



Group Instruction for Supply

GIS 34-201

Centrifugal Pumps (ISO 13709 or API 610)

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Foreword

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

- This specification is based on API Std 610, “Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries”, tenth edition, 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.
- API 610, tenth edition, is technically equivalent to ISO 13709:2003.
- This specification is modified from Group Instruction for Supply (GIS) 34-201, Centrifugal Pumps (API 610), October, 2003.

Because of the extent of changes, revisions are not identified by a bar in the margin as is normal practice.



Introduction

- a. Requirements for centrifugal pumps are based on ISO 13709:2003 or API 610:2004. API 610:2004 is technically equivalent to ISO 13709:2003.
- b. Requirements of this GIS are modifications to ISO 13709 or API 610.
- c. Modifications to ISO 13709 or API 610 are defined as Add, Delete, or Modify to Read.
- d. Paragraph numbers in this GIS correspond to ISO 13709 or API 610.
- e. Paragraphs of ISO 13709 or API 610 that are not revised remain applicable.



1 Scope

Add

1.1 General

This GIS, together with the related documents referenced herein, provide minimum technical requirements for centrifugal pumps.

1.2 Precedence for conflicting requirements

- a. If information in this GIS conflicts with an inquiry or order, the order of precedence shall be:
 1. Local codes and standards.
 2. Purchase order/requisition/contract.
 3. Project data sheets and drawings.
 4. This GIS.
 5. Referenced BP documents, codes, and industry standards.
- b. In the event of a conflict, the Vendor shall immediately notify BP for written resolution. Deviation from specified requirements shall not be assumed to be acceptable.

1.3 Alternative design

- a. Quotation shall comply with this GIS.
- b. As an option, basic quotation may be supplemented with alternate quotations, if the following conditions are met:
 1. Alternate quotation has significant process, lifecycle costing, or delivery date advantage and is a superior product at a justifiably higher price or a product of equal quality at a lower lifecycle cost.
 2. Alternative designs with improved lifecycle value or other advantages may be proposed, if design and technology has a minimum demonstrable field experience of 16 000 hr. Acceptance of alternate offerings shall be subject to audit and approval by the BP responsible engineer.

1.4 Spare parts

Original manufacturer part number for bought out parts shall be provided.

2 Normative references

Add

BP GIS 06-601	Painting of Metal Surfaces.
BP GIS 12-201	Low Voltage Induction Motors (IEC).
BP GIS 12-202	Low Voltage Induction Motors (NEMA) (PIP ELSMT01D).
BP GIS 12-203	High Voltage Induction Motors (IEC).
BP GIS 12-204	Medium Voltage Induction Motors (API 541).
BP GIS 12-205	Synchronous Motors (IEC).
BP GIS 12-206	Synchronous Motors (API 546).
BP GIS 15-011	Noise Control.
BP GIS 34-301	General Purpose Steam Turbines (API 611).



BP GIS 34-302	Special Purpose Steam Turbines (API 612).
BP GIS 34-303	Gas Turbines (API 616).
BP GIS 34-501	Special Purpose Gear Units (API 613).
BP GIS 34-502	General Purpose Gear Units (API 677).
BP GIS 34-503	Special Purpose Couplings (ISO 10441 or API 671).
BP GIS 34-701	Special Purpose Oil Systems (ISO/FDIS 10438, Part 2).
BP GIS 34-704	Pump Shaft Seal Systems (API 682).
BP GIS 34-705	Machinery Protection Systems (API 670).
BP GIS 34-801	Machinery Installation and Installation Design (API 686).
BP GIS 36-25	Materials for Sour Service in Exploration and Production Operations.
BP GIS 36-26	Materials for Sour Service in Refining and Marketing Operations.
BP GIS 36-102	Hardness Testing, Post Weld Heat Treatment, Stress Relief, and Pickling for Pressure Vessels, Piping, and Other Components.
BP GIS 36-103	Positive Materials Identification (PMI) for Pressure Vessels, Piping, and other components.
BP GP 30-70	Control and Instrumentation in Vendor Packaged Equipment.
BP GP 36-10	Metallic Materials Selection.
ASME B16.34	Valves Flanged, Threaded and Welding End.
BS EN 10241	Steel Threaded Pipe Fittings.

3 Terms and definitions

Add

3.60 High energy pumps

Pumps that have an energy density (product of pump rated power, kW [hp], and rated speed, rpm) at least $4,0 \times 10^6$ kW/min ($5,4 \times 10^6$ hp/min) as defined in API 610, Table 9, Note c).

4 Classification and designation

4.3 Units and governing requirements

4.3.1 Add

Vendor furnished data, drawings, documents, and nameplates shall be in English, unless specified otherwise, and in SI units with U.S. customary units in parentheses.

5 Basic design

5.1 General

5.1.1 Add

Proposal shall state any Vendor required shutdowns during this 3 yr period.

5.1.6 Add

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



5.1.10 Modify to Read

- a. NPSHR shall not be greater than 80% NPSHA and at least 1,5 m (5 ft) less than NPSHA, at any capacity from rated flow to quoted minimum continuous stable flow. If these requirements cannot be met, see 7.3.1.4.
- b. For high energy pumps (refer to 3.60), NPSHR at worn conditions shall be within specified margin.
- c. For water pump applications:
 1. BP should define the amount of entrained air.
 2. Vendor shall determine either:
 - a) Required NPSHR to keep the air suppressed.
 - b) At less than the required suppression pressure, a method for gas elimination during operation such that pump performance is met.

5.1.11 Add

- a. Water service with power levels above 100 hp per stage and first stage boiler feedwater pump impeller suction specific speed (N_{ss}) shall not exceed 175 (9 000), where:

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

Where:

$Q = m^3/s$ (gpm). Note: $Q = 1/2$ 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).

5.1.13 Modify to Read

- a. Pumps shall:
 1. Have stable head/capacity curves that continuously rise to shutoff.
 2. Be suitable for parallel operation.
- b. Head rise from rated point to shutoff shall be from 10% to 25% of head at rated capacity.
- c. In parallel operation, duty point on each curve shall match within 2%.

5.1.14 Modify to Read

- a. Pumps should be selected with a BEP that is as close as possible to the normal operating point.
- b. No operating point shall exceed 110% of the BEP or be less than 80% of BEP.
- c. For variable speed pumps, requirements in b. shall relate to the BEP and minimum flows at the expected operating speed.

5.1.16 Modify to Read

- a. Equipment furnished shall comply with GIS 15-011.
- b. Noise attenuating enclosures shall be subject to approval by the BP responsible engineer.
- c. Design of enclosures shall be such that normal operation and maintenance are not unduly compromised. In particular, instrumentation and controls shall be either:
 1. Mounted externally to enclosure.



2. Clearly visible and controllable from outside of enclosure.
- d. Enclosures shall be adequately purged and cooled.
- e. Instrumentation, sensors, and cables installed inside enclosures shall not be subject to an environment that causes component to be operated outside vendor specified ambient temperature limits.
- f. If insulation is used for noise control, “corrosion under insulation” shall be considered in the design of the insulation.

5.1.19 Add

Bearing cooling shall not be considered in achieving required L10 life.

5.1.21 Add

Auxiliary process piping shall not go through cooling jackets.

5.1.22 Add

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

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 have a register fit.

5.1.28 Modify Second Sentence to Read

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

5.1.30 Add

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

5.1.31 Add

- a. If studs securing wear plates (shrouds) pass through casing wall, casing designs for slurry pumps shall not be acceptable.
- b. High temperature antiseize compound shall be used on case bolting.

5.3 Pressure casings

5.3.2 Modify First Sentence and a), b), c) to Read

Maximum discharge pressure shall be increased by the additional differential pressure developed during one or more of the following operating circumstances:

- a) Maximum specified relative density at any specified operating condition.
- b) Installation of an impeller of maximum diameter and/or number of stages that pump can accommodate.
- c) Operation to trip speed, if specified.

5.3.6 Add

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

5.3.9 Add

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

**5.3.14** Add

- a. If studs securing wear plates (shrouds) pass through casing wall, casing designs for slurry pumps shall not be 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 SS and made up with nonlead, nonchloride, and antigalling thread lubricant.

Add**5.3.15** **Hold down arrangements**

- a. Hold down bolt holes in pump support feet shall be at least 1,6 mm (1/16 in) larger than bolt diameter and not larger than bolt head.
- b. Between bearings pumps shall have provisions for doweling pump at supports for coupling end only.
- c. Hold down arrangement for hot duty pumps shall allow for movement of the nondrive end because of thermal expansion of the casing. This shall be reflected in bolt hole design and in clearance between bolt head and top of the pump support.

5.3.16 **Machining**

- a. Underside of 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 in both directions.
- b. 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**Add

- 5.4.1.3 All connections that are less than or equal to DN 40 (NPS 1 1/2) shall be gusseted.

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

If nonstandard flanges are supplied on the pump, piping shall have mating, nonstandard flanges and gaskets.

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

Except for seal glands, connections into process pressure containing components shall not be threaded.

5.4.3.4 Add

Socket weld flanges shall not be used in hydrogen fluoride (HF) services.

5.4.3.5 Add

Connections shall not limit MAWP of the case.

5.4.3.7 Modify to Read

- a. Pressure casing connections shall be allowed only for primary piping, auxiliary piping, or drain and vent piping connections that will be used in service.
- b. Openings shall not be plugged or blinded.



5.4.3.10 Add

- a. If a vent connection is required, vent piping shall terminate with a flange. Vent connections shall be at least DN 20 (NPS 3/4), flanged and socket welded to casing.
- b. Fluid passages within pumps
 1. Fluid passages within pumps (including auxiliary piping) shall be arranged for complete drainage. If this arrangement is not feasible (e.g., for horizontal multistage pumps), proposal shall state specific areas within pump that cannot be completely drained.
 2. Drain piping
 - a) Drain piping shall terminate with a flange.
 - b) Drain connections shall be at least DN 20 (NPS 3/4), flanged and socket welded to casing.
 - c) Drain connections for pump cases over 0,75 m³ (200 US gallons) shall be at least DN 40 (NPS 1 1/2), flanged and socket welded to casing.
 - d) For pumps mounted on baseplates, drain piping shall extend to edge of baseplate.
- c. Slurry services
 1. Drain and vent connections shall be at least DN 20 (NPS 3/4).
 2. Valve shall be ball type.
 3. Piping shall be minimal between valve and casing.
 4. If double volute construction results in an internal liquid trap, a drain hole shall be provided at low point of inner volute to allow complete drainage of volute section.
- d. If drains are likely to block, piping shall be designed to facilitate mechanical cleaning.
- e. Pumps operating at temperatures greater than 260°C (500°F) have a tendency to coke. To facilitate rodding out plugged drains, the following applies:
 1. Drain shall come off the case horizontally.
 2. Piping between case and first joint shall be straight.

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 1500 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.

**5.6.6** Modify to Read

Shaft to sleeve fits shall be F7/h6 in accordance with ISO 286.

5.6.10 Modify e) 1) to Read

- 1) For areas to be observed by radial vibration probes, 25% of allowed peak to peak vibration amplitude or 6 μm (0,24 mil), 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 may be offered.

5.8 **Mechanical shaft seals****5.8.1** Modify to Read

- a. Seals and sealing systems shall be furnished in accordance with GIS 34-704.
- b. Manufacturer, type, configuration, and duty of mechanical seals shall be subject to:
 1. Agreement between seal vendor and pump vendor.
 2. Approval by the BP responsible engineer.

5.9 **Dynamics****5.9.2** **Torsional analysis****5.9.2.2.** Add

Excitations of torsional frequencies shall be considered, based on drive characteristics and number of masses.

5.9.2.4 Modify Last Sentence to Read

Acceptance criteria for this analysis shall be obtained from BP.

5.9.2.6 Modify First Sentence to Read

Manufacturer shall furnish a detailed report of the torsional analysis.

Add

- f) Acceptance requirements and list of all frequencies evaluated.

Add

- 5.9.2.7 Torsional analysis shall be performed in accordance with API Publ 684.

5.9.3 **Vibration****5.9.3.2** Add

Vibration measurements shall be unfiltered.

5.9.3.3 Modify Second Sentence to Read

Plotted spectra shall be included with pump test results.

5.9.3.6 Add

- a. If, subject to approval by the BP responsible engineer, pump is tested with a shop driver at less than rated speed, vibration limits stated shall be reduced by ratio of square of speed (actual/design) for pumps referenced in Tables 7 and 8. Overall vibration levels shall not exceed 25 μm (1 mil) peak to peak.



- b. Table 7 discrete frequencies shall be corrected to $v_f < 2,0$ mm/s (0,08 in/s) rms.

Table 7 - Vibration limits for overhung and between-bearings pumps

Add Note to Table 7

Figure 29 shall not be used unless approved by the BP responsible engineer.

5.9.4 Balancing

5.9.4.4 Modify to Read

Impellers, balancing drums, and similar rotating components shall be dynamically balanced in accordance with ISO 1940-1, grade G1.

5.10 Bearings and bearing housings

5.10.1 Bearings

5.10.1.2 Add

- a. Maximum loads calculated and loading at two times the new pump initial internal clearances shall be used to select antifriction bearings for rating life and hydrodynamic bearing sizes.
- b. Thrust collars
 1. Thrust collars shall be replaceable.
 2. Hydrodynamic thrust bearing sizing criteria and calculations shall be submitted for BP review and shall be subject to approval by the BP responsible engineer.
 3. Mounting details for thrust collars shall be provided. Vendor shall provide design details to prevent fretting between shaft and thrust collar.
- c. If hydrodynamic thrust bearings are proposed, the following shall apply:
 1. Thrust bearings shall be designed for loading in both directions.
 2. Proposal shall include curves showing variation of axial load with capacity (zero flow to 125% flow) for design internal clearances and two times design internal clearances. For variable speed units, similar curves for maximum continuous speed and minimum continuous speed shall be submitted.

5.10.1.3 Add

- a. Outer race of antifriction thrust bearings shall be:
 1. Located in housing by machined shoulders that are an integral part of the housing.
 2. Retained by a bolted cover.
- b. If a rolling element thrust bearing is retained within a bore and the pump has fluid film journal bearings, the outer race to bore clearance shall be specified. Clearance shall not restrict shaft movement within the radial bearing at maximum clearances.

5.10.1.5 Modify First Sentence to Read

Ball thrust bearings shall be duplex, single row 0,70 radian (40 degree) angular contact type (7000 series), except that double suction pump applications shall be 0,26 radian (15 degree) angular contact type.

Add

Vendor shall furnish axial load data and ensure that bearings have adequate axial load to prevent skidding.

**5.10.2 Bearing housings****5.10.2.2 Add**

- a. Oilers and sight glasses shall have separate connections on sides of bearing boxes. Connections on bottom shall not be allowed.
- b. Piping connecting oiler and housing shall not have any low points.
- c. Bearing housings shall have fill and valved drain openings and any necessary shaft seals, slingers, equalizers, vents, or other devices to prevent loss of lubricant.
- d. Constant level oiler shall be vented to bearing housing using stainless steel tubing.

5.10.2.4 Add

- a. Temperature limits shall be adjusted to account for variations between test conditions and actual operating conditions. Higher or lower ambient and process conditions will affect bearing temperatures.
- b. Vendor shall provide assumptions to BP prior to testing.

5.10.2.4 Modify a) to Read

For pressurized systems, oil outlet temperature less than 70°C (160°F) and bearing metal temperatures (if bearing temperature sensors are supplied) less than 90°C (194°F). During shop testing and under the most adverse specified operating conditions, the bearing oil temperature rise shall not exceed 28 K (50°R).

5.10.2.4 Modify b) to Read

For ring oiled or splash systems, oil sump temperature less than 82°C (180°F). During shop testing, sump oil temperature rise shall not exceed 40 K (70°R), and if bearing temperature sensors are supplied, outer ring temperatures shall not exceed 90°C (194°F).

5.10.2.5 Add

If estuarine or seawater is specified by BP for cooling, water velocities and small bore connection sizes, as well as the materials to be used in the cooling system, shall be subject to agreement with the BP responsible engineer.

5.10.2.6 Add

All bearing housings shall be cast steel.

5.10.2.7 Add

Bearing isolators shall be provided.

5.10.2.8 Add to a)

All internal passages, oil drainback holes, etc., that would allow bypassing of oil mist around the bearing shall be plugged, or if necessary, a bushing shall be installed in the bearing housing to eliminate oil mist bypassing the bearing.

5.10.2.8 Add

- f) For horizontal pumps with single bearing, housing shall be equipped for pure oil mist lubrication as follows:
 1. One DN 6 (1/4 NPT) minimum hole in the top of the bearing housing located in the cavity between the thrust bearings and the radial bearing. This connection shall be marked "OIL MIST VENT".
 2. One DN 10 (3/8 NPT) minimum hole in the bottom of the bearing housing located in the cavity between the thrust bearings and the radial bearing. This connection shall be marked "OIL MIST DRAIN".



3. Two DN 6 (1/4 NPT) oil mist inlet holes located in the bearing housing or bearing end caps in the space between the bearing and the end cap closures. One connection will be for thrust bearings and one for the radial bearing. Each connection shall be marked "OIL MIST IN".
- g) Vertical pumps shall be equipped for pure oil mist lubrication as follows:
1. Two DN 6 (1/4 NPT) minimum holes, 180 degrees apart in the bearing housing, located in the cavity between the thrust bearings and the radial bearing. Each connection shall be marked "OIL MIST VENT".
 2. Two DN 6 (1/4 NPT) minimum holes, 180 degrees apart in the bearing housing or bearing end cap for the space between the thrust bearings and end closure. These connections shall be marked "OIL MIST IN".
 3. Two DN 6 (1/4 NPT) (DN 10 [3/8 NPT] preferred) minimum holes, 180 degrees apart in the bearing housing or bearing end cap for the space between the radial bearing and end closure marked "OIL MIST DRAIN".
- h) Between bearings pumps with rolling element bearing only shall be equipped for pure oil mist lubrication as follows:
1. Each bearing housing shall have a DN 6 (1/4 NPT) minimum hole in the top of the housing or bearing end cap into the space between the bearing and housing closure. These connections shall be marked "OIL MIST IN". This connection shall not be in the same cavity as the bearing housing drain hole.
 2. Each bearing housing shall have a DN 6 (1/4 NPT) minimum hole in the top of the housing or bearing end cap in the space on the opposite side of the bearing from the oil mist inlet. These connections shall be marked "OIL MIST VENT".
 3. Each bearing housing shall have a DN 10 (3/8 NPT) minimum hole in the bottom of the housing into the same cavity as the oil mist vent hole and on the opposite side of the bearing from the oil mist inlet. These connections shall be marked "OIL MIST DRAIN".
- i) Between bearings pumps with hydrodynamic bearings and ring oil lubrication shall be equipped for purge oil mist.

5.10.2.11 Modify to Read

Bearing housing shall have threaded connection(s) for permanently mounting vibration transducers in accordance with GIS 34-705.

5.11 Lubrication

5.11.2 Modify to Read

- a. Operation and maintenance manual shall describe how the lubrication system circulates oil.
- b. Oil rings shall:
 1. Be supplied for purge mist applications.
 2. Be used to deliver oil to the bearings.
 3. Have an operating submergence of 3 mm to 6,4 mm (0,12 in to 0,25 in) above the lower edge of the bore of the oil ring.

5.11.3 Modify to Read

Provisions shall be made for either pure oil or purge oil mist lubrication (see 5.10.2.8 for requirements).

Add**5.11.5 Ring oil lubricated sleeve bearings without a circulating system**

- a. For ring oil lubricated sleeve bearings without a circulating system, the following shall be attached to the bottom of the bearing housing in the order indicated:
 1. Bronze gate valve.
 2. Clear plastic sight indicator.
 3. Petcock.
- b. Oil flingers (rings) shall be grooved on the inside diameter for enhanced oil circulation.

5.12 Materials**5.12.1 General****5.12.1.2 Add**

Duties for which 12% Cr steel is specified as the casing material, grade CA6NM shall be supplied.

5.12.1.6 Modify First Sentence to Read

Classification of pump materials shall comply with a) through g):

Add

- d) Minimum material requirements for hydrocarbon service shall be S-5 or S-6 construction.
- e) VS1, VS2, VS3, VS6, and VS7 in water service shall be, as a minimum, cast iron, bronze fitted with stainless steel shaft and hardware.
- f) Unless it is not compatible with service fluid, mechanical seal gland shall be 316 SS.
- g) Alternate metallurgy shall be subject to approval by the BP responsible engineer.
- h) S8 or A8 material shall be used for amine service.

5.12.1.8 Add

For pump applications with a normal pumping temperature of 343°C (650°F) or 68 barg (1 000 psig) discharge pressure, chemical and mechanical data shall be provided for the foundry heat from which material is supplied for pressure containing parts, impellers, and shafts.

5.12.1.12 Add to e)

Unless specified otherwise, GP 36-26 (NACE MR0103) shall be used for refining service and GP 36-25 (NACE MR0175) shall be used for midstream and upstream services. BP will list the appropriate standard on the equipment datasheet.

5.12.1.12 Add

- f) Pumps handling seawater or brine greater than 40°C (104°F) that is contaminated with oil and H₂S shall be fabricated in a super duplex stainless steel or a more corrosion resistant material.

Add**5.12.1.15 With reference to API 610, Annex G, Table G.1, in the Service column and the row addressing diesel oil, gasoline, naphtha, kerosene, etc., at temperatures above 370°C (700°F), the following shall apply:**

- a. Material for construction of the casing shall be subject to approval by the BP responsible engineer.