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Guidance on Industry Standard for API 610 Centrifugal Pumps

GIS 34-201

BP GROUP
ENGINEERING TECHNICAL PRACTICES

Foreword

This is the first issue of Engineering Technical Practice (ETP) BP GIS 34-201. This Guidance on Industry Standard (GIS) is based on parts of heritage documents from the merged BP companies as follows:

BP (Pre-1998)

GS 34-201 Centrifugal Pumps to API 610, December 1997.

Amoco ACES

A RE-PUMP-610-P Rotating Equipment—Pumps—API 610 Centrifugal—Procurement Specification.
A RE-PUMP-00-G Rotating Equipment—Pumps—Guide.

ARCO ES

Std ES-11 Centrifugal Pumps for General Refinery Service, 8th Edition, 1992.

GOMDW

1400-20-ME-SP-2020 Addendum to API Standard 610, "Centrifugal Pumps for Petroleum, Heavy Duty Chemical and Gas Industry Services", Eighth Edition, August 1995.

PTA

PTA RE-PUMP-610-P Rotating Equipment—Pumps—API 610 Centrifugal—Procurement Specification.
PTA RE-PUMP-00-G Rotating Equipment—Pumps—Guide.

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Introduction

- a. Guidance for centrifugal pumps is based on American Petroleum Institute (API) Standard 610, eighth edition, August 1995.
- b. Guidance statements of this GIS are modifications to API Std 610.
- c. Modifications to API Std 610 are identified as Add, Modify to Read, or Delete.
- d. Paragraph numbers in this GIS correspond to API Std 610.
- e. Paragraphs of API Std 610 that are not revised remain applicable.

Section 1 – General

1.1 Scope

1.1.1 Add

This GIS provides guidance on industry standard for the design, materials, fabrication, inspection, testing, documentation, and preparation for shipment of centrifugal pumps and hydraulic power recovery turbines that generally comply with API 610.

1.1.4 Delete

Refer to GP 34-00 clause 6.2.2.1

1.2 Alternative designs

1.2.1 Modify to Read

Quotation shall comply with this standard. Quotation may be supplemented if the following two conditions are met:

- a. Alternate quotation has Lower Life Cycle Costs over a 20 year period.
- b. Alternate quotation states all deviations from this standard and complete engineering details of alternate material and/or design is submitted to BP. Deviations from this standard shall be subject to written approval from BP.

1.2.2 Add

This GIS refers to national and international standards that are widely accepted. Codes and standards of the country where the equipment is manufactured and/or operated will be considered and may be accepted if they can be used to achieve an equivalent technical result.

1.3 Conflicting requirements

Modify to Read

In case of conflict between this GIS and inquiry or order, the order of precedence shall be:

- a. Local authority or statutory regulations.

For example, if pumps are to be installed within the European Union, Vendor is responsible for affixing the CE mark, and issuing a Certificate of Conformity signifying compliance with all applicable European directives.



If Vendor is not supplier for purpose of complying with the Machinery Directive, a Certificate of Incorporation shall be issued by the Vendor. In such cases, supplier who is responsible for affixing CE mark shall be established.

- b. Equipment requisition or purchase order and data sheet.
- c. This GIS.
- d. API standards.
- e. Other industry and national standards and specifications.

Add

1.6 Abbreviations

- a. CW Cooling water.
- b. CSWIP Certification Scheme for Welding and Inspection Personnel.
- c. FFT Fast Fourier transform.
- d. NDT Nondestructive testing.
- e. NPSH Net positive suction head.
- f. NPSHA Net positive suction head available.
- g. NPSHR Net positive suction head required.
- h. SPL Sound pressure level.

Section 2 – Basic design

2.1 General

2.1.1

The exclusion of parts from the 20 year life basis should be considered on the basis of the particular design criteria. For example, the impact of corrosion rates on casing material may preclude a 20 year life in particular instances, but generally a casing should be capable of meeting the basic design criteria.

2.1.4 Add

Impeller size shall be no greater than 95% of maximum available size, except for vertical suspended pumps. BP shall be advised if this requirement results in next larger pump size.

2.1.8 Add

For water pump applications, the purchaser should define the amount of entrained air, and the vendor shall determine the required NPSHR to keep the air suppressed, or at less than the required suppression pressure, the vendor shall determine a method for gas elimination during operation such that the pump performance is met.

Cooling water systems may contain more than 3% entrained gas (air) that over time can become free gas in the cooling water system and consume pump capacity or become trapped in the impeller eye.

2.1.9 Add

- a. First stage boiler feedwater pump impeller suction specific speed (N_{ss}) shall not exceed 174 (9 000), where $N_{ss} = (\text{rpm}) (Q)^{1/2} / (\text{NPSHR})^{3/4}$, $Q = \text{m}^3/\text{s}$ (gpm), $\text{NPSHR} = \text{m}$ (ft) at maximum impeller diameter and best efficiency point (BEP).



- b. Unless approved otherwise by BP, other pumps shall have Nss less than or equal to 232 (12 000). Net positive suction head required (NPSHR) shall be less than or equal to net positive suction head available (NPSHA).

Pump Handbook (Karassik, Krutzsch, Fraser, Messina) has curves that relate pump specific speed to suction specific speed and the suction recirculation, percent of best efficiency flow. This information helps identify required minimum flow.

2.1.11 Modify to Read

- a. Pumps shall have stable head/capacity curves that continuously rise to shutoff and shall be suitable for parallel operation.
- b. Head rise from rated point to shutoff shall be minimum of 10% and maximum of 25% of head at rated capacity.

The objective of parallel operation is for the number of operating pumps to share the loading equally. To achieve this objective, pump characteristics must match and achieve the same duty point at the operating flow conditions. Allowing for a range of duties (including off design conditions) is best achieved by a performance characteristic that equally shares the loading when operating in an identical system. Pump operating points are determined by the interaction of the system and pump characteristics. In parallel operation, each characteristic's gradient and the extent by which the curves deviate from each other are factors in determining the load sharing. The flatter the pump characteristic, the greater the flow deviation for a given head differential. As a general rule, the duty point on each curve should match within 2%, and the head rise to shutoff should not be less than 10%. The requirements for head rise should consider the impact of allowable tolerances during pump testing.

Downbore multi-stage centrifugal pumps often have an "S" type curve, which can achieve the head rise to shutoff from the design point, but there is usually a plateau in the curve. This gives an operating region that is very unstable under pressure control, and is difficult to control at pump changeover and in parallel operation.

2.1.14 Modify to Read

- a. Equipment furnished by Vendor shall comply with **GIS 14-101**.
- b. If detailed requirements are not specified, noise pressure levels at or beyond 1 m (3 ft) from the machine (plus driver, transmission and ancillaries) surfaces, shall not exceed 85 dB (A).
Allowable noise pressure level from pump set (pump auxiliaries and driver) is affected by operating pattern in the installation. If 12 hour shifts are worked, it may be necessary to reduce noise limits accordingly.
- c. Vendor shall provide the following details of Vendor noise emission from Vendor equipment:
 1. Sound pressure level (SPL) in octave bands obtained by test methods as specified in EEMUA Publication No. 140.
 2. Narrow band or impulsive noise that is noticeable to the ear and octave band or bands in which it occurs.
- d. If Vendor cannot meet the foregoing limits without the addition of noise attenuation features, levels with and without these features shall be stated in proposal.
- e. Noise attenuation measures proposed by Vendor shall not conflict with other requirements of this GIS. Noise attenuating enclosures shall be subject to approval by BP.

Enclosures should be accepted only if there is no alternative form of noise control.



- f. Design of these enclosures shall be such that normal operation and maintenance are not unduly compromised. In particular, all instrumentation and controls shall be either mounted externally to enclosure or clearly visible and controllable from outside of enclosure.
- g. Enclosures shall be adequately purged and cooled. Instrumentation, sensors, and cables installed in enclosures shall not be subject to an environment that causes component to be operated outside Vendor specified ambient temperature limits.

2.1.16

The need for proven operational experience with pumps of high energy levels should be the first reassurance of suitability for an application. If application experience is not available, performance testing should be carefully evaluated.

2.1.17

Reliance on bearing housing cooling to achieve operational capability of bearings, or to achieve L10 life required must be considered a last resort. If cooling is required, BP will specify the cooling media type, pressure and temperature.

2.1.20 Add

Maximum pressure drop shall be calculated from inlet termination point to outlet termination point and shall include all components provided by the Vendor.

Design basis for CW systems should be obtained from existing site utilities data sheet, if available, and should take account of local CW specification. For green field projects design basis should be obtained from the project utilities data sheet.

2.1.24 Add

For vertically suspended pumps, mating faces bowl to bowl, bowl to column, or steady bearing spiders to column assemblies shall be fully machined and register fitted.

2.1.29 Add

Unless specified otherwise, installation shall be outdoors, without roof.

Weather and other environmental conditions (such as those listed in API 610, 2.1.29) need to be specified.

2.2 Pressure casings2.2.4 Modify Last Sentence to Read

These pump regions should be designed for the maximum allowable working pressure.

For very high pressure service, e.g., reservoir water injection, mechanical seals may not be available to withstand the casing MAWP. In this case, pressure relief is required to limit the pressure to that which the mechanical seals can withstand.

Piping between the suction valve, including valve, and the pump suction flange needs to be designed for the full MAWP.

If any region of a pump casing is not rated for full MAWP, a satisfactory method for isolating the high and low pressure sections during future hydrotesting shall also be provided.

A pump not rated for full MAWP may be less expensive, but requires relief valve(s) and may prove difficult to hydrotest in the future due to distortion of internal sealing faces.

2.2.6

The joint face of an axially split casing pump may prove difficult to make leak tight at high pressures. If axially split casing pumps are proposed for multistage pumps,



joint configuration and bolt loading requirements of joint, and operating experience with design should be evaluated against required duty (for example: high pressure, high temperature water is superheated steam under atmospheric conditions).

2.2.8

The note appended to this paragraph in API 610 emphasises that piping loads should be restricted to values quoted in Section 2.4. Refer to GIS 34-801 for further piping design requirements.

Effect of temperature on alignment or on loading that piping imposes on pumps should be considered to ensure that design is compatible with pumping temperatures.

2.2.13 Modify to Read

Bolting shall be as specified in 2.2.13.1 through 2.2.13.8.

2.2.13.2 Add

Casing designs for slurry pumps where studs securing wear plates (shrouds) pass through casing wall are not acceptable.

2.2.13.3 Modify to Read

Bolting used in wetted areas shall be of a material fully resistant to corrosive attack by pumped liquid.

Add

2.2.13.8 Studs for gland or mechanical seal end plate design shall prevent backing out on tapped end. Such studs and associated nuts and bolts shall both be 18-8 stainless steel made up with nonlead, nonchloride, and antigalling thread lubricant.

Add

2.2.14 Hold down boltholes in pump support feet shall be minimum of 1,5 mm (1/16 in) larger than bolt diameter and no larger than bolt head. On between bearings pumps, provisions shall be made for doweling pump at supports at coupling end only.

Hold down arrangement for hot duty pumps needs to allow for movement of the non-drive-end because of thermal expansion of the casing. This needs to be reflected in bolthole design and in clearance between the bolt head and the top of the pump foot.

2.3 **Nozzle and pressure casing connections**2.3.1 **Casing opening sizes**

2.3.1.2

If vent and drain connections are terminated with valves, bracing may be necessary to ensure that connection is not overloaded or subject to fatigue failure.

2.3.3 **Pressure casing connections**2.3.3.4 Add

Socket weld flanges shall not be used in corrosive services.

2.3.3.7 Modify to Read

Pressure casing connections are permitted only for primary piping, auxiliary piping or drain and vent piping connections that will be used in service. Plugged openings are not permitted.

