

DEP SPECIFICATION

**CENTRIFUGAL PUMPS
(AMENDMENTS/SUPPLEMENTS TO ISO 13709)**

DEP 31.29.02.30-Gen.

February 2011
(DEP Circular 85/11 has been incorporated)

DESIGN AND ENGINEERING PRACTICE

DEM1



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PART I INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for centrifugal pumps.

This DEP is based on ISO 13709:2009. Part III and Part IV of this DEP amend, supplement and delete various clauses of ISO 13709.

NOTE: API 610, 11th edition, is identical to ISO 13709:2009.

Part III of this DEP applies to pumps for non-essential service and to spared pumps for essential service.

Part IV of this DEP applies, in addition to Part III, to pumps for vital service and to unspared pumps for essential service.

All clauses of ISO 13709 not modified by this DEP shall remain valid as written.

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual DEM 1 – Application of Technical Standards.

This is a revision of the DEP of the same number dated January 2010; 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 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 capitalised term **SHALL [PS]** indicates a process safety 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 V).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated January 2010.

The changes are extensive, due to the changes in ISO 13709, and it is not practical to list them in a table.

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://www.shell.com/standards> and on the main page of the DEPs DVD-ROM.

1.7 DUAL UNITS

**Amended per
Circular 85/11**

Dual units have been incorporated throughout this DEP.

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.

PART II GENERAL

Part III and IV of this DEP is written as amendments and supplements to ISO 13709:2009. Wherever reference is made to ISO 13709:2009, it shall be understood to mean ISO 13709:2009 as amended/supplemented by this DEP.

For ease of reference, the clause numbering of ISO 13709:2009 has been used throughout Part III and IV of this DEP.

Clauses in ISO 13709:2009, which are not mentioned in this DEP, shall remain valid as written.

PART III PUMPS FOR NON-ESSENTIAL SERVICE AND SPARED PUMPS FOR ESSENTIAL SERVICE (AMENDMENTS/SUPPLEMENTS TO ISO 13709:2009)

1. SCOPE

Add to this clause:

Part II of this DEP applies to pumps for non-essential service and to spared pumps for essential service.

3. DEFINITION OF TERMS

Add new clause:

3.65 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;

Add new clause:

3.66 hazardous service

service comprising the following categories, which shall be specified on the data/requisition sheets:

Category 1

- Liquids classified as "very toxic - acute", where single exposure via inhalation, skin or ingestion to this process stream can cause serious adverse health effects/fatality. Example: Strong acids (sulphuric acid, nitric acid, hydrogen fluoride, hydrogen chloride); Strong Alkalis (sodium hydroxide, potassium hydroxide, ammonia, phenol); tetra ethyl lead; tetra methyl lead; hydrogen fluoride; mercury; and hydrogen sulphide in concentrations at or above 600 mg/kg (600 ppm by weight). Liquids containing ethylene oxide

Category 2

- Liquids classified as "very toxic - chronic", where repeated or long-term exposure via inhalation to this process stream can cause serious adverse health effects which may lead to fatality. Example: Benzene, 1,3-butadiene ethylene oxide, propylene oxide, epichlorohydrin, carbon monoxide, 2-methoxyethanol, 2-ethoxyethanol, 2-methoxyethyl acetate.
- Hydrocarbon liquids at an operating temperature above their auto-ignition temperature.

Category 3

- Hydrocarbon liquids with a seal chamber vapour pressure higher than 500 kPaa (73 psia);
- Light hydrocarbon services (ISO 21049:2004, Clause 3.38).

Add new clause:

3.68 abrasive service

service in which there is an expected wear rate of 0.1 mm (1/250 in) or more per year, or where hard particles larger than 0.1 mm (1/250 in) exist in quantities exceeding 100 mg/kg (100 ppm).

Add new clause:

3.69 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.

4. GENERAL

4.2 CLASSIFICATION AND DESIGNATION

4.2.2 Pump designations and descriptions

4.2.2.4 Add To This Clause:

Pump type OH4 shall not be used.

4.2.2.5 Add To This Clause:

OH5 pumps shall also comply with BS 4082-1, with a casing test pressure rating of Code R.

4.2.2.10 Add To This Clause:

Pump type BB4 shall not be used.

4.2.2.15 Add To This Clause:

Pump type VS4 is not preferred and its selection is subject to the approval of the Principal.

6. BASIC DESIGN

6.1 GENERAL

6.1.8 Replace this clause by:

The Net Positive Suction Head Required (NPSH3) shall be based on water [at a temperature of less than 65 °C (150 °F)] at the rated flow and rated speed; no reduction or correction factors shall be applied for other liquids.

The Net Positive Suction Head Available (NPSHA) shall exceed the Net Positive Suction Head Required (NPSH3) by at least 1 m (3 ft) throughout the range from minimum continuous stable flow up to and including the rated capacity, and by 0.3 m (1 ft) at the lessor of 120 % of rated flow and maximum system capacity. If the suction pressure at the pump is less than atmospheric, this margin shall be at least 2 m (6 ft).

For sulfinol, carbonate and amine services, NPSH margin ratio (i.e. NPSHA / NPSH3) shall be at least 1.3 for tip speeds up to 35 m/s (115 ft/s), at least 1.5 for tip speeds between 35 m/s (115 ft/s) and 60 m/s (197 ft/s), and at least 2.0 for tip speeds above 60 m/s (197 ft/s).

6.1.9 Add to this clause:

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 Annex A, however using the following units:

- rotative speed expressed in revolutions per minute;
- flow rate expressed in cubic metres per hour;
- NPSH3 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;
- NPSH3 expressed in feet.

6.1.11 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 Noise Control

Replace this clause by:

6.1.14.1 Information to be submitted with the tender

For each pump service with a driver 75 kW (100 HP) and larger, 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.

6.1.15 Add to this clause:

The numbers of vanes in impellers shall be different to the numbers of vanes in diffusers. On pumps with two or more stages impellers/diffuser configuration shall be staggered to avoid coincidence of pressure pulses.

6.1.17 Replace the first sentence of this clause by:

Cooling water plans shall not be supplied, unless it is required by the seal flush plan or if the pumping temperature exceeds 200 °C (400 °F). Above 200 °C (400 °F) cooling water plans shall only be applied if recommended by the vendor.

6.1.18 Replace this clause by:

Heating jackets for seal chambers, and bearings shall be integrally cast or welded design. The coolant passage shall allow cleaning, flushing and draining of the entire passageway. Only heating chambers for bearing brackets may be equipped with O-ring sealed covers to facilitate cleaning.

6.1.24 Replace this clause by:

All major joints shall make up metal-to-metal. Pump designs which require gauging for parallelism shall not be used.

6.1.28 Add to this clause:

For marine applications, the vendor shall state the maximum inclination at which the pump can operate.

Add new clause:

6.1.35 For balancing axial thrust in multi-stage pumps, only the following arrangements shall be used, either alone or in combination:

- individually-balanced impellers or opposed arrangements of impellers;
- a balancing piston (except that this shall not be used if the pump is for abrasive service (see 3.63)).

Balance disk or combinations with a balance disk shall not be used.

6.3 PRESSURE CASINGS

6.3.5 All parts referred to in the definition of pressure casing (3.43) SHALL [PS] have the same MAWP.

6.3.9 Replace subclause a) by:

a) When specified, a pumping temperature of 100 °C (200 °F) or higher.

6.4 NOZZLE AND PRESSURE CASING CONNECTIONS

6.4.2 Suction and discharge nozzles

6.4.2.1 Replace this clause by:

All pumps shall have flanged suction and discharge nozzles of equal ASME pressure/temperature ratings.

6.4.3 Auxiliary connections

6.4.3.1 Add to this clause:

All auxiliary connections to the pressure casing shall be fitted with flanged stubs. Integral flanges may be used. If the pump nozzles are Class 900 or above, or the pumping temperature is 0 °C (32 °F) or below, or if the pump is for hazardous service, or if ISO 15156 or NACE MR0103 is applicable, then socket welded connections shall not be used. In these cases full penetration butt welded connections are required.

Balance lines and their connections shall be flanged. Unions shall not be used.

6.4.3.9 Add to this clause:

Valves shall not be welded to the pump

6.6 ROTORS

6.6.3 Replace the third sentence of this clause by:

Collets shall not be used in vertical pumps.

6.6.11 Add to this clause:

The use of target rings requires the approval of the Principal.

Add new clause:

6.6.15 Shafts and impellers shall not be plated for repair purposes. Repairs to rotating elements shall be subject to review and approval by the Principal.

6.7 WEAR RINGS AND RUNNING CLEARANCES

6.7.2 **Add to this clause:**

The minimum hardness of wear rings shall be 250 HBW except where restricted by Appendix 1 of this DEP.

6.7.3 **Add to this clause:**

Wear rings shall not be of a U-shaped design.

6.8 MECHANICAL SHAFT SEALS

6.8.1 **Replace this clause by:**

All mechanical seals and sealing systems SHALL [PS] be in accordance with DEP 31.29.00.33-Gen.

To ensure selection of the optimum mechanical seal and seal auxiliary facilities for the duty specified, the pump manufacturer shall be responsible for the engineering coordination, installation, and performance of its auxiliary facilities such as circulation, injection, quenching and cooling, as required for the seal selected by the seal manufacturer.

6.8.2 **Add to this clause:**

... except for vertical pumps types OH5 and OH6.

6.9 DYNAMICS

6.9.2 Torsional analysis

6.9.2.2 **Add to this clause:**

Torsional analysis shall be performed if specified by the Principal.

NOTE: It is unusual for a torsional analysis to be required for a pump. A torsional analysis and the associated report can be expensive, so caution should be exercised when specifying a torsional analysis.

Replace sub-clause e) by:

e) electric motor with variable frequency drive (VFD) rated at 500 kW (670 hp) or higher.

6.9.3 Vibration

6.9.3.2 **Add to this clause:**

For vertical, close-coupled, in-line pumps vibration readings shall be taken on both bearings for the electric motor driver in the horizontal plane at 90° to each other. For vertical pumps with a flexible coupling additional readings shall be taken at the pump top bearing.

6.9.3.3 **Add to this clause:**

The plotted spectra shall be included with the pump test results.

6.10 BEARINGS AND BEARING HOUSINGS

6.10.1 Bearings

6.10.1.2 **Add sub-clause e):**

Non-metallic cages shall not be used.

6.10.1.6 **Add to this clause:**

The bearing system life calculations shall be furnished.

Table 10 **Add sub-clause d):**

d) journal sizes greater than 150 mm (6 in).

6.10.2.6 **Add to this clause:**

Non-SPEC pumps with a steam-quench of the seal shall have magnetic bearing isolators.