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Producers

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# Supplementary Specification to ANSI/API Standard 610 Centrifugal Pumps



#### Revision history

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1.0	January 2019	Issued for Publication

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## Acknowledgements

This IOGP Specification was prepared by a Joint Industry Project 33 Standardization of Equipment Specifications for Procurement organized by IOGP with support by the World Economic Forum (WEF).

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## Foreword

This specification was prepared under a Joint Industry Project 33 (JIP33) “Standardization of Equipment Specifications for Procurement” organized by the International Oil & Gas Producers Association (IOGP) with the support from the World Economic Forum (WEF). Ten key oil and gas companies from the IOGP membership participated in developing this specification under JIP33 Phase 2 with the objective to leverage and improve industry level standardization for projects globally in the oil and gas sector. The work has developed a minimized set of supplementary requirements for procurement, with life cycle cost in mind, based on the ten participating members’ company specifications, resulting in a common and jointly approved specification, and building on recognized industry and international standards.

This specification has been developed in consultation with a broad user and supplier base to promote the opportunity to realize benefits from standardization and achieve significant cost reductions for upstream project costs. The JIP33 work groups performed their activities in accordance with IOGP’s Competition Law Guidelines (November 2014).

Recent trends in oil and gas projects have demonstrated substantial budget and schedule overruns. The Oil and Gas Community within the World Economic Forum (WEF) has implemented a Capital Project Complexity (CPC) initiative which seeks to drive a structural reduction in upstream project costs with a focus on industry-wide, non-competitive collaboration and standardization. The vision from the CPC industry is to standardize specifications for global procurement for equipment and packages, facilitating improved standardization of major projects across the globe. While individual oil and gas companies have been improving standardization within their own businesses, this has limited value potential and the industry lags behind other industries and has eroded value by creating bespoke components in projects.

This specification aims to significantly reduce this waste, decrease project costs and improve schedule through pre-competitive collaboration on standardization. This document defines the supplementary requirements to recognized international standard ANSI/API Standard 610 11<sup>th</sup> Edition September 2010 Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries, an identical adoption of ISO 13709:2009 with the same title, which is indispensable for the application of this specification.

Following agreement of the relevant JIP33 work group and approval by the JIP33 Steering Committee, the IOGP Management Committee has agreed to the publication of this specification by IOGP. Where adopted by the individual operating companies, this specification and associated documentation aims to supersede existing company documentation for the purpose of industry-harmonized standardization.

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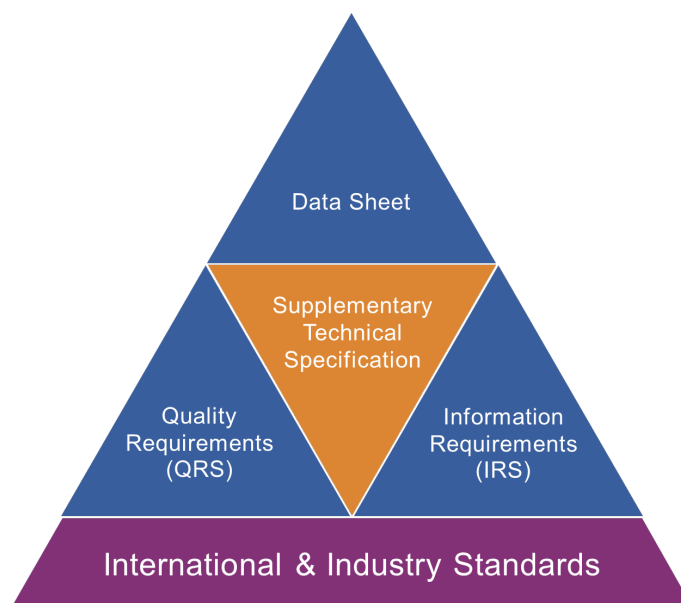
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## Introduction

The purpose of this specification is to define a minimum common set of supplementary requirements for procurement of centrifugal pumps in accordance with ANSI/API Standard 610 11<sup>th</sup> Edition September 2010 Centrifugal Pumps, which is an identical adoption of ISO 13709:2009 with the same title, for application in the petroleum and natural gas industries.

This JIP33 standardized procurement specification follows a common document structure comprising the four documents as shown below, which together with the purchase order define the overall technical specification for procurement.



### JIP33 Specification for Procurement Documents Supplementary Technical Specification

It is required to use all of these documents in conjunction with each other when applying this specification, as follows:

#### **S-615: Supplementary specification to ANSI/API Standard 610 for Centrifugal Pumps**

This specification is written as an overlay to ANSI/API Std 610, following the clause structure of the parent standard, to assist in cross-referencing the requirements. Where clauses from the parent standard (ANSI/API Std 610) are not covered in this specification, there are no supplementary requirements or modifications to the respective clause. The terminology used within this specification follows that of the parent standard and otherwise is in accordance with ISO/IEC Directives, Part 2.

Modifications to the parent standard defined in this specification are identified as Add (add to clause or add new clause), Replace (part of or entire clause) or Delete.

#### **S-615D: Data sheets for Centrifugal Pumps**

This document provides project specific requirements where the supplementary specification and its parent standard require the purchaser to define an application specific requirement. It also includes information required by the purchaser for technical evaluation. Additional purchaser supplied documents are also listed on the data sheets, to define scope and technical requirements for enquiry and purchase of the equipment.

**S-615L: Information requirements for Centrifugal Pumps**

This document defines the information requirements, including format, timing and purpose, for information to be provided by the vendor. It also defines the specific conditions which must be met for conditional information requirements to become mandatory. The information requirements listed on the IRS have references to the source of the requirement..

**S-615Q: Quality requirements for Centrifugal Pumps**

This document includes a conformity assessment system (CAS) which specifies standardized user interventions against quality management activities at four different levels. The applicable CAS level is specified by the purchaser on the data sheets.

The data sheets and IRS are published as editable documents for the user to specify application specific requirements. The supplementary specification and QRS are fixed documents.

Unless defined otherwise in the purchase order, the order of precedence (highest authority listed first) of the documents shall be:

- a) regulatory requirements;
- b) contract documentation (e.g. purchase order);
- c) purchaser defined requirements (data sheets, IRS, QRS);
- d) this specification;
- e) the parent standard.

## 1 Scope

### Add after second paragraph

This specification does not apply to all pumps and services within the scope of ANSI/API Std 610.

The scope excludes the following:

a) types:

- OH4, BB4 and BB5 pumps;
- single volute overhung pumps requiring a driver rated in excess of 112 kW (150 HP);
- overhung pumps with two or more stages;
- double suction overhung pumps;

b) services:

- pumps in cryogenic services [ $< -100\text{ °C}$  ( $-148\text{ °F}$ )];
- pumps in multi-phase service.

c) auxiliaries:

- pumps with drivers  $> 1\ 000\text{kW}$  (1 340 HP);
- pumps with ANSI/API Std 614 force feed lubrication systems.

## 2 Normative references

### Delete from clause

ISO 1940-1	Mechanical vibration — Balance quality requirements for rotors in a constant (rigid) state — Part 1: Specification and verification of balance tolerances
ISO 9906	Rotodynamic pumps — Hydraulic performance acceptance tests
ISO 21049:2004	Pumps — Shaft sealing systems for centrifugal and rotary pumps
ANSI/HI 1.6	Centrifugal Tests

### Add to clause

ISO 9906	Rotodynamic pumps — Hydraulic performance acceptance tests - Grades 1, 2 and 3 - Second Edition
ISO 21940-11	Mechanical vibration — Rotor balancing — Part 11: Procedures and tolerances for rotors with rigid behaviour
ANSI/API Std 682	Pumps — Shaft sealing systems for centrifugal and rotary pumps
ANSI/HI 14.6	Rotodynamic Pumps for Hydraulic Performance Acceptance Tests



### 3 Terms and definitions

#### 3.22 maximum discharge pressure

*Replace subclause with*

maximum discharge pressure is the maximum suction pressure plus the maximum differential pressure that the pump is capable of developing at shut-off when operating with the maximum specified relative density (specific gravity) with:

- the maximum impeller diameter at the rated speed for constant speed applications;
- the rated impeller diameter at the trip speed for variable speed applications

#### 3.23 maximum dynamic sealing pressure

*Replace fifth sentence of note with*

See ANSI/API Std 682.

#### 3.24 maximum operating temperature

*Replace second sentence of note with*

See ANSI/API Std 682.

#### 3.43 pressure casing

*Replace subclause with*

composite of all stationary pressure-containing parts of the pump, including all nozzles, seal glands, seal chambers and all auxiliary process fluid containing piping permanently attached to the pump casing but excluding the stationary and rotating members of mechanical seals

### 5 Requirements

#### 5.1 Units

*Replace subclause with*

The units required for all vendor's documentation shall be as per the data sheet units. However, piping dimensions shall be in accordance with ANSI.

### 6 Basic design

#### 6.1 General

##### 6.1.1

*Add to subclause*

Only equipment of proven reliability with equivalent design features to the units proposed and operating in similar service conditions shall be included in the vendor's proposal. Prototypes shall not be proposed. The vendor shall confirm that the quoted equipment (including pump, driver and gear) design is proven and demonstrate experience of 24 000 operating hours with the same equipment in at least three similar installations by providing the related necessary evidence.

#### 6.1.4

##### Add to subclause

For fixed speed pumps, the proposed rated impeller diameter for pumps with constant speed drivers shall be not be greater than 95 % or less than 80 % of the maximum impeller diameter that can be installed in the pump casing.

For pumps with variable speed drives, the impeller diameter giving the maximum efficiency shall be selected. If this results in the selected impeller diameter being the maximum for the chosen casing, then the driver and pump shall be capable of the speed increase necessary to give a 5 % increase in head (per subclause 6.1.4 of ANSI/API Std 610) and to correct any head shortfall during testing, including the -3 % tolerance allowed by Table 16 of ANSI/API Std 610.

#### 6.1.7

##### Replace second sentence of second paragraph with

During operation, the seal chamber pressure shall be at least a gauge pressure of 35 kPa (0,35 bar; 5 psi); see ANSI/API Std 682.

#### 6.1.9

##### Replace subclause with

The pump suction-specific speed shall be calculated in accordance with Annex A of ANSI/API Std 610. With the exception of OH6 type pumps, suction-specific speed values shall not exceed 213 m<sup>3</sup>/s, rpm, m (11 000 gpm, rpm, ft). Suction-specific speed values higher than 213 m<sup>3</sup>/s, rpm, m (11 000 gpm, rpm, ft) may be accepted if the vendor can demonstrate proven experience of at least 3 years of operation at similar operating conditions such as NPSH margins and percentage of operating point to BEP.

Pumps with suction inducers may be considered if approved by purchaser. In which case the vendor shall:

- clearly indicate that the proposed pump includes a suction inducer;
- state the suction-specific speed for the impeller only;
- clearly show the allowable operating region on the pump curve.

#### 6.1.10

##### Add to subclause at end of first paragraph

The proposal and final test curves for pumps in viscous service shall also include:

- the expected performance curves with specified viscous product;
- the maximum expected absorbed powers based on a cold viscous start up and normal viscous operation.

#### 6.1.11

##### Replace subclause with

Pumps that have stable head versus flowrate curves (continuous head rise to shutoff) are required for all applications. The head rise from rated point to shutoff shall be at least 10 %. If a discharge orifice is required as a means of providing a continuous rise to shutoff, this shall be subject to purchaser's approval. Where offered, the vendor shall furnish full performance curves for the pump with and without the orifice installed.

A pump suction side restriction ring, commonly known as a "Bull Ring" is not allowed.

#### **6.1.24**

##### Add to subclause

Any non-rotating maintenance part weighing more than 25 kg shall be supplied with an appropriately located tapped hole to fit a removable lifting eye.

#### **6.1.28**

##### Add to subclause

For floating applications, the vendor shall state the maximum inclination and time period of oscillation at which the pump can operate.

#### **6.1.29 Bolting and threads**

##### **6.1.29.1**

##### Replace first sentence with

The details of threading shall conform to ISO 261, ISO 262, ISO 724, ISO 965 (all parts), ANSI/ASME B1.1 or other internationally standardized threading.

##### Add new subclause

#### **6.1.35**

Any requirement for instantaneous start-up shall be specified on the data sheet.

##### Add new subclause

#### **6.1.36 Warm up and cool down**

The vendor shall specify on the data sheet details of a separate warm-up (or cool-down) line, if required, to achieve instantaneous start-up of the pump with the pumping temperatures indicated on the data sheet. If an instantaneous start-up is not possible under any circumstances, the vendor shall make provisions to ensure that rapid heat-up does not damage the pump, accessories, or seals. The vendor shall submit the warm-up (or cool-down) procedure.

##### Add new subclause heading

#### **6.1.37 Insulation and heat tracing**

##### Add new subclause

##### **6.1.37.1**

If specified, personnel protection hot insulation shall be applied to all parts that are exposed to contact with persons during control and routine maintenance operations.

##### Add new subclause

##### **6.1.37.2**

If specified, frost protection or wax formation protection heat tracing and insulation shall be applied to all necessary parts to maintain all the equipment in its normal operating state when the pump is on standby.

Add new subclause

**6.1.37.3**

Where such insulation is required, insulation shall comply with the requirements specified on the data sheet. The vendor shall provide sufficient stand-offs and clearance from the insulated surface throughout for pipe flanges, valves and all instrument equipment to allow the fitment of the insulation and access for maintenance. Surface coatings under insulation shall comply with the requirements specified on the data sheet.

Add new subclause

**6.1.38**

All equipment installed in a hazardous area shall be certified for use in explosive atmospheres in accordance with applicable regulatory requirements.

**6.3 Pressure casings**

**6.3.1**

Replace subclause with

The maximum discharge pressure is defined in 3.22.

NOTE The basis of determining maximum discharge pressure is an application issue.

**6.3.5**

Replace paragraph after note 2 with

The pump-seal chamber and seal gland shall have a pressure-temperature rating at least equal to the maximum allowable working pressure and temperature of the pump casing to which it is attached, in accordance with subclause 3.1.52 of ANSI/API Std 682:2014.

**6.3.6**

Replace subclause with

All parts referred to in the definition of pressure casing shall have the same MAWP.

**6.3.10**

Replace third sentence of note with

ANSI/API Std 682 specifically requires O-ring gaskets on low temperature [ $< 175\text{ }^{\circ}\text{C}$  ( $350\text{ }^{\circ}\text{F}$ )] pressure-seal gland plates.

**6.3.11**

Add to subclause

Centreline or near centreline supported pumps operating above  $204\text{ }^{\circ}\text{C}$  ( $400\text{ }^{\circ}\text{F}$ ) shall have a casing guide or key slot along the centreline and at each support pedestal. For pumps with four centreline or near centreline mounting feet, the key guides shall be on the non-drive end pedestals guiding thermal expansion away from the coupling end of the pump.

## 6.4 Nozzles and pressure casing connections

### 6.4.1 Casing opening sizes

#### 6.4.1.2

Add to subclause

Drain connections of pumps handling fluids with a viscosity  $\geq 400$  cP, or products with higher than ambient pour point temperature, or slurries shall be DN25 (NPS 1) minimum and shall be free draining.

### 6.4.2 Suction and discharge nozzles

#### 6.4.2.1

Replace second sentence with

All pumps shall have suction and discharge flanges of equal rating.

### 6.4.3 Auxiliary connections

#### 6.4.3.1

Add to subclause

Socket welded connections shall not be used when:

- a) the pump nozzles are Class 900 or above, or;
- b) the minimum pumping temperature is 0 °C (32 °F) or below, or;
- c) the pump is for hazardous service, or;
- d) NACE MR0175 or NACE MR0103 is applicable.

#### 6.4.3.10

Replace first sentence with

Piping less than DN50 (NPS 2) shall be gusseted in two orthogonal planes to increase the rigidity of the piped connection, in accordance with the following stipulations.

Replace item e) with

- e) Gussets shall not be bolted to the casing.

#### 6.4.3.11

Add to subclause after fifth sentence

Plugs that may require subsequent removal or plugs in cast iron casings shall be 316 stainless steel.

## 6.6 Rotors

### 6.6.3

Replace third sentence with

Collets shall not be used in vertical pumps.

Add new subclause

### 6.6.15

Impellers with four vanes shall not be provided in double volute pumps.

Add new subclause

### 6.6.16

Repairs to correct machining errors shall be subject to approval by the purchaser. Metal plating shall not be used for shaft or impeller repairs. Weld repair of shaft shall not be permitted.

## 6.7 Wear rings and running clearances

### 6.7.3

Replace subclause with

Renewable wear rings, if used, shall be held in place by a press fit with three axial screws or by tack welding in at least three places.

### 6.7.4

Replace first sentence with

Running clearances shall meet the requirements of 6.7.4 a) to 6.7.4 c). Quoted pump performance and curve shall be based on the clearances used by the vendor after making allowances for any added clearance based on temperature, viscosity and galling tendencies.

Add new subclause

### 6.7.5

Run-out of casing wear rings and casing-to-cover area shall not exceed 50  $\mu\text{m}$  (0,002 in) TIR.

## 6.8 Mechanical shaft seals

### 6.8.1

Replace subclause with

Pumps shall be equipped with mechanical seals and sealing systems in accordance with ANSI/API Std 682. Pump and seal interface dimensions shall be in accordance with Table 7 and Figure 26 of ANSI/API Std 610. The purchaser shall specify the category of seal required. The purchaser should use the datasheets in ANSI/API Std 682 for this purpose.

The pump vendor shall be responsible for the engineering co-ordination, installation and performance of the mechanical seal and its auxiliary facilities such as circulation, injection, quenching and cooling.

## 6.8.2

### Replace subclause with

The seal cartridge shall be removable without disturbing the driver, except for vertical pumps types OH5 and OH6.

## 6.8.7

### Replace second sentence with

Symbols shall be in accordance with those specified in ANSI/API Std 682.

## 6.8.11

### Replace first sentence with

If specified, or deemed to be required by the vendor, jackets shall be provided on seal chambers for heating.

## 6.9 Dynamics

### 6.9.2 Torsional analysis

#### 6.9.2.1

##### Add to end of item c)

Transient conditions include short circuit between two phases, start-up and, if specified, re-acceleration. A stress analysis shall be performed for the transient conditions to ensure that shaft-end, coupling and drive-component ratings are not exceeded.

#### 6.9.2.10

##### Replace first sentence with

If either a steady-state, damped-response analysis or a transient torsional analysis is performed, the vendor shall furnish a detailed report of the torsional analysis.

### 6.9.3 Vibration

#### 6.9.3.3

##### Replace second sentence with

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

### 6.9.4 Balancing

#### 6.9.4.1

##### Replace first sentence with

Impellers, balancing drums and similar major rotating components shall be dynamically balanced to ISO 21940-11, grade G2.5.

#### 6.9.4.4

Replace first sentence of first paragraph with

If specified, impellers, balancing drums and similar major rotating components shall be dynamically balanced to ISO 21940-11, grade G1 (equivalent to 4WIn in USC terminology).

Replace second sentence of third paragraph with

In international standards, unbalance is expressed as a balance quality grade of ISO 21940-11.

### 6.10 Bearings and bearing housings

#### 6.10.1 Bearings

##### 6.10.1.1

Replace second paragraph with

The bearing type and arrangement shall be selected in accordance with the limitations in Table 10 of ANSI/API Std 610.

##### 6.10.1.4

Replace third sentence with

Pressed steel cages shall not be used.

#### 6.10.2 Bearing housings

##### 6.10.2.4

Replace first sentence with

Cooling, including an allowance for fouling, shall be provided to maintain oil and bearing temperatures as follows, based on the operating conditions and the lubrication system design ambient temperature specified on the data sheet:

Replace item a) with

- a) for pressurized systems, unless otherwise specified on the datasheet, oil outlet temperature below 70 °C (160 °F) and bearing metal temperatures (if bearing-temperature sensors are supplied) less than 93 °C (200 °F); during shop testing, and under the most adverse specified operating conditions, the bearing-oil temperature rise shall not exceed 28 K (50 °R);

Replace item b) with

- b) for ring-oiled or splash systems, unless otherwise specified on the datasheet, an oil-sump temperature below 82 °C (180 °F); during shop testing, the sump oil temperature rise shall not exceed 40 K (70 °R) above the ambient temperature in the test cell measured at the time of each reading and (if bearing-temperature sensors are supplied) outer ring temperatures shall not exceed 93 °C (200 °F).



## 6.11 Lubrication

### 6.11.4

Replace subclause with

Grease lubrication shall not be used except for VS4 and VS5 pumps as per subclause 9.3.12.4 of ANSI/API Std 610. Grease lubrication may be used for OH3 pumps subject to approval by the purchaser.

## 6.12 Materials

### 6.12.1 General

#### 6.12.1.3

Replace second sentence with

O-rings shall be selected and their application limited in accordance with ANSI/API Std 682.

#### 6.12.1.8

Replace subclause with

The vendor shall furnish material certificates that include chemical analysis and mechanical properties for the heats from which the material is supplied for the items listed below. Items (excluding lifting points) in sour service shall be supplied with material certificates containing a declaration of conformity to NACE MR0175 (all parts) or NACE MR0103 as specified on the data sheet.

- all process pressure-containing components, including any material welded directly to them;
- all process pressure retaining components;
- impellers;
- shafts;
- lifting points.

### 6.12.2 Castings

#### 6.12.2.3

Add to item a)

Weld repairs shall be defined as major when the depth of the cavity after preparation for repair exceeds 20 % of the actual wall thickness, or 25 mm (1 in), whichever is smaller, or when the extent of the cavity exceeds approximately 65 cm<sup>2</sup> (10 in<sup>2</sup>). All other weld repairs shall be considered minor.

Major weld repairs shall be documented.

Castings shall be heat-treated after major weld repairs according to the applicable material standard. Heat treatment after minor weld repairs is not required except where specified in the applicable material standard or upon agreement between the vendor and the purchaser.

#### 6.12.2.5

Replace subclause with

For casting repairs made in the vendor's shop, these shall be carried out in accordance with a weld repair procedure compliant with the component ASTM material specification. For major repairs as defined in 6.12.2.3, the vendor shall prepare documentation including weld repair maps showing the location and dimensions of weld repair cavities, qualification records, drawings, photographs, heat treatment detail, non-destructive examination requirements and other specified documents shall be submitted for purchaser's approval. The purchaser shall specify if approval is required before proceeding with repair. Repairs made at the foundry level shall be controlled by the casting material specification ("producing specification").

### 6.12.3 Welding

#### 6.12.3.4

Delete from item e)

The purchaser shall specify if the following additional examinations shall be performed:

- 1) magnetic-particle or liquid-penetrant examination of auxiliary connection welds;
- 2) ultrasonic or radiographic examination of any casing welds.

### 6.13 Nameplates and rotation arrows

#### 6.13.1

Replace subclause with

A nameplate shall be securely attached at a readily visible location on the equipment (including after any insulation is fitted) and on any other major piece of auxiliary equipment.

#### 6.13.2

Replace first sentence with

The nameplate shall be stamped with characters of 5 mm (0,2 in) minimum size, and in the language specified by the purchaser with the following information, in units consistent with the data sheet:

Add to list

- k) year of manufacture;
- l) shaft lift (for vertical pumps).

#### 6.13.3

Replace subclause with

In addition to being stamped on the nameplate, the pump serial number shall be plainly and permanently marked on the pump casing main constituents: casing, casing cover, lower and upper half casings, discharge head and suction can.

## 7 Accessories

### 7.1 Drivers

#### 7.1.3

Replace subclause with

For drive-train components that have a mass greater than 100 kg (220 lb), the equipment feet shall be provided with vertical jackscrews. The vendor shall allow a minimum clearance of 50 mm (2 in) under the driver to enable the use of a hydraulic jack when there are no jackscrews fitted.

#### 7.1.4

Replace second sentence with

On pumps where it is only possible to carry out shop testing with the contract motor, the motor rating shall be sufficient to permit shop testing with water. An overload of 10 % above the motor rated power at the pump rated duty point may be allowed during the test period subject to approval of the motor manufacturer.

#### 7.1.6

Replace subclause with

For which ever type of pump starting method is specified (for example against closed discharge valve, open system, bypass) the motor driver starting torque capability at 80 % voltage shall exceed the speed-torque requirements of the driven equipment by 10 % minimum of the required torque, along all points on the driven equipment speed-torque curve.

#### 7.1.7

Replace subclause with

Vertical suspended pumps and vertical in-line pumps shall have motors designed for vertical service. Unless otherwise specified on the data sheet, motors for vertical pumps shall have solid shafts. If the pump thrust bearing is in the motor, the motor shall meet the shaft and base tolerances shown in Figure 36 of ANSI/API Std 610. For all vertical pumps, the vendor shall shop mount, align, and match mark the motor. Specific motor requirements will be incorporated on the motor data sheet.

### 7.2 Couplings and guards

#### 7.2.3

Replace subclause with

Couplings shall be balanced to ISO 21940-11, grade G6.3 or a more stringent balance grade.

#### 7.2.14

Replace subclause with

Coupling guards shall be constructed of an agreed spark-resistant material (see subclause 6.10.2.6 and note of ANSI/API Std 610).

## 7.3 Baseplates

### 7.3.5

Replace first sentence of second paragraph with

This requirement shall be demonstrated in the pump-vendor's shop prior to mounting of the equipment and with the baseplate supported at the foundation bolt holes only.

### 7.3.6

Replace first paragraph third sentence with

Shim packs shall not be thicker than 13 mm (0,5 in) nor contain more than 3 shims.

### 7.3.10

Replace sixth sentence with

Vent holes at least 13 mm (0,5 in) in diameter shall be provided at each of the corners in each bulkhead section of the baseplate.

### 7.3.13

Replace subclause with

For pump baseplates required to be un-grouted, the baseplate and pedestal support assembly shall maintain alignment and the deflection criteria defined in Table 13 of ANSI/API Std 610 when the pump is subjected to the nozzle loads defined in Table 5 of ANSI/API Std 610.

### 7.3.17

Replace first sentence with

Transverse and axial alignment positioning jackscrews shall be provided for drive-train components having a mass greater than 100 kg (220 lb) to facilitate transverse horizontal and longitudinal adjustments.

Add new subclause

### 7.3.22

Two grounding lugs shall be provided on each baseplate, located at diagonal opposite corners, with 13 mm ( $1/2$  in) brass studs, nuts and washers.

## 7.4 Instrumentation

### 7.4.2 Vibration, position and temperature detectors

#### 7.4.2.2

Replace first sentence with

For equipment with hydrodynamic bearings, provision shall be made for mounting two radial-vibration probes in each housing, two axial-position probes at the thrust end of each machine. Provision for mounting a one-event-per-revolution probe in each driver shall be made.

Add to subclause after first sentence

Probes shall be located so that any spill is avoided during probe change out.

#### 7.4.2.3

Replace first sentence with

Hydrodynamic thrust and radial bearings shall be fitted with bearing metal temperature detectors.

Add new sub-clause

#### 7.4.2.5

A complete instrument list and individual instrument data sheets shall be submitted to the purchaser for all instruments supplied by the vendor.

## 7.5 Piping and appurtenances

### 7.5.1 General

#### 7.5.1.4

Replace subclause with

Barrier or buffer fluid reservoirs shall be designed for mounting on the pump baseplate or motor support stand (vertical pumps). These reservoirs and the fluid-circulation tubing shall be fully installed and supported.

#### 7.5.1.6

Replace subclause with

Each piping system shall be manifolded to a single purchaser's inlet or outlet flanged connection to the edge and within the boundary of the baseplate.

NOTE The datasheet allows selection of this option for vent, cooling and drain connections.

Add new subclause

#### 7.5.1.9

Other than for seal plans, tubing shall not be used for any process wetted systems.

Add new subclause

**7.5.1.10**

Brackets and supports welded on the mechanical equipment or on the baseplate shall have full length welds. Stitch welding is unacceptable.

**7.5.2 Auxiliary process liquid piping**

**7.5.2.4**

Add to subclause

The orifice shall be a removable, flat orifice plate mounted between flanges. Restriction orifices shall have the size and orifice tag number stamped on the upstream side of the orifice tab.

**7.5.2.6**

Replace subclause with

Except for connections to cast iron, threaded vent and drain connections are not permitted.

**7.5.2.8**

Replace subclause with

Unions shall not be used.

**7.6 Special tools**

Add new subclause

**7.6.3**

Operating procedures for special tools, if any, shall be included in the installation, operating and maintenance manual.

**8 Inspection, testing and preparation for shipment**

**8.1 General**

**8.1.5**

Replace subclause with

Prior to release for shipment, the purchaser's and the vendor's representative shall mutually agree compliance in accordance with an inspector's checklist such as that provided in ANSI/API Std 610 Annex E by initialling and dating the completed checklist.

## 8.2 Inspection

### 8.2.2 Pressure-casing materials inspection

#### 8.2.2.1

Add to sub-clause

The vendor shall submit to the purchaser the detailed pertinent non-destructive examination procedures.

**Table 14 – Pressure casing material inspection requirements**

Add rows to Table 14

Fabricated casing welds	VI	VI, plus MT or PT	VI, plus MT or RT (100 %)
Casing attachment welds	VI	VI, plus MT or PT	VI, plus MT or PT

#### 8.2.2.7

Replace first sentence with

When sour service is specified, the hardness of parts, welds and heat-affected zones shall be verified as being within allowable values by testing.

#### 8.2.2.8

Replace first sentence with

Pressure boundary parts of alloy materials, including overlays shall be subject to positive material identification (PMI) using recognized testing methods, instrumentation and standards.

## 8.3 Testing

### 8.3.1 General

#### 8.3.1.1

Replace first sentence with

The vendor shall submit to the purchaser detailed procedures for all running tests and all specified optional tests (subclause 8.3.4 of ANSI/API Std 610).

#### 8.3.1.2

Replace first sentence with

Performance and NPSH test shall be conducted using the methods and uncertainty requirements of ISO 9906 Grade 1, ANSI/HI 14.6 (for centrifugal pumps) or ANSI/HI 2.6 (for vertical pumps).

### 8.3.2 Hydrostatic test

#### 8.3.2.1

Add to sub-clause

The vendor shall submit to the purchaser the detailed hydrostatic test procedure.

**8.3.2.2**Add to subclause after first sentence

The test shall be conducted after completion of case machining except when subclause 8.3.2.10 of ANSI/API Std 610 applies.

**8.3.2.9**Replace third sentence with

Gland plates and removable seal chambers shall be tested as specified in ANSI/API Std 682.

Delete NOTE from subclause**8.3.2.10**Replace second paragraph with

Any areas that are to be machined after hydrostatic testing shall be identified on the hydrotest report that shall be submitted to the purchaser prior to start of post hydrostatic test machining.

**8.3.2.12**Replace subclause with

All pumps pressure containing parts shall be tested to the same pressure. Segmental testing shall not be allowed.

Add new subclause**8.3.2.17**

Any repairs required after the hydrostatic test shall be subject to approval by the purchaser.

**8.3.3 Performance test****8.3.3.1**Add to subclause

Spare rotor purchased with the main equipment shall undergo the same performance test and mechanical running tests as the main equipment. The vendor shall provide all necessary spares (gaskets, O-rings, etc.) associated with the test.

**8.3.3.2**Replace first sentence with

The following requirements of a) through j) shall be met while the pump is operating on the test stand and before the performance test is performed.

Replace item b) with

- b) Substitute seals may be used during the performance test if needed to prevent damage to the contract seals or if the contract seals are not compatible with the test liquid. See subclause 10.3.6 of ANSI/API Std 682:2014. Shop buffer or barrier liquid systems may be used during bare-shaft pump performance test.



Replace item c) first paragraph first sentence with

Containment seal and quench drains shall be left open or unplugged during the performance test. The seal (or seals) shall not have a leakage rate during any phase of the pump performance test that is in excess of that specified in subclause A.1.3 of ANSI/API Std 682:2014, or as otherwise agreed by the vendor and the purchaser.

Replace item c) second paragraph second sentence with

Subclause A.1.3 of ANSI/API Std 682:2014, should be reviewed to confirm that a zero-visible-leakage criterion is appropriate for the seals being tested.

Delete NOTE from item c)

Replace item d) with

- d) If leakage during test is over limit specified in the test procedure, the assembled pump and seal shall be re-tested to demonstrate satisfactory seal performance.

Add to list

- j) Pumps specified for oil mist lubrication shall have running tests performed whilst using the vendor's oil mist supply system.

### 8.3.3.3

Replace item a) with

- a) The vendor shall record test data, including head, flowrate, power and vibration at a minimum of six points:
- 1) shut off (vibration for information only);
  - 2) minimum continuous stable flow (beginning of allowable operating region);
  - 3) midway between minimum continuous flow and rated flow;
  - 4) within  $\pm 2$  % of rated flow;
  - 5) approximately the best efficiency flow (if rated flow is not within 5 % of best efficiency flowrate);
  - 6) end of allowable operating region.

Add to end of item b)

Pumps that are specified to operate in parallel shall:

- 1) have the same shut off head (within a tolerance of  $\pm 3$  %), which shall be confirmed at the performance test;
- 2) between 80 % and 110 % of best efficiency point, the tested head of the second pump shall be less than 101,5 % and greater than 98,5 % of the tested head of the first pump at the same flow. This does not allow the second pump to be outside the contractual performance limits.

Replace item e) with

- e) In addition to formal submittal of final data in accordance with 10.3.2.2 of ANSI/API Std 610, curves and test data (corrected for speed, specific gravity, clearances and viscosity) shall be submitted within 24 h after completion of performance testing for the purchaser's review and acceptance prior to shipment.

### 8.3.3.5

Replace item b) with

- b) If applicable, the bearing temperatures and bearing oil temperatures shall be measured and recorded throughout the test. Where supplied, the contract resistance temperature detectors shall be used during the test.

### 8.3.3.6

Replace subclause with

If specified, the performance test shall be conducted with:

- a) test stand NPSHA controlled to no more than 110 % of the NPSHA specified on the data sheet;  
b) vertical submerged pumps operated at minimum submergence.

NOTE It is the purpose of this test to evaluate pump performance with the specified NPSHA at pump suction.

### 8.3.3.7

Add to item a)

The impeller(s) shall not be modified after the performance test to correct hydraulic performance by under filing, over filing, V-cutting or any other such technique, unless approved by the purchaser. If approved, the vendor shall submit a drawing showing the details of the modification.

Replace item b) with

- b) If specified, disassembly of multistage pumps for any head adjustment (including less than 5 % diameter change) after test shall require the rotor to be rebalanced in accordance with this specification and shall be cause for retest.

## 8.3.4 Optional tests

### 8.3.4.2 Mechanical run test

#### 8.3.4.2.1

Replace subclause with

After oil temperature stabilisation (subclause 6.10.2.4 of ANSI/API Std 610), the pump shall be run on the test stand at the rated flow for 2 hours. Oil temperature stabilisation is achieved when the rise is not greater than 1 °C (2 °F) over a 10 minute period.

#### 8.3.4.2.2

Replace subclause with

During the mechanical run test, pump flow rates, pressures, power, speed, filtered and unfiltered vibration, lube oil flow, temperature, and pressure and bearing temperature, shall be recorded at intervals of 15 minutes or less during the first hour of testing, and at 30 minute intervals thereafter for the rest of the test duration. The parameters measured shall conform to the requirements specified by the purchaser for the performance test.

### 8.3.4.3 NPSH required test

#### 8.3.4.3.1

Replace subclause with

If specified, NPSH3 or submergence test (vertical submerged type pumps) shall be determined at each test point identified in 8.3.3.3 a), except shut-off. Refer to the data sheet for the type of NPSH3 test required and the acceptance criteria.

#### 8.3.4.3.3

Replace seventh sentence with

These NPSH3 curves shall be developed and submitted in accordance with hydraulic institute standards ANSI/HI 14.6 or ISO 9906, as specified.

## 8.4 Preparation for shipment

### 8.4.2.1

Replace first sentence with

Axial movement of rotors with no thrust bearings shall be blocked. Axial and radial movement of rotors with hydrodynamic bearings shall be blocked.

### 8.4.2.4

Replace first sentence with

Refer to the data sheet for the applicable painting specification. If the vendor's standard is acceptable to purchaser, then exterior surfaces, except for machined surfaces, shall be given at least one coat of the vendor's standard paint. The vendor shall submit to the purchaser the detailed painting procedure.

### 8.4.2.7

Add to subclause

Threaded openings which are normally plugged during service shall be fitted with stainless steel plugs in accordance with ASME B16.11.

## 9 Specific pump types

### 9.1 Single-stage overhung pumps

#### 9.1.3 Integral gear-driven (type OH6) pumps

##### 9.1.3.7

Replace first sentence with

Inducers, impellers and similar major rotating components shall be dynamically balanced to ISO 21940-11, grade G2.5, or to a residual unbalance of 7 g·mm (0,01 oz·in), whichever is greater.

## 9.2 Between-bearings pumps (types BB1, BB2, BB3 and BB5)

### 9.2.1 Pressure casings

#### 9.2.1.2

Replace subclause with

Pumps for service temperatures below 120 °C (248 °F) may be foot-mounted.

### 9.2.4 Dynamics

#### 9.2.4.2 Rotor balancing

##### 9.2.4.2.2

Replace second paragraph first sentence with

Table 19 of ANSI/API Std 610 shows ISO 21940-11, grade G2.5 for all interference fit rotors to speeds of 3 800 r/min.

### 9.2.5 Bearings and bearing housings

Add new subclause

#### 9.2.5.5

On multi-stage pumps, bearing housings shall be doweled after verification of stuffing box runout.

### 9.2.6 Lubrication

#### 9.2.6.4

Replace subclause with

Pressure-lubrication systems shall be as specified on the data sheet.

### 9.2.7 Testing

#### 9.2.7.5

Replace subclause with

Hydrodynamic bearings shall be removed, inspected by the purchaser or the purchaser's representative, and reassembled after the performance test is completed.

## 9.3 Vertically suspended pumps (types VS1 through VS7)

### 9.3.3 Rotors

#### 9.3.3.2

Add to subclause

The shaft of vertical pumps shall be 25 mm (1 in) in diameter (minimum). Shaft length shall not exceed 6 000 mm (236 in).

### 9.3.5 Dynamics

#### Replace subclause with

The vendor is not required to furnish a dynamic analysis of the pump and its support structure to confirm acceptability of the design.

### 9.3.6 Bushings and bearings

#### 9.3.6.1

#### Add to subclause

If specified that VS pumps shall operate for short periods with no lubrication (dry column during start up) or shall be subject to periods of standby, the bushings shall not shrink or swell.

### 9.3.8 Accessories

#### 9.3.8.3 Mounting plates

##### 9.3.8.3.1

#### Add to subclause after first sentence

This mounting plate shall be continuously welded to the can (outer casing) on both sides and machined on its bottom surface to align with the sole plate. No shims shall be used between the bottom of the mounting plate and the top of the sole plate.

##### 9.3.8.3.2

#### Replace subclause with

A minimum of four alignment-position screws shall be provided for each drive-train component that has a mass greater than 100 kg (225 lb) to facilitate horizontal adjustment.

##### 9.3.8.3.3

#### Replace subclause with

Pumps shall be provided with a separate sole plate for bolting and grouting to the foundation (see Figure 38 of ANSI/API Std 610). The bottom of the sole plate shall be blasted and prepared for epoxy grout. This plate shall be machined on its top surface for mounting of the discharge head, can or motor support and shall have four levelling screws, one adjacent to each holding down bolt hole.

### 9.3.9 Testing

#### 9.3.9.1

#### Replace subclause with

Pumps shall be tested as complete assemblies unless otherwise agreed by the purchaser and subsequently specified on the data sheet. Any length of vertical pump tested shall include at least two lineshaft bearings. Suction cans, if supplied, are not required for performance testing.

### 9.3.13 Double-casing diffuser (VS6) and volute (VS7) pumps

#### 9.3.13.3

Replace subclause with

Complete outer-case venting shall be ensured by means of a DN25 (NPS 1) minimum flanged high-point vent connection.

#### 9.3.13.4

Replace subclause with

Complete venting of the inner assembly within the seal chamber or associated auxiliary process piping shall be ensured by means of a DN15 (NPS 1/2) minimum flanged high-point vent connection.

#### 9.3.13.5

Replace subclause with

The suction can shall be supplied with an internal drain piped to the surface and terminating with a DN 25 (NPS 1) minimum flanged connection. The internal drain pipe shall be affixed to bowl assembly and column bolting to avoid vibration. The internal drain pipe shall have means for removal from the underside of the discharge head.

Add new subclause

#### 9.3.13.7

Bowls shall be flanged and shall have metal-to-metal rabbeted fits.

## 10 Vendor's data

### 10.2 Proposals

#### 10.2.3 Technical data

Replace item l) with

l) a list of similar machines installed and operating under similar conditions;

Replace item n) with

n) calculated specific speed and suction-specific speed;

Add to list

q) test procedure for vertical pumps that cannot be tested completely assembled.

#### 10.2.5 Options

Replace subclause with

The vendor shall furnish an outline of the procedures used for each of the special or optional tests that have been specified by the purchaser or proposed by the vendor.

### **10.3 Contract data**

#### **10.3.2 Drawings and technical data**

##### **10.3.2.2**

*Replace first sentence with*

Certified test curves and data (see example in Annex M) and valid calibration certificates for all test instrumentation shall be submitted after testing in accordance with the IRS and shall include head, power recalculated to the proper specific gravity and efficiency plotted against flowrate.

#### **10.3.4 Parts lists and recommended spares**

*Add new subclause*

##### **10.3.4.3**

For antifriction bearings, the spare parts list shall include full bearing designation number with appropriate suffixes that clearly indicate bearing type, size, cage type, and the selected internal clearance or pre-load.

#### **10.3.5 Data manuals**

*Add new sub-clause*

##### **10.3.5.4 Manufacturing record book**

A manual containing all manufacturing records, personnel qualifications, certification and inspection and test reports. As a minimum, the manufacturing record book shall include all as built and verifying documentation detailed in the inspection and test plan.

## **Annex L** (informative) **Vendor drawing and data requirements**

### **L.1 General**

Replace sub-clause and Figure L.1 with

Refer to S-615L for proposal and contract document requirements. The document content requirements are given in S-615L and ANSI/API Std 610 6.9.2.10, 8.3, 10.2, 10.3, L.2, I.1.4 and I.3 as amended by S-615L.



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This specification supplements ANSI/API Std 610 Centrifugal Pumps (2010), referring sequentially to the same clause numbers.