

## DEP SPECIFICATION

# LIQUID RING VACUUM PUMPS AND COMPRESSORS (AMENDMENTS/SUPPLEMENTS TO API STD 681)

DEP 31.29.42.30-Gen.

February 2012

ECCN EAR99

## DESIGN AND ENGINEERING PRACTICE



© 2012 Shell Group of companies

All rights reserved. No part of this publication 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 contains information that is classified as EAR99 and, as a consequence, can neither be exported nor re-exported to any country which is under an embargo of the U.S. government pursuant to Part 746 of the Export Administration Regulations (15 C.F.R. Parts 746) nor can be made available to any national of such country. In addition, the information in this document cannot be exported nor re-exported to an end-user or for an end-use that is prohibited by Part 744 of the Export Administration Regulations (15 C.F.R. Parts 744).

## 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 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**

|                                                                            |                                                                |           |
|----------------------------------------------------------------------------|----------------------------------------------------------------|-----------|
| <b>PART I</b>                                                              | <b>INTRODUCTION .....</b>                                      | <b>4</b>  |
| 1.1                                                                        | SCOPE.....                                                     | 4         |
| 1.2                                                                        | DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS ..... | 4         |
| 1.3                                                                        | DEFINITIONS .....                                              | 4         |
| 1.4                                                                        | CROSS-REFERENCES .....                                         | 5         |
| 1.5                                                                        | GUIDANCE FOR USE .....                                         | 5         |
| 1.6                                                                        | SUMMARY OF MAIN CHANGES.....                                   | 5         |
| 1.7                                                                        | COMMENTS ON THIS DEP .....                                     | 6         |
| 1.8                                                                        | DUAL UNITS.....                                                | 6         |
| <b>PART II</b>                                                             | <b>GENERAL.....</b>                                            | <b>7</b>  |
| <b>PART III</b>                                                            | <b>AMENDMENTS/SUPPLEMENTS TO API STD 681.....</b>              | <b>8</b>  |
| <b>SECTION 1 - GENERAL .....</b>                                           | <b>8</b>                                                       |           |
| 1.3                                                                        | Conflicting Requirements.....                                  | 8         |
| 1.4                                                                        | Definition of Terms.....                                       | 8         |
| 1.5                                                                        | References.....                                                | 8         |
| <b>SECTION 2 - BASIC DESIGN .....</b>                                      | <b>9</b>                                                       |           |
| 2.1                                                                        | General .....                                                  | 9         |
| 2.3                                                                        | Casing Connections.....                                        | 9         |
| 2.5                                                                        | Rotating Elements.....                                         | 9         |
| 2.6                                                                        | Mechanical Shaft Seals .....                                   | 9         |
| 2.7                                                                        | Dynamics .....                                                 | 10        |
| 2.8                                                                        | Bearings, Bearing Housings, and Lubrication.....               | 10        |
| 2.9                                                                        | Materials.....                                                 | 10        |
| <b>SECTION 3 - ACCESSORIES .....</b>                                       | <b>11</b>                                                      |           |
| 3.1                                                                        | Ring Liquid System .....                                       | 11        |
| 3.2                                                                        | Controls and Instrumentation.....                              | 12        |
| 3.3                                                                        | Drivers and Transmissions .....                                | 12        |
| 3.7                                                                        | Piping .....                                                   | 13        |
| <b>SECTION 4 - INSPECTION, TESTING, AND PREPARATION FOR SHIPMENT .....</b> | <b>14</b>                                                      |           |
| 4.1                                                                        | General .....                                                  | 14        |
| 4.2                                                                        | Inspection.....                                                | 15        |
| 4.3                                                                        | Testing .....                                                  | 15        |
| <b>PART IV</b>                                                             | <b>REFERENCES .....</b>                                        | <b>16</b> |

## PART I INTRODUCTION

### 1.1 SCOPE

This DEP specifies requirements and gives recommendations for liquid ring vacuum pumps and compressors and is based on API STD 681.

Part III of this DEP gives amendments and supplements the clauses of API STD 681 and follows the clause numbering of API STD 681.

This DEP is a revision of the DEP of the same number dated December 2004; a summary of the main changes is given in (1.6).

### 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 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 to 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 with the object of obtaining agreement to follow this DEP as closely as possible.

### 1.3 DEFINITIONS

#### 1.3.1 General definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project, or operation or maintenance of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The term **Vendor** is used in API STD 681. In the context of this DEP, Vendor shall be understood to mean **Manufacturer/Supplier**.

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 term **Purchaser** is used in API STD 681. In the context of this DEP, Purchaser shall be understood to mean **Principal**.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

**1.3.2 Abbreviations**

| <b>Term</b> | <b>Definition</b>               |
|-------------|---------------------------------|
| <b>gpm</b>  | gallons per minute              |
| <b>hp</b>   | horsepower                      |
| <b>kW</b>   | kilowatt                        |
| <b>OEM</b>  | 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 ( ). Referenced section numbers in the API document are not shown in brackets. Other documents referenced in this DEP are listed in (Part III).

**1.5 GUIDANCE FOR USE**

A bullet (●) in the margin of certain clauses in both this DEP and API STD 681 indicates that a decision is required of the Contractor and/or the Principal. These decisions shall be indicated directly on the relevant data/requisition sheet where provisions are made for them. Otherwise, they shall be indicated on the data/requisition sheet(s) under the heading "Additional Requirements" or stated in the purchase order.

**1.6 SUMMARY OF MAIN CHANGES**

This DEP is a revision of the DEP of the same number dated December 2004 with circular 91/08. The following are the main, non-editorial changes.

| <b>Old Section</b> | <b>New Section</b> | <b>Change</b>                                                                                                                                                                                             |
|--------------------|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| N/A                | 1.4.27             | Definition of hazardous service                                                                                                                                                                           |
| N/A                | 2.1.12             | Added requirements for base line vibration data.                                                                                                                                                          |
| 2.9.4              | 2.9.4              | Requires Purchaser approval prior to purchase.                                                                                                                                                            |
| 3.1.1.4            | 3.1.1.4            | Requirements added for flow meter and for signs to indicate minimum and maximum allowable liquid level inside the pump. Included specific requirements for multiple injection ports and seal pipe design. |
| N/A                | 3.1.2.3            | Added requirements for vessel retention time.                                                                                                                                                             |
| 3.1.3.1            | 3.1.3.1            | Requires transflo valves for duplex arrangements.                                                                                                                                                         |
| N/A                | 3.1.4.3            | Added requirements for duplex filter arrangement.                                                                                                                                                         |
| N/A                | 3.1.6.1            | Added self draining requirement for discharge piping.                                                                                                                                                     |
| N/A                | 3.1.6.2            | Included requirements for seal flow regulation.                                                                                                                                                           |
| 3.3.5              | 3.3.5              | Added dual units and reference to electric motor drives.                                                                                                                                                  |
| 3.7.1.5            | 3.7.1.5            | Requires balanced seal fluid piping.                                                                                                                                                                      |
| N/A                | 4.3.3.3.1          | Added recommendations for testing units in excess of 75 kW (100 hp).                                                                                                                                      |
| Part III           | Part IV            | Added References: DEP 33.66.05.35-Gen. and DEP 33.66.05.36-Gen.                                                                                                                                           |