, maximum density and lowest pumping temperature with the maximum impeller size installed. <i>Not applicable for submerged generator liquid expanders.</i>
Maximum rated discharge pressure	The maximum suction pressure plus the maximum differential head that the pump would be able to develop when operating at the specified conditions of speed, maximum density and lowest pumping temperature with the maximum impeller size installed. <i>Not applicable for submerged generator liquid expanders.</i>
Maximum suction pressure	The highest suction pressure to which the pump may be subjected during operation. <i>Not applicable for submerged generator liquid expanders.</i>
Minimum Continuous flow	The higher of the minimum continuous flow and the minimum continuous thermal flow. Minimum flow does not refer to the minimum required process flow.
Minimum continuous thermal flow	The lowest flow at which the pump can operate without its operation being impaired by the temperature rise of the pumped liquid. <i>Not applicable for submerged generator liquid expanders.</i>
Minimum continuous stable flow	The lowest flow at which the pump can operate without exceeding the vibration limits imposed by this DEP.

Term	Definition
Net positive suction head (NPSH)	The total suction head determined at the suction flange (bell mouth) or at the centreline of the first impeller or inducer of the pump, minus the vapour pressure of the liquid at the highest temperature specified. Both suction head and vapour pressure are expressed in metres liquid absolute. <i>Not applicable for submerged generator liquid expanders.</i>
Net positive suction head available (NPSHA)	NPSHA is the total suction head determined at a reference location (see below) minus the vapour pressure of the liquid at the highest temperature specified and at rated flow. <i>Not applicable for submerged generator liquid expanders.</i> <i>Both suction head and vapour pressure are typically expressed in metres liquid absolute.</i> <i>For pot-mounted pumps, the NPSHA is referenced to the suction flange of the pot.</i> <i>For column-mounted pumps, the NPSHA is referenced to the centre line of the inducer or the impeller of the pump.</i>
Net positive suction head required (NPSHR)	The minimum NPSH required at rated flow and at highest specified liquid temperature to prevent a head drop of more than 3% to the overall head value measured due to cavitation within the pump. This is due to the properties of cold boiling liquids which result in instantaneous loss of performance. NPSHR is determined by the Manufacturer/Supplier and expressed in metres (or feet) of actual liquid. <i>Not applicable for submerged generator liquid expanders.</i>
Pressure casing	This comprises all stationary pressure-containing parts of the complete pump unit, including all nozzles or other parts attached thereto subject to a differential pressure greater than 1 bar (ga).
Pot-mounted	The installation of a complete pump assembly or expander assembly, process auxiliaries and power connections in a pressure vessel.
Pressurised storage service	The handling of liquefied butane or lighter hydrocarbons stored in pressurised vessels at specified temperature.
Rated discharge pressure	The discharge pressure developed by the pump at the guarantee point with the furnished impeller size and at rated flow, speed, suction pressure and density. <i>Not applicable for submerged generator liquid expanders.</i>
Rated flow	The flow at the guarantee point.
Rated power	The power required by the pump at the guarantee point.
Refrigerated product service	The handling of butane or lighter hydrocarbons that are in the liquid phase under atmospheric pressure.

Term	Definition
Rated suction pressure	The specified suction pressure of the pump at the guarantee point. <i>Not applicable for submerged generator liquid expanders.</i>
Stiff Shaft	A stiff shaft design operates below its first critical speed.

1.3.3 Abbreviations

Term	Definition
BEP	Best Efficiency Point
CFD	Computational Fluid/ Flow Dynamics
NPSH	Net Positive Suction Head
NPSHA	Net Positive Suction Head Available
NPSHR	Net Positive Suction Head Required
RMS	Root Mean Square
TEM	Thrust Equalizing Mechanism

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced clause number is shown in brackets. Other documents referenced by this DEP are listed in [5].

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated February 2011. 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://swwww.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 HIERARCHY OF DOCUMENTS

In the event of conflict between documents relating to the enquiry or order, the following hierarchy shall apply:

- First level: local regulations and statutes
- Second level: purchase order and variations thereto
- Third level: data/requisition sheets and drawings
- Fourth level: this DEP (and by construction, the underlying industrial standards)

2. DESIGN

2.1 GENERAL

1. Pump and expander ratings shall:
 - a. not exceed the limits of the Manufacturer/Supplier's design;
 - b. be within the Manufacturer/Supplier's actual experience, without extrapolation from existing models/types.
2. Contractor shall confirm that Manufacturer/Supplier's equipment is proven in similar service.

Equipment are be proven in similar service when at least three (3) units of equal type and size have had at least 8,000 hours of continuous operation.
3. Pumps with constant-speed drivers shall be capable of at least a 5% head increase at rated conditions with the impeller(s) replaced by impeller(s) of larger diameter or different proven hydraulic design.

Incorporating a variable speed motor or using blank stage(s) is another means of pump being capable of a 5% head increase.
4. Pumps may be of single or multi-stage design.
5. Pumps shall have a stable head versus flowrate curve which continuously rise by at least 5% from rated capacity to shut-off.
 - a. If parallel operation is specified, the head rise from rated point to shutoff shall be a minimum of 10%, to ensure continuous stable parallel operation;
 - b. During performance testing, the test points shall show increasing differential head with decreasing flow.
6. Pumps shall be selected with the guarantee point between 80% and 110% of best efficiency point, applicable to the impeller diameter fitted.
 - a. The following data shall be shown on the data/requisition sheets for the guarantee point:
 - i. flow;
 - ii. total differential head;
 - iii. rated suction pressure;
 - iv. density and viscosity of the pumped liquid;
 - v. NPSHA;
 - 1). NPSHA for the pumping system shall be submitted to the Principal for review.
 - vi. speed.
7. Pumps shall have a preferred operating region of 70%-120% of the best efficiency flow rate.
 - a. The Manufacturer/Supplier's proposal shall include both the NPSHR curve from minimum continuous flow rate to end of curve flow rate, as well as the power consumption curve.
 - i. NPSHR shall be based on the pump handling the actual product specified on the data/requisition sheet.