

SEALLESS CENTRIFUGAL PUMPS (AMENDMENTS/SUPPLEMENTS TO API 685)

DEP 31.29.02.31-Gen.

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DESIGN AND ENGINEERING PRACTICE



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PART I INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for sealless centrifugal pumps in spared vital and essential services.

This DEP is based on API Std 685, First Edition, October 2000 (including Errata dated October 2007). Part II of this DEP amends, supplements and deletes various clauses of API 685.

Any clauses of API 685 not modified by this DEP shall remain valid as written.

1.2 DISTRIBUTION, APPLICABILITY 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.

This DEP is intended for use in oil refineries, gas plants, chemical plants and oil and gas production 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 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

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

The **Principal** is the party which 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 **Purchaser** may be the Contractor or the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

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 (Part III).

1.5 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the DEP Administrator at standards@shell.com. Shell staff may also post comments on this DEP on the Surface Global Network (SGN) under the Standards folder.

**PART II SEALLESS PUMPS IN SPARED VITAL AND ESSENTIAL SERVICES
[AMENDMENTS/SUPPLEMENTS TO API Std 685, First Edition, October 2000
(including Errata dated October 2007)]**

3. DEFINITION OF TERMS

ADD NEW CLAUSE:

3.86 continuous operation

uninterrupted operation for a period of at least 24,000 h at the specified operating conditions

NOTE: This does not include intermittent operations such as:

- pumps started and stopped automatically at intervals by process-operated controls;
- pumps started up and stopped manually for batch transfer;

3.87 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).

3.88 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) are present in quantities exceeding 100 mg/kg (100 ppm).

3.89 vital, essential and 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 of the plant or installation resulting in jeopardy to life and/or major damage (fire, explosion etc.).	A service in which failure of equipment renders a plant or process unit inoperable or reduces performance to a level unacceptable to the Principal.	A service in which failure of equipment renders a plant or process unit inoperable or reduces performance to a level unacceptable to the Principal.	All other services.
Examples	- Firewater pumps with diesel and motor drives; - Emergency Shutdown (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 Feedwater (BFW) pumps; - Fractionator's bottom pumps; - Fresh gas compressors (HCU).	- Drinking water pumps; - Sewage pumps.

5. REQUIREMENTS

5.1 Units of measure

REPLACE THIS CLAUSE BY:

Drawings and maintenance dimensions of pumps shall be in SI units or US Customary units.

API 658 Appendix B includes datasheets in both SI and US Customary units. Use of an SI units datasheet means that SI units shall be used. Use of a US Customary units datasheet means that US Customary units shall be used.

5.3 Alternative designs

REPLACE THIS CLAUSE BY:

5.3.1 The Vendor's primary quotation shall be in accordance with this DEP.

5.3.2 An alternative quotation may be submitted if the design offers significant price, delivery, or technical advantages over the primary quotation. Alternative quotation shall clearly identify the requirements that are different from those in this DEP.

5.4 Conflicting requirements

REPLACE THIS CLAUSE BY:

In case of conflicting requirements between documents relating to the inquiry or order, the following hierarchy of documents shall apply:

- upper level: applicable regulations

- second level: purchase order and variations thereto;
- third level: data/requisition sheets and drawings;
- fourth level: this DEP

6. BASIC DESIGN

6.1 General

6.1.4 ADD TO THIS CLAUSE:

The Vendor shall verify that the motor is large enough to operate at this higher head.

6.1.9 ADD TO THIS CLAUSE:

Net Positive Suction Head Available (NPSHA) shall exceed the Net Positive Suction Head Required (NPSHR) by at least 1.5 m (5 ft) throughout the range from minimum continuous flow to 110 % of the rated capacity, and by 0.6 m (2 ft) at 120 % of rated flow. If the suction pressure at the pump is less than atmospheric, this margin shall be at least 2 m (6.7 ft).

For liquids containing dissolved gases, to avoid cavitation damage due to vapor-induced flow path restrictions, NPSHA shall be 1.5 x NPSHR, with a minimum margin of 5 m (16.5 ft) between NPSHA and NPSHR.

6.1.10 REPLACE THIS CLAUSE BY:

Suction specific speeds shall be no greater than 12,800 unless approved by the Principal.

NOTES: 1. The above value shall be calculated in accordance with clause 3.76, however using the following units:

- rotative speed expressed in revolutions per minute;
- flow rate expressed in cubic metres per hour;
- NPSHR expressed in metres.

2. The above value is 11,000 when calculated using the following US Customary units:

- rotative speed expressed in revolutions per minute;
- flow rate expressed in U.S. gallons per minute;
- NPSHR expressed in feet.

6.1.12 REPLACE THE FIRST SENTENCE OF THIS CLAUSE BY:

Pumps shall have stable head/capacity curves, which continuously rise by at least 5 % from rated capacity to shut-off. The gradient of the tangent to the curve shall continuously decrease from 125 % of the best efficiency point to minimum continuous stable flow and shall remain positive.

6.1.14 REPLACE THIS CLAUSE BY:

Normal flow rate of the pump shall fall between 70 % and 100 % of the best efficiency capacity of the furnished impeller.

6.1.15 Noise Control

REPLACE THIS CLAUSE BY:

6.1.15.1 Limits

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 forms part of the requisition. The Vendor is responsible for assuring that these equipment noise limitations have been specified.

6.1.15.2 Information to be submitted with the tender

The Vendor shall submit guaranteed sound power levels and sound pressure levels (including octave band spectrum) of the equipment, together with any other relevant information as requested in the data sheet, DEP 31.10.00.94-Gen. The Vendor shall indicate what special silencing measures, if any, are proposed in order to meet the specified levels.

6.1.19 REPLACE THE FIRST SENTENCE OF THIS CLAUSE BY:

Cooling water plans shall not be supplied unless they are required by the seal flush plan, or if the pumping temperature exceeds 200 °C (400 °F) and are recommended by the Vendor.

6.1.25 REPLACE THIS CLAUSE BY:

Major parts such as the casing components and bearing housings shall be designed with a registered fit to ensure accurate alignment on reassembly. Pump designs that require gauging for parallelism shall not be used.

6.1.27 REPLACE THIS CLAUSE BY:

The pump and its driver shall perform on their test stand and on their permanent foundation within the acceptance criteria specified in 8.3.3.3.3. After installation, the performance of the combined units shall be the joint responsibility of the Purchaser and the Vendor who has unit responsibility.

6.2 Critical design and application considerations

6.2.1 ADD TO THIS CLAUSE:

The minimum continuous flow of the pump shall be based on the requirements in this DEP for material thicknesses and material of construction of the containment shell if these requirements cause power losses higher than those caused by the vendor's standard shell.

The Vendor shall confirm in the proposal the solids capabilities of the pump, including the allowable concentration and micron size of suspended solids in the pumped fluid. Vendor shall also confirm how the solids are prevented from entering the bearings and/or plugging up other small clearances and passageways.

In abrasive services, the mean speed of the pumpage at the discharge flange shall not exceed 5 m/s (16.4 ft/s).

ADD NEW CLAUSES:

6.2.4 The process cooling/lubrication system for internal bearings shall be designed to maintain a minimum of 0.7 bar (10 psi) vapor pressure margin at all points in the flow path. This margin shall be maintained at any capacity between minimum continuous flow and 110 % of the best efficiency capacity of the furnished impeller with the fluid entering the pump at maximum allowable suction temperature.

6.2.5 The pump rotor assembly shall be hydraulically balanced to minimize thrust load. Hydraulic balancing should be effective throughout the entire range of operation from minimum continuous flow to 110 % of the best efficiency capacity of the furnished impeller.

6.2.6 The rotor assembly thrust load shall be stable without thrust reversal throughout the entire range of operation. The Vendor shall confirm in the proposal how this is accomplished.

6.2.7 The Vendor shall supply in the proposal a capacity vs. thrust load curve. As a minimum, the capacity shall be from minimum continuous flow to 110 % of the best efficiency capacity of the furnished impeller.

6.3 Pressure casings

6.3.1 REPLACE THIS CLAUSE BY:

Tensile stress used in the design of the pressure casing for any material shall not exceed 0.25 times the minimum ultimate tensile strength or 0.67 times the minimum yield strength for that material, whichever is lower, across the full range of specified operating temperatures. For castings, the design tensile stress values shall be multiplied by the appropriate casting factor, as shown in Table II-1. The Manufacturer shall state the source of the material properties from those listed in Appendix H, Table H-2 (i.e. ASTM, UNS, ISO, EN, JIS), as well as the casting factors applied, in his proposal. Use of national material standards other than those listed in Appendix H, Table H-2 require approval of the Principal.

Table II-1 Casting factors

Type of NDE	Casting Factor
Visual, magnetic particle and/or liquid penetrant	0.8
Spot radiography	0.9
Ultrasonics	0.9
Full radiography	1.0

- NOTES:
1. In general, the criteria in 6.3.7 result in deflection (strain) governing the design of pump casings. Ultimate tensile strength or yield strength is seldom the governing factor.
 2. For bolting, the allowable tensile stress is used to determine the total bolting area based on hydrostatic load or gasket preload. It is recognized that to provide the initial load required to obtain a reliable bolted joint, the bolting will be tightened to produce a tensile stress higher than the design tensile stress. Values in the range of 0.7 times yield are common.

6.3.4 REPLACE THIS CLAUSE BY:

Pump Casings shall be radially split.

6.3.5 REPLACE THIS CLAUSE BY:

The pressure casing shall be designed to:

- a) operate without leakage or internal contact between rotating and stationary components while subject simultaneously to the MAWP (and corresponding temperature) and the worst case combination of twice the allowable nozzle loads of Table 1A (1B) applied through each nozzle;
- b) withstand the hydrostatic test (see 8.3.2)

NOTE: The twice nozzle load requirement is a pressure casing design criteria. Allowable nozzle loads for piping designers are the values given in Table 1A (1B). Other factors such as casing supports or baseplate stiffness affect allowable nozzle loads.

6.3.8 REPLACE THIS CLAUSE BY:

Centerline supported pump casings shall be used for all horizontal pump.

6.4 Nozzle and pressure casing connections

6.4.3 Pressure Casing Connections

6.4.3.1 REPLACE THIS CLAUSE BY:

All auxiliary connections to the pressure casing shall be fitted with flanged stubs. Integral flanges may be used.

Full-penetration butt welded connections, not socket-welded connections, shall be used if any of the following conditions apply: