

DEP SPECIFICATION

PUMPS - SELECTION, TESTING AND INSTALLATION

DEP 31.29.02.11-Gen.

February 2011

DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the type selection and basic design of pumps. This DEP also specifies procurement procedures which should be applied to the procurement of heavy duty centrifugal pumps which utilise mechanical seals for shaft sealing.

Pumps for refrigerated product service are not covered by DEP, but are covered in DEP 31.29.06.30-Gen.

This DEP is intended for pumps in vital, essential, and non-essential services (see 1.3.2.13).

This DEP is a revision of the DEP of the same number dated June 2007; see (1.6) for a summary of the main changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

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This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification and, where applicable, supply/marketing installations. 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.

Selected Vendors are those Pump and or Seal Vendors who are invited to submit proposals.

Nominated Vendors are those Vendors who are given purchase orders to supply the Pumps and or Mechanical Seals and associated auxiliary systems.

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.

1.3.2 Specific definitions

term	definition
abrasive service	service in which there is an expected wear rate of 0.1 mm (0.004 in) or more per year, or where hard particles larger than 100 µm (0.004 in) exist in quantities exceeding 100 mg/kg (100 ppm).
alternative design pumps	pumps other than Heavy-duty pumps and Light-duty pumps. Examples: • Specially engineered pumps such as slurry pumps, vortex pumps, and self-priming pumps • Fire fighting pumps according to NFPA 20.
continuous operation	uninterrupted operation for a period of at least 24,000 h at the specified operating conditions.
hazardous service	service comprising the following categories, which shall be specified on the data/requisition sheets: Category 1 • Liquids classified as "very toxic - acute" in DEP 01.00.01.30-Gen. • Liquids containing ethylene oxide Category 2 • Liquids classified as "very toxic - chronic" in DEP 01.00.01.30-Gen. • Hydrocarbon liquids at an operating temperature above their auto-ignition temperature. Category 3 • Hydrocarbon liquids with a seal chamber vapour pressure higher than 500 kPa (abs) [73 psia]; • Light hydrocarbon services (ISO 21049:2004, Clause 3.38).
heavy-duty pump	pump complying with ISO 13709, ISO 13710, API 675, API 676, API 685 and/or BS 4082-1 Code R. NOTES: 1. API 610 is technically equivalent to ISO 13709. 2. API 674 is technically equivalent to ISO 13710.
intermittent operation	operation that is not classified as continuous operation. Examples: • Pumps started up and stopped automatically at intervals by process-operated controls; • Pumps started up and stopped manually for batch transfer.
light-duty pump	Process pump built to a standard other than those listed under Heavy-duty pump, e.g. pumps complying with DIN, CHEM, ASME/ANSI, BS 4082 1 Code L.
minimum continuous flow	The greater of minimum continuous stable flow as defined by the applicable industry standard and minimum continuous thermal flow.

term	definition
Modularization	When the pump(s) are mounted, along with piping, valves, instruments, etc, in a truckable or shippable or bargeable structural module which is transported to the site and set in place. This approach moves construction hours from the site to a module yard, where gains are made in labour productivity and construction quality, leading to a lower total installed cost.
non-corrosive or mildly corrosive service	• Streams with no corrosive elements and with a service temperature not exceeding 400°C (752°F). • Streams containing sulphur compounds and naphthenic acids with an acid value in excess of 500 mg/kg (500 ppm by mass) KOH, but with a service temperature not exceeding 230°C (446°F). • Streams containing sulphur compounds and naphthenic acids with an acid value up to but not exceeding 500 mg/kg (500 ppm by mass) KOH, and with a service temperature not exceeding 330°C (626°F). • De-aerated boiler feed water and condensate. • Stripped sour water. • Caustic soda at a service temperature not exceeding 50°C (122 °F). • Caustic soda with a concentration not exceeding 10 % by mass at a service temperature not exceeding 70°C (158°F). • All concentrations of lean ADIP/DEA/MEA (Sulfinol) at a service temperature not exceeding 70°C (158°F). NOTE: See also DEP 31.29.02.30-Gen., Appendix 1.
Shell Pre-engineered Equipment Catalogue (SPEC)	The development of Shell Pre-engineered Equipment Catalogue (SPEC) agreements involves qualification of Vendors and their products, as well as agreeing engineering and quality standards, documentation and scope of supply requirements. The most commonly utilised standard fit-for-purpose products offered by highly respected Centrifugal Pump Vendors and Mechanical Seal Vendors, have been reviewed and designated as SPEC products. Full details of SPEC products are given in Vendor-maintained SPEC agreements, the content of which is controlled by SHELL GSI. SPEC products have been pre-engineered and approved as fit-for-purpose for supply to Shell projects against the functional specification as detailed on the datasheets. Full details of the available SPEC agreements and an introduction to the SPEC concept and its benefits are given in Shell GSI report GS.06.51386. <i>Access to this report and to the SPEC agreements is restricted to Shell projects.</i>

term definition

Approvals classification of proposals Vendors shall indicate on the datasheet the Approvals Classification of their proposal, which shall determine the level of approvals required, based on the following table:

Classification	Usage	Approvals
Fully SPEC compliant	SPEC Vendors only: Standard SPEC products, operating within the pre-approved application parameters.	Pre-engineered product which requires no further engineering or approval by the Contractor or Principal, other than evaluation and acceptance of proposal.
Engineered Solution	All Vendors: All other products not covered by the above (including products offered by SPEC Vendors, which are not in full compliance with the SPEC agreement).	Qualification and acceptance of product for the application required by Contractor/ Principal, including review of references and design as well as acceptance of any deviations from the relevant DEPs.

Centrifugal Pump Type Codes

OH1 – foot-mounted single-stage overhung pump
 OH2 – centreline-mounted single-stage overhung pump
 OH3 – vertical in-line single-stage overhung pumps
 OH4 – rigidly-coupled vertical in-line single-stage overhung pumps
 OH5 – close-coupled vertical in-line single-stage overhung pumps
 OH6 – high-speed integral gear-driven single-stage overhung pumps
 BB1 – axially-split one- and two-stage between-bearings pumps
 BB2 – radially-split one- and two-stage between-bearings pumps
 BB3 – axially-split multistage between-bearings pumps
 BB4 – single-casing (ring-section) radially-split multistage between-bearings pumps
 BB5 – double-casing radially-split multistage between-bearings pumps
 VS1 – vertically-suspended, single-casing diffuser pumps
 VS2 – vertically-suspended, single-casing volute pumps
 VS3 – vertically-suspended, single-casing axial flow pumps
 VS4 – vertically-suspended, single-casing volute line-shaft driven sump pumps
 VS5 – vertically-suspended cantilever sump pumps
 VS6 – double-casing diffuser vertically-suspended pumps
 VS7 – double-casing volute vertically-suspended pumps

Vital, essential, non-essential services

These terms are defined as follows:

	SAFETY EQUIPMENT	OTHER EQUIPMENT		
	SERVICE CATEGORY			
	VITAL	ESSENTIAL		NON-ESSENTIAL
Non-spared equipment		Spared equipment		
Definition	A service in which failure of equipment causes an unsafe condition , resulting in jeopardy to life and/or major damage (fire, explosion etc.).	A service in which failure of equipment renders a plant inoperable or reduces performance to a level unacceptable to the Principal.	A service in which failure of equipment renders a plant inoperable or reduces performance to a level unacceptable to the Principal.	All other services.
Selection Criteria	Equipment shall be adequately spared to ensure as near as practical 100 % availability of the service under all circumstances	A decision not to install spare equipment is based upon economic considerations and proven equipment availability. Non-spared equipment availability may be upgraded by means of additional Capex to match required plant availability.	Installed spare equipment is normally selected where potential losses due to equipment outage greatly outweigh equipment Capex. Sparing philosophy shall be economically evaluated and is typically 2x100 % or 3x50 %.	Economic evaluation required to justify spared equipment.
Driver Selection Criteria	Independent power sources shall be selected to ensure near 100 % service availability		Independent power sources may be selected, for start-up and utility availability reasons	
Examples	• Firewater pumps with diesel and motor drives; • Emergency shut-down (ESD) systems; • Emergency Instrument Air (EIA) compressor.	• Hydrocracker (HCU) feed pump; • HCU recycle compressor; • Cat. Cracker (FCCU) main air compressor; • Forced Draft (FD) and Induced Draft (ID) fans.	• Boiler Feed Water (BFW) pumps; • Fractionator bottom pumps; • Fresh gas compressors (HCU).	• Drinking water pumps; • Sewage pumps.

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 (6).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated June 2007. The main non-editorial changes to this DEP were to separate it into Specification and Informative.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of "DEPs on the Web", available through the Global Technical Standards web portal <http://sww.shell.com/standards> and on the main page of the DEPs DVD-ROM.

1.7 DUAL UNITS

In this DEP, the International System of units (SI) shall be understood to prevail over US Customary (USC) units. USC units are provided in brackets following the SI units for information.

2. GENERAL

2.1 PROCUREMENT PROCESS

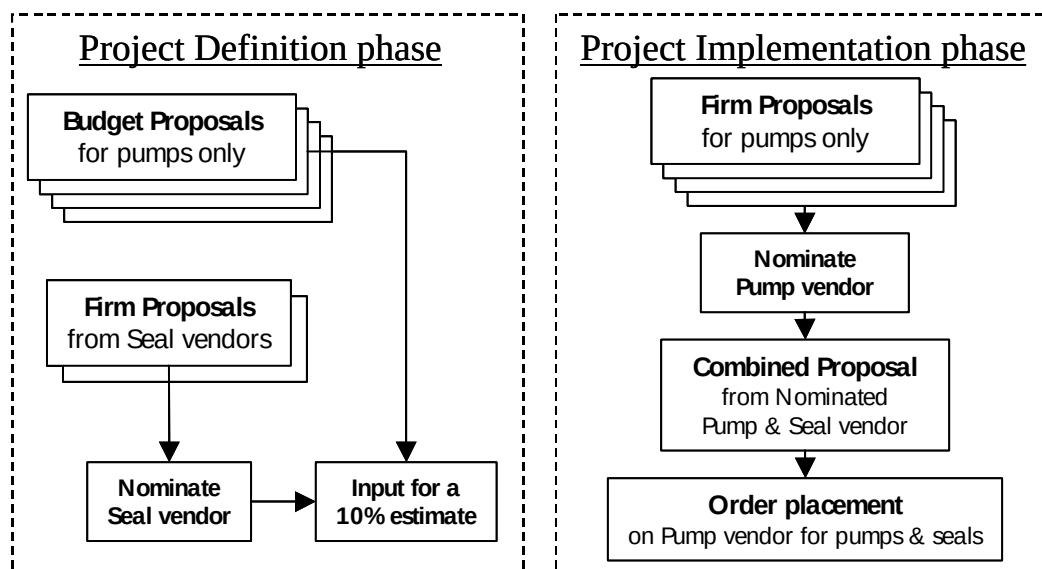
The procurement process as described below should be used for the procurement of all heavy duty centrifugal pumps which utilize mechanical seals for shaft sealing.

During the Front End Development phase of the project, a list of selected Pump Vendors and a separate list of selected Seal Vendors should be drawn up in accordance with (Appendix A).

SPEC agreements should be used for all pump and/or seal applications to which SPEC agreements are applicable, as defined in (Appendix B).

Enquiries for applications to which SPEC agreements are applicable shall be processed separate from other enquiries.

The Vendor nomination processes for pumps shall be completely separate from the Vendor nomination processes for seals and the timing of these shall be as illustrated below.



Pump Vendors shall not be requested to, nor shall they:

- include Seal Vendors' scope of supply in their Budget or Firm Proposals;
- nominate the Seal Vendor.

Seal Vendors shall not be requested to provide Firm Proposals directly to Pump Vendors. For further information on Vendor nomination and order placement processes, refer to (Appendix C) of this DEP.

All Contractor, Project and Vendors' staff, shall comply with the procedures as stated above and as detailed in (Appendices A to E) of this DEP.

2.2 VARIETY OF PUMPS

Every effort shall be made to optimise the spares stock levels that need to be kept by the Principal by rationalising the variety of makes and types of pumps, drivers and auxiliary equipment selected for any particular project.

This rationalisation shall be applied stringently provided it does not interfere with the selection of an optimal pump for the specified operating conditions.

2.3 PROTOTYPE PUMPS

Selected pumps shall be within the range of the Manufacturer's proven equipment in all respects and shall not involve the use of any prototype design or components, unless the

design of such equipment has been fully reviewed and accepted by Principal as the only viable solution available for the application.

NOTE: In this respect, proven equipment is defined as equipment of which at least three units of similar type, size and specific loading have together accumulated a minimum of 24,000 h of comparable satisfactory service.

In selecting equipment, care shall be taken to ensure that prospective Vendors do not exceed the ratings of their design in their efforts to offer competitively.

2.4 OPERATING DATA

All necessary operating data, i.e., normal, start-up, shutdown, etc., shall be stated on the data/requisition sheet(s). This shall also cover any special operating requirements such as mode of operation (parallel or series), or operating with fluids of different properties or at different operating temperatures, or being required to operate at or below minimum continuous flow (which will require minimum flow by-pass features).

For each pump service, the Buyer shall indicate if the service is flammable or hazardous, and the Hazardous Category.

2.5 NOISE CONTROL

The Contractor shall comply with DEP 31.10.00.31-Gen. and thereby communicate to the Vendor the specified equipment noise limitations by using data sheet DEP 31.10.00.94-Gen., which shall form part of the requisition. The Contractor is responsible for ensuring that these equipment noise limitations have been specified.

For pumps with drivers 75 kW (100 HP) and larger, the Vendor shall supply the guaranteed sound pressure levels for:

- Overall unit
- Pump
- Gearbox (if applicable)
- Driver
- Auxiliaries (if applicable)

2.6 SAFEGUARDING

Safeguarding and Instrumented Protective Functions (IPF) for equipment shall comply with DEP 32.29.20.10-Gen.

2.7 PREVENTION OF BRITTLE FRACTURE

In order to prevent brittle fracture, material selections for low temperature applications shall comply with DEP 30.10.02.31-Gen. However, this specification should not be issued to suppliers. Instead, either the Purchaser shall determine the required material prior to enquiry, or the Vendor shall propose a material for review and approval by the Purchaser (against the requirements of that DEP).

2.8 INSTALLATION

Installation design and installation of rotating equipment shall comply with DEP 31.38.01.11-Gen and DEP 31.29.00.10-Gen.

2.9 MODULARIZATION

Vertical in-line pumps are the easiest to modularize, and should be favoured for projects that are modularized. Small horizontal pumps are also relatively easy to modularize, although care must be paid to ensure the shaft is installed horizontal for oil-ring lubricated pumps, and to avoid structural resonances.

Modularization of horizontal pumps 187 kW (250 HP) and larger should be avoided, and instead they should be installed on foundations and the ancillary items around them (piping, valves, instruments, etc) modularized. If they must be modularized, then: the structural and installation details shall be well thought through to achieve an installation that will give reliable service. Furthermore, detailed structural and dynamic studies should be conducted

by a specialist firm, to ensure that there are no structural resonances coinciding with multiples of running speed(s) or vane-pass frequencies.

2.10 DESIGN CLASS CONSIDERATIONS

Design Class consideration for pumps shall not significantly alter the pump selection criteria (i.e. the pump selection process shall follow the order presented in Section 3 of this DEP). However, the application limits are less restrictive for Design Class 1 (lower first cost, lower on-stream factor, etc) than for Design Class 3 (higher first cost, higher on-stream factor, etc) projects. In addition, Design Class 1 projects are more frequently modularized than are Design Class 3 projects.

2.10.1 Heavy-Duty Vertical In-line Centrifugal Pumps

Recommended application limits for vertical in-line centrifugal pumps are as follows:

	Modularized	Not Modularized
Design Class 1 plant	Tip speed < 75 m/s (245 ft/s); No power limit	Tip speed < 75 m/s (245 ft/s); Max 150 kW (200 HP) for 2-pole, 300 kW (400 HP) for 4-pole, 450 kW (600 HP) for 6-pole
Design Class 3 plant	Tip speed < 62 m/s (205 ft/s); Max 150 kW (200 HP) for 2-pole, 300 kW (400 HP) for 4-pole, 450 kW (600 HP) for 6-pole	Tip speed < 62 m/s (205 ft/s); Max 75 kW (100 HP) for 2-pole, 150 kW (200 HP) for 4-pole, 225 kW (300 HP) for 6-pole