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GIS 34-201

Centrifugal Pumps (ISO 13709 or API 610)

Group Instruction for Supply

**BP GROUP
ENGINEERING TECHNICAL PRACTICES**

Foreword

This issue of Engineering Technical Practice (ETP GIS 34-201 incorporates changes to align with ISO 13709-2003 and API Std 610-2004.

- a. This specification is based on the API Standard 610, “*Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries*,” (Tenth Edition, Publication date October 2004). The numerical identification of sections and paragraphs in this specification corresponds to section and paragraph numbering of the referenced industry standard. Requirements that are not revised remain applicable.
- b. API 610, Tenth edition, is technically equivalent to ISO 13709:2003.
- c. This specification is modified from GIS 34-201, “*Guidance on Industry Standard for API 610 Centrifugal Pumps*,” (Publication date October 24, 2003).

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In the event of a conflict between this document and a relevant law or regulation, the relevant law or regulation shall be followed. If the document creates a higher obligation, it shall be followed as long as this also achieves full compliance with the law or regulation.



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Introduction

Modifications are defined as Add, Delete, or Modify to Read. Resulting action of these modifications are defined below:

<u>Add</u>	Either a new text has been added to the existing paragraph or a new paragraph has been added. For a new paragraph, “ <u>Add</u> ” is placed above the paragraph number.
<u>Delete</u>	Either a complete paragraph has been deleted or the specific words identified within “.” in a statement of the paragraphs have been deleted.
<u>Modify to Read</u>	Either a specific statement of a paragraph or a complete paragraph has been rephrased.



1.0 Scope

Add

1.1 General

This Specification together with the related documents referenced herein constitutes the minimum technical requirements for this equipment.

Add

1.2 Precedence for Conflicting Requirements

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

- a. Local Codes and Standards
- b. Purchase Order/Requisition/Contract
- c. Project Data Sheets and Drawings
- d. This BP Specification
- e. Referenced BP documents, Codes and Industry Standards

In the event of a conflict, the manufacturer shall immediately notify BP for written resolution. Deviation from the requirements specified shall not be assumed acceptable by the manufacturer.

Add

1.3 Alternative design

The Vendor's quotation shall be in accordance with this Specification. As an option, the Vendor may supplement his basic quotation with alternate quotations provided the following conditions are met:

- a. The alternate quotation has significant process, life cycle costing or delivery date advantage, is a superior product at a justifiably higher price, or a product of equal quality at a lower life cycle cost.
- b. The alternate quotation states all deviations from this Specification and complete engineering details of alternate material and/or design is submitted to BP. Deviations from this Specification shall receive written approval from BP's rotating machinery specialist.
- c. Alternative designs with improved life cycle value or other advantages may be proposed if design and technology has a minimum demonstrable field experience of 16,000 hours. Acceptance of alternate offerings is subject to BP audit and approval.

1.5 Spare parts

The vendor shall provide BP with the original manufacturers' part number for all bought out parts.

2 Normative References

API

Add

API RP 945

Avoiding Environmental Cracking in Amine Units



ASME Add

B16.34-2004 Valves-Flanged, Threaded and Welding End

Add

BP

GP 06-20 Materials for Sour Service

GP 12-45 Electrical for Packaged Equipment.

GIS 12-201 Low Voltage Induction Motors (IEC).

GIS 12-202 NEMA Low Voltage Induction Motors.

GIS 12-203 High Voltage Induction Motors (IEC).

GIS 12-204 Medium Voltage Induction Motors (API 541).

GIS 12-205 Synchronous Motors (IEC).

GIS 12-206 Synchronous Motors (API 546).

GIS 15-011 Noise Control.

GP 30-70 Control and Instrumentation in Vendor Packaged Equipment.

GIS 34-301 Guidance on Industry Standard for General Purpose Steam Turbines (API 611).

GIS 34-302 Special Purpose Steam Turbines (API 612).

GIS 34-303 Gas Turbines (API 616).

GIS 34-501 Special Purpose Gear Units (API 613).

GIS 34-502 General Purpose Gear Units (API 677).

GIS 34-503 Special Purpose Couplings (ISO 10441 or API 671).

GIS 34-504 General Purpose Couplings (ISO 14691).

GIS 34-701 Lubrication, Shaft-Sealing and Control-Oil Systems and Auxiliaries (ISO 10438).

GIS 34-704 Pump Shaft Seal Systems (API 682).

GIS 34-705 Machinery Protective Systems (API 670).

GIS 34-801 Machinery Installation and Installation Design (API 686).

GP 36-10 Metallic Materials Selection.

GIS 36-102 Hardness Testing, Post Weld Heat Treatment, Stress Relief, and Pickling for Pressure Vessels, Piping, and Other Components.

GIS 36-103 Positive Materials Identification (PMI) for Pressure Vessels, Piping and other components.

GP 42-10 Piping Systems (ASME B31.3).

Add

EEMUA

EEMUA Pub No. 140 Noise Procedure Specification.

EN

Add

EN 10241 Steel Threaded Pipe Fittings (BSI BS EN 10241).

NACE

Add

NACE RP 0472 Standard Recommended Practice Methods and Controls to Prevent In-Service Environmental Cracking of Carbon Steel Weldments in Corrosive Petroleum Refining Environments.



Add

TEMA

TEMA Standards of the Tubular Exchanger Manufacturers Association.

Add

MSS

MSS-SP-55 Quality Standard for Steel Castings for Valves, Flanges, Fittings and Other Piping Components. Visual Method for Evaluation of Surface Irregularities.

3.0 Terms and definitions**3.60 High Energy Pumps**

Pumps which have an energy density [product of pump rated power, kW (hp) and rated speed, r/min] equal or greater than $4,0 \times 10^6$ kW/min ($5,4 \times 10^6$ hp/min). As defined in API 610 Table 9 (c).

4.0 Classification and designation**4.3 Units and governing requirements****4.3.1 Add**

Vendor furnished data, drawings, documents, and nameplates shall be in the 'English' language, unless otherwise specified, in 'SI' units with 'US Customary' units in brackets.

5.0 Basic Design**5.1 General****5.1.1 Add**

The proposal shall state any vendor-required shutdowns during this 3-year period.

5.1.1

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.

5.1.6 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.

5.1.10 Modify to Read

NPSHR shall be no more than 80 percent of the NPSHA and at least 1,5 m (5 ft) less than NPSHA at any capacity from rated flow to quoted minimum continuous stable flow. See paragraph 7.3.1.4 if above requirements cannot be met.

For high energy pumps (ref 3.60) NPSHR at worn conditions shall be within the specified margin.

NPSH available is calculated from the NLL (Normal Liquid Level). This needs to be redefined in applications with large level swings.



Worn conditions increase internal recirculation effectively pushing the pump further out on its curve. NPSHR increases due to its actual operating point. The requirement for the vendor is to calculate the recirculation increase at worn conditions and define the operating point in this condition.

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 5% 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.

5.1.11 Add

- a. First stage boiler feedwater pump impeller suction specific speed (N_{ss}) shall not exceed 175 (9 000), where:

$$N_{ss} = \frac{(rpm)(Q)^{1/2}}{(NPSHR)^{3/4}}$$

Q = m³/s (gpm) - Note Q = ½ for a double suction impeller.

NPSHR = m (ft) at maximum impeller diameter and best efficiency point (BEP).

- b. Unless approved otherwise by BP, other pumps shall have N_{ss} less than or equal to 230 (12 000).

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.

5.1.13 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.
- c. In parallel operation, the duty point on each curve shall match within 2%.

The objective of parallel operation is for the number of operating pumps to share the loading equally. To achieve this objective, pump characteristics need to 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. 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.



5.1.14 Modify to Read

Pumps shall be selected with the best efficiency point as close as possible to the normal operating point. No operating point shall exceed 115% of the best efficiency point, nor be less than 50% of BEP. For variable speed pumps these requirements shall relate to the best efficiency point and minimum flows at the expected operating speed.

5.1.16 Modify to Read

- a. Equipment furnished by vendor shall comply with GIS 15-011.
- b. Noise attenuating enclosures shall be subject to approval by BP.
Enclosure should be accepted only if there is no alternative form of noise control.
- c. 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.
- d. 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.
- e. Instrumentation, sensors, and cables installed inside enclosures shall not be subjected to environment that causes component to be operated outside vendor specified ambient temperature limits.
- f. If insulation is used for noise control, vendor shall consider "corrosion under insulation" into the design of the insulation.

5.1.18

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.

5.1.19 Add

Bearing cooling shall not be considered to achieve required L10 life.

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

5.1.21 Add

Auxiliary process piping shall not go through the cooling jackets.

5.1.22 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.

5.1.26 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 with a register fit.

5.1.28 Modify Second Sentence to Read

After installation, the performance of the combined units shall be the responsibility of the prime equipment vendor (usually the pump vendor) provided equipment is installed within GIS 34-801 requirements.



5.1.30 Add

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

Weather and other environmental conditions (such as those listed in API 610, 5.1.30) need to be specified.

5.1.31 Add

- a. Casing designs for slurry pumps where studs securing wear plates (shrouds) pass through casing wall are not acceptable.
- b. High temperature anti-seize compound shall be used on all case bolting.

5.3 Pressure casings5.3.2.a Delete

Delete "If specified"

5.3.2.b Delete

Delete "If specified"

5.3.3

The note appended to this paragraph in API 610 emphasises that piping loads should be restricted to values quoted in Section 5.5. 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.

5.3.5 Add

For high pressure applications MAWP 10% over the maximum discharge pressure may be excessive. Need to review application to determine if this requirement can be reduced.

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.

5.3.6 Add

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 hydro testing shall also be provided.

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

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.

5.3.9 Add

Ring section casings with external tie bolts shall not be used.

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).



5.3.14 Add

- a. Casing designs for slurry pumps where studs securing wear plates (shrouds) pass through casing wall are not acceptable.
- b. Studs for gland or mechanical seal end plate design shall prevent backing out on tapped end. Such studs and associated nuts and bolts shall be 18-8 stainless steel and made up with non-lead, non-chloride, and anti-galling thread lubricant.

Add

- 5.3.15** Hold down boltholes in pump support feet shall be a minimum of 1,6 mm (1/16 in) larger than bolt diameter and not 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 support.

Add

- 5.3.16** The underside of the horizontal pump support feet shall be machined flat and parallel to each other within 0,04 mm/m (0,000 5 in/ft) slope difference, both directions. The underside of vertical suspended pump heads shall be machined flat within 0,05 mm (0,002 in).

5.4 **Nozzle and pressure casing connections****5.4.1** **Casing opening sizes****5.4.1.2**

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.

5.4.2 **Suction and discharge nozzles****5.4.2.4** Add

If non-standard flanges are supplied on the pump, the vendor shall supply mating non-standard flanges and gaskets for the piping.

5.4.3 **Auxiliary connections****5.4.3.1** Modify to Read

Threaded connections into process pressure containing components, except for seal glands, shall not be used.

5.4.3.4 Add

Socket weld flanges shall not be used in HF services.

5.4.3.5 Add

Connections shall not limit the MAWP of the case.

5.4.3.7 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 or blinded openings are not permitted.



5.4.3.10 Add

- a. If a vent connection is required, vent piping shall terminate with a flange. Vent connections shall be NPS 3/4 minimum flanged, socket welded to casing, connection.
- b. Fluid passages within pump (including auxiliary piping) shall be arranged for complete drainage. If this arrangement is not feasible (such as for horizontal multistage pumps), proposal shall state specific areas within pump that can not be completely drained. Drain piping shall terminate with a flange. Drain connections shall be NPS 3/4 minimum flanged, socket welded to casing, connection. For pumps mounted on baseplates, drain piping shall extend to edge of baseplate.
- c. For slurry services, drain and vent connections shall be at least NPS 3/4, valve shall be ball type, and piping shall be minimal between valve and casing. If double volute construction results in an internal liquid trap, a drain hole shall be provided at low point of inner volute to permit complete drainage of volute section.
- d. For duties where drains are likely to block, piping shall be designed to facilitate mechanical cleaning.
- e. Pumps operating at temperatures above 260°C (500°F) have a tendency to coke. In these instances, the drain shall come off the case horizontally and the piping between the case and the first joint shall be straight. This facilitates rodding out plugged drains.

5.5 External nozzle forces and moments**5.5.5 Modify to Read**

Annex F shall not be used.

5.6 Rotors**5.6.1 Add**

Impeller diameters shall be 410 mm (16 in) or less for single stage overhung pumps operating above 1,500 rpm.

5.6.3 Modify Second Sentence to Read

Impellers on vertical suspended pumps shall not be collet mounted.

Add

Impellers on multistage pumps shall be individually secured against axial movement along shaft in either direction.

Snap rings may not be sufficient to prevent axial movement. Locking methods should be reviewed with the pump supplier.

5.6.6 Modify to Read

Shaft to sleeve fits shall be F7/h6 in accordance with ISO 286 (all parts).

5.6.10.e.1 Modify to Read

1. For areas to be observed by radial vibration probes, 25% of the allowed peak-to-peak vibration amplitude or 0,25 mil (6 µm), whichever is less.

5.7 Wear rings and running clearances**5.7.1 Add**

If efficiency can be improved and reliability is not compromised, wear rings made from alternative materials (e.g. Polyetheretherketone PEEK) material may be offered by the manufacturer.

