

DEP SPECIFICATION

SEAWATER LIFT PUMPS

DEP 31.29.06.31-Gen.

February 2017

DESIGN AND ENGINEERING PRACTICE



© 2017 Shell Group of companies

All rights reserved. No part of this document may be reproduced, stored in a retrieval system, published or transmitted, in any form or by any means, without the prior written permission of the copyright owner or Shell Global Solutions International BV.

This document has been supplied under license by Shell to:
UOP Honeywell ted.fuger@honeywell.com 19/01/2018 07:23:40

AVA Documents
Document Sharing Hub

PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of Shell Global Solutions International B.V. (Shell GSI) and, in some cases, of other Shell Companies.

These views are based on the experience acquired during involvement with the design, construction, operation and maintenance of processing units and facilities. Where deemed appropriate DEPs are based on, or reference international, regional, national and industry standards.

The objective is to set the standard for good design and engineering practice to be applied by Shell companies in oil and gas production, oil refining, gas handling, gasification, chemical processing, or any other such facility, and thereby to help achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to Shell companies for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual Operating Units to adapt the information set forth in DEPs to their own environment and requirements.

When Contractors or Manufacturers/Suppliers use DEPs, they shall be solely responsible for such use, including the quality of their work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will typically expect them to follow those design and engineering practices that will achieve at least the same level of integrity as reflected in the DEPs. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal.

The right to obtain and to use DEPs is restricted, and is typically granted by Shell GSI (and in some cases by other Shell Companies) under a Service Agreement or a License Agreement. This right is granted primarily to Shell companies and other companies receiving technical advice and services from Shell GSI or another Shell Company. Consequently, three categories of users of DEPs can be distinguished:

- 1) Operating Units having a Service Agreement with Shell GSI or another Shell Company. The use of DEPs by these Operating Units is subject in all respects to the terms and conditions of the relevant Service Agreement.
- 2) Other parties who are authorised to use DEPs subject to appropriate contractual arrangements (whether as part of a Service Agreement or otherwise).
- 3) Contractors/subcontractors and Manufacturers/Suppliers under a contract with users referred to under 1) or 2) which requires that tenders for projects, materials supplied or - generally - work performed on behalf of the said users comply with the relevant standards.

Subject to any particular terms and conditions as may be set forth in specific agreements with users, Shell GSI disclaims any liability of whatsoever nature for any damage (including injury or death) suffered by any company or person whomsoever as a result of or in connection with the use, application or implementation of any DEP, combination of DEPs or any part thereof, even if it is wholly or partly caused by negligence on the part of Shell GSI or other Shell Company. The benefit of this disclaimer shall inure in all respects to Shell GSI and/or any Shell Company, or companies affiliated to these companies, that may issue DEPs or advise or require the use of DEPs.

Without prejudice to any specific terms in respect of confidentiality under relevant contractual arrangements, DEPs shall not, without the prior written consent of Shell GSI, be disclosed by users to any company or person whomsoever and the DEPs shall be used exclusively for the purpose for which they have been provided to the user. They shall be returned after use, including any copies which shall only be made by users with the express prior written consent of Shell GSI. The copyright of DEPs vests in Shell Group of companies. Users shall arrange for DEPs to be held in safe custody and Shell GSI may at any time require information satisfactory to them in order to ascertain how users implement this requirement.

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

TABLE OF CONTENTS

1.	INTRODUCTION	4
1.1	SCOPE	4
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	4
1.3	DEFINITIONS	4
1.4	CROSS-REFERENCES	5
1.5	SUMMARY OF MAIN CHANGES.....	5
1.6	COMMENTS ON THIS DEP	6
1.7	DUAL UNITS.....	6
1.8	NON NORMATIVE TEXT (COMMENTARY).....	6
2.	GENERAL REQUIREMENTS	7
2.1	CONFLICT	7
3.	DESIGN AND MANUFACTURING REQUIREMENTS	7
3.1	SCOPE	7
3.2	PERFORMANCE	8
3.3	GENERAL DESIGN	9
3.4	PUMP UNIT	11
3.5	DYNAMICS	13
3.6	RISE MAIN/ DISCHARGE HEAD	15
3.7	PUMP MATERIALS	17
3.8	ELECTRIC MOTORS	17
3.9	COUPLINGS AND GUARDS.....	22
3.10	ANTI-MARINE FOULING SYSTEM.....	22
3.11	TRANSPORTATION AND STORAGE CONTAINER	24
3.12	INSPECTION AND TESTING - GENERAL	24
3.13	TESTING	24
3.14	NOISE LIMITS	25
3.15	NAMEPLATE	25
4.	PREPARATION FOR SHIPMENT AND STORAGE.....	25
5.	MASS CONTROL	26
5.1	INFORMATION WITH QUOTATION	26
5.2	INFORMATION FOLLOWING AN ORDER	26
5.3	MASS CONTROL DURING MANUFACTURE	26
6.	DOCUMENTATION	27
6.1	TECHNICAL MANUALS	27
6.2	OTHER DOCUMENTATION	29
7.	REFERENCES	30

APPENDICES

APPENDIX 1	DATA SHEET FOR LEADING DIMENSIONS OF SUBMERSIBLE MOTOR PUMP	32
APPENDIX 2	DOCUMENTATION REQUIREMENTS SCHEDULE.....	33
APPENDIX 3	SCHEDULE OF ESSENTIAL TESTS AND INSPECTIONS	34
APPENDIX 4	FIGURES.....	35

1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for seawater lift pumps for use on offshore production facilities. It may also be used for similar applications handling fluids other than water, e.g., diesel oil from leg storage. This DEP covers both electro-submersible and line-shaft driven pumps.

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 offshore oil and gas production. 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.

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

1.3.2 Specific Definitions

Term	Definition
Continuous Operation	Uninterrupted operation for a period of at least 24,000 hours at the specified operating conditions. This does not include intermittent operations such as: - pumps started and stopped automatically at intervals by process-operated controls, and - pumps started up and stopped manually for batch transfer.
Parallel operation	When two or more pumps are required to operate at the same time to meet the process demand.
Proven Equipment	Equipment of which at least three units of similar type, size and specific loading have together accumulated a minimum of 24,000 hours of comparable satisfactory service.

1.3.3 Abbreviations

Term	Definition
BEP	Best Efficiency Point
CA	Certifying Authority
E-SPIR	Electronic Spare Parts and Interchangeability Record
LAT	Lowest Astronomical Tide
NPSH	Net Positive Suction Head

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 (7).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a minor revision of the DEP of the same number dated February 2013. The changes followed a requirements quality review and were not a technical update. The following are the main, non-editorial changes.

Section/Clause	Change
Part III 1.3.2	Added definitions
3.2.2	Reworded Impeller Depth section for clarity.
3.3.1	Added clarity around proven designs, novelty, prototype.
6.1	Updated Documentation section to align with Offshore Firewater Pump DEP 37.29.01.10 Gen.

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.

2. GENERAL REQUIREMENTS

2.1 CONFLICT

1. Any apparent conflict between the requirements of this DEP and any other relevant documents shall be brought to the Purchaser's attention.
2. Unless otherwise agreed, the following descending order of precedence shall apply:
 - a. Local Regulations;
 - b. The Purchase Order;
 - c. The Pump Data Sheet;
 - d. This DEP;
 - e. Industry codes and standards.

3. DESIGN AND MANUFACTURING REQUIREMENTS

3.1 SCOPE

1. The pump package supplier shall have overall technical responsibility for the complete vertical seawater lift pump scope of supply, including design, manufacture and testing activities.
2. Electro-submersible pumps shall be specified for seawater pumping applications to achieve higher reliability.
3. The seawater lift pump scope of supply shall include, but not be limited to, the following items:
 - a. Complete pump assembly;
 - b. Suction strainer;
 - c. Rising main and line shaft (as applicable);
 - d. Discharge head;
 - e. Electric motor or submersible electric motor with cable (as applicable);
 - f. Complete sealing support system including header tank for submersible electric motor, cabling, piping, instrumentation etc;
 - g. Transportation/storage and erection cradle;
 - h. Cable handling system (when applicable for submersible electric motor);
 - i. Ion exchange type of anti-marine fouling system (if specified in the requisition);
 - j. Anti-marine fouling header and distribution for seawater service (this excludes the generator). Air vent valve/vacuum breakers required within the pumping package with typical termination at the pump system discharge flange on topside;
 - k. Junction boxes with supports, for motor and anti-marine fouling system;
 - l. All connecting tubing and flexible connections;
 - m. Special tools (for dismantling/re-assembly);
 - n. Special tools are those necessary to dismantle/assemble the pumping system including removal/installation of the complete pump, electric motor, rising main, sealing system and all the cabling and anti-marine fouling injection system;
 - o. Protection and Condition monitoring for line-shaft driven or electro Submersible motor and pump;
 - p. Gearbox and driver for line shaft pump (if specified in the requisition).

3.2 PERFORMANCE

3.2.1 Characteristics

1. Pumps shall have stable head/capacity curves which continuously rise by at least 10% from rated capacity to shut-off.
 - a. The gradient of the tangent to the curve shall continuously decrease from 125% of the best efficiency point to minimum continuous stable flow and remain positive.
 - b. The performance curve shall run out at least 15% beyond the rated point.
2. Unless otherwise approved by Principal, pumps selected to run in parallel shall be of the same size and hydraulic performance.
3. Pumps for parallel operation shall have a similar percentage head rise to shut-off.

Parallel operation is when two or more pumps are required to operate at the same time to meet the process demand.
4. Rated flow shall be selected between 80% – 110% of best efficiency point (BEP) for the rated impeller.
5. Pumps with rated capacity of 1000 m³/hr (4400 US GPM) or greater shall be selected within 10% of the best Efficiency Point (BEP).
6. Pumps with constant speed drivers shall be capable of at least a 5% head increase at rated conditions by installing larger impeller or impellers.
7. For pumps handling fluids more viscous than water, the performance shall be corrected in accordance with the "Performance Correction Chart for Viscous Fluids" within the latest edition of HI ANSI/HI 3.1-3.5 (Hydraulic Institute).

14th Edition of the standard has this chart as figures 71 and 72.
8. The reference point to be used for specifying the required delivery pressure shall be at the horizontal centre-line of the discharge flange at deck level.

This point is referred to as the 'deck level reference point'.
9. Using the pressure required at the deck level reference point and details of elevations, the Supplier shall estimate losses in the riser pipe and determine the total differential head required, assuming the pumped fluid is at the minimum operating level stated on the datasheet and allowing for 'draw-down' in the caisson.

For pumps taking suction from the sea, the minimum operating level is the Lowest Astronomical Tide (LAT) level.

3.2.2 Impeller immersion depth

1. The impeller immersion depth shall be the greatest of the following:
 - a. The depth sufficient to ensure that the inlet to the first stage impeller meets the minimum submergence requirements as specified by the Manufacturer at the Lowest Astronomical Tide (LAT) level and allowing for the 100-year wave trough depth (assuming the wave trough depth from LAT is one-third of the total wave height from trough to apex);
 - b. The depth sufficient to provide the (NPSH) required by the pump at LAT level with no wave trough allowance, plus a margin equal to the greater of the following:
 - i. 50% of the NPSH required by the pump at the inlet to the first stage impeller; or
 - ii. 3.0 m (10 ft).
 - c. An immersion depth specified on the data/requisition sheet.
2. In calculating the immersion depth, the following allowances shall be made and demonstrated by the Supplier:
 - a. Draw-down in the caisson;
 - b. Pressure drop around the anti-fouling device (if applicable).

3.3 GENERAL DESIGN

3.3.1 Vendor qualification requirements and design criteria

1. Selected pumps shall be within the range of the Manufacturer/Supplier's proven equipment.
2. Pumps or components outside of the Manufacturer/Supplier's proven experience (also referred to as "prototype" or "novelty" equipment) may be used if an equipment novelty assessment is carried out and approved by the Principal.

Refer to GS.10.50237 (PTE-XREQ Novelty Assessment) for guidance around the Development Release process.

3. In selecting equipment, Contractor shall ensure that the equipment of prospective Manufacturer/Suppliers is within the ratings of Contractor's design.
4. The pump and motor unit shall be designed for 25,000 hours continuous operation, with 2,000 stops/starts between overhauls.

In this context, continuous means the capability to pump as specified for the period stated. The pump unit could shut down during the stated period for other operational reasons. It is anticipated that pumps will be removed for overhaul after each four-year operating period.

3.3.2 Pressure casings

1. The pressure casing shall be designed for the maximum pump discharge pressure generated at shut-off (maximum boost at the highest suction pressure) at the specified pumping temperature plus an allowance for head increases as required by (3.2.1 Item 6).
2. The resulting design pressure shall apply to all parts of the bowl assembly, rising main and discharge header supplied by the pump packager.
3. The stress used in the design for any given material shall not exceed the values given in Section VIII, Division 1, of the ASME Boiler and Pressure Vessel Code for the material.
 - a. For cast materials, the factor specified in the same codes shall be applied.

3.3.3 Connections

1. The following nominal sizes shall not be used for pump discharge or auxiliary connections: DN 32 (NPS 1 ¼), DN 65 (NPS 2 ½), DN 90 (NPS 3 ½), DN 125 (NPS 5).
2. Flanges shall conform to ASME B16.1, except for the following:
 - a. Ni-resist cast iron flanges and bronze flanges shall be flat-faced and be ASME B16.1 Class 250 minimum thickness for sizes 8 in and smaller;
 - b. Flanges may be thicker and have a larger outside diameter than required by ASME;
 - c. Flat-faced flanges with full raised face thickness on heads other than cast iron or bronze shall not be provided.
3. Studded connections shall be furnished with studs installed.
 - a. Blind stud holes should only be drilled deep enough to allow a preferred tap depth 1½ times the major diameter of the stud.
 - b. The first 1½ threads at both ends of each stud shall be removed.

3.3.4 Fasteners

1. All fasteners on any rotating part and all fasteners on static parts of the pump inside the caisson (including the rising main) shall be positively locked against becoming loose in service.
 - a. Locking methods that rely on friction to operate (e.g., lock nuts) shall not be used.
2. Bolting and studs shall comply with ISO 262/ANSI B16.5.
3. To facilitate dismantling and maintenance, internal and external bolting shall be resistant to corrosive attack by the fluid pumped.
4. Bolting materials shall be specified in the proposal.
5. Studded connections shall be furnished with studs installed.
 - a. Blind stud holes should only be drilled deep enough to allow a preferred tap depth 1½ times the major diameter of the stud.
 - b. The first 1½ threads at both ends of each stud shall be removed.

3.3.5 Painting

1. All Carbon steel components shall be coated with a paint system suitable for an open marine tropical environment.
2. Details of the coating procedure shall be provided in the proposal and be subject to approval by the Principal.
 - a. Details shall include surface preparation, paint materials/application/thicknesses and the paint manufacturer's data sheets.
 - b. The components to be coated should include the motor stool, junction box support structures and the transportation container/cable handling systems.

3.4 PUMP UNIT

3.4.1 Configuration

1. The pump unit shall be a vertically mounted, radially split single or multi-stage bowl assembly.
2. Bowl to bowl connections shall be located by spigots and secured with studs and nuts.

3.4.2 Strainer

1. A coarse mesh strainer shall be located around the pump suction bell.
 - a. The strainer shall have a free area of at least four times the area of the suction bell and the openings sized to prevent the passage of a 12 mm ($\frac{1}{2}$ in) sphere.

3.4.3 Reverse rotation

1. The pump unit shall be designed to prevent or tolerate reverse rotation, so that the motor can be re-started immediately after a shutdown.
2. For line-shaft driven pumps, a non-reverse ratchet shall be incorporated in the motor or thrust bearing.
3. For submersible motor driven pumps, the unit shall be capable of re-start with the motor internal voltage 180 degrees out of phase with the incoming supply voltage.

This will allow the pump to restart at any time even if the water column is running the impeller in the opposite direction immediately after a stop.

3.4.4 Rotating elements

1. Impellers shall be of the enclosed type, manufactured from single piece castings with solid hubs.
2. Impellers shall be secured to the pump shaft and retained against circumferential movement by keying or tapered shrink fit.
 - a. Other retaining methods of the Supplier's standard design may be proposed but are subject to approval by the Purchaser.
3. Shafts shall be machined and finished throughout their length so that there is no more than 25 μ m (0.001 in) total indicated runout.
4. Steps and keyways in shafts shall be machined with an internal radius of not less than 1.5 mm (0.060 in).
5. The shaft in the bowl assembly shall be of one piece unless otherwise approved by the Purchaser (because of total shaft length or shipping restrictions).
6. Guide bushings that are corrosion- and abrasion-resistant for the specified product and temperature shall be furnished at all steady bearing points in the pump unit (bowl assembly).