



GROUP GENERAL SPECIFICATION

ROTATING MACHINERY

GS GR MEC 271

CENTRIFUGAL PUMPS

API 610 9th edition

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Foreword

When the specification is applicable to their contract, the Engineering Companies and Design Offices are obligated always to check that the applicable regulations, in particular regarding SAFETY, QUALITY and protection of the ENVIRONMENT, do not impose more restrictive measures. If they do, alternative solutions in accordance with the regulations must be submitted in writing to the appointed Entity.

To be applicable, this specification must be mentioned in a contract in which an Entity of the TOTAL Group is acting as Owner, Delegated Contracting Authority or Service Provider linked to the Owner by a support contract.

For new equipment, this specification cancels and replaces the specifications:

- **GS RM MEC 101** revision 00 Feb. 2003,
- **GS MEC 271** revision 00 Feb 2001,
- **SGM 1511 MEC** revision 04 June 1998.

API 610th edition CENTRIFUGAL PUMPS

A Subject

The present document constitutes the TOTAL specification for centrifugal pumps used for petroleum, petrochemical and natural gas industries including on-site and off-site units.

The standard API 610 9th edition "CENTRIFUGAL PUMP FOR PETROLEUM, HEAVY DUTY CHEMICAL AND GAS INDUSTRY SERVICES" and its appendices are part of this specification.

Chapter C contains all modified and additional clauses.

The clause numbers used are those of API 610 9th edition.

Clause numbers that do not exist in API 610 are additional clauses. (Addition)

Only those clauses in API 610 that have been totally modified (Substitution) or partially modified (Clarification) by the present specification are mentioned. All other clauses remain applicable.

Any later revisions of API 610 will result in a revision to the present specification.

For this specification API 610 9th edition is considered technically equivalent to the ISO Final draft International Standard 13709.

B Referenced documents– Regulation

Unless otherwise stated in the particular contractual conditions, all the referenced documents, and their addenda, are applicable in their latest revision.

Standards

Reference	Title
ISO 281	Rolling bearings. Dynamic load ratings and rating life.
ISO 1940-1	Mechanical vibration - Balance quality requirements for rotors in a constant (rigid) state - Part 1: specification and verification of balance tolerances
ISO 3744	Acoustics. Determination of sound power levels of noise sources using sound pressure. Engineering method in AN essentially free Field over A reflecting plane.
ISO 5199	Technical specifications for centrifugal pumps - Class II
ISO 9906	Rotodynamic pumps - Hydraulic performance acceptance tests - Grades 1 and 2
ISO 10441	Petroleum and natural gas industries. Flexible couplings for mechanical power transmission. Special purpose applications.
ISO 10474	Steel and steel products. Inspection documents.
ISO 13709	Centrifugal pumps for petroleum, petrochemical and natural gas industries
ISO 14120	Safety of machinery - Guards - General requirements for the design and construction of fixed and movable guards
NF EN ISO 4042	Fasteners. Electroplated coatings.
EN 287	Approval testing of welders. Fusion welding.
EN 288	Specification and approval of welding procedures for metallic materials.
EN 10204	Metallic products. Types of inspection documents.
EN 13445	Unfired pressure vessels

Professional documents

Reference	Title
API 610 9th edition	Centrifugal pumps for petroleum, petrochemical and natural gas industries
API 682 2nd edition	Pumps – Shaft sealing system for centrifugal and rotary pumps
API 685	Sealless centrifugal pumps for petroleum heavy-duty chemical and gas industry services downstream segment.
API 670	Machinery protection systems
API 671	Special purpose couplings for petroleum and gas industry services
ASTM F1941M	Standard specification for electrodeposited coatings on threaded fasteners
ASTM B633	Standard specification for electrodeposited coatings of zinc on iron and steel

Regulation

Reference	Title
91/368EEC	Directive of the EEC Council of 6/20/1991 which modifies the directive 89/392 concerning the approach of member states relative to machinery
Directive 93/68/EEC	Directive of the European Parliament and of the Council of 22 June 1998 on the approximation of the laws of the Member States relating to machinery

Directive 94/9/EEC	Directive the European Parliament and of the Council of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres
Directive 97/23/EEC	Directive of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment
Directive 98/37/EEC	Directive of the European Parliament and of the Council of 22 June 1998 on the approximation of the laws of the Member States relating to machinery as amended by Directive 98/79/EC

Codes

Reference	Title
ASME B73.1M	Specification for horizontal and suction centrifugal pumps for chemical process

Specifications

Reference	Title
GS RM PVA 101	Refinery piping material classes

Other documents

Reference	Title
No applicable	

B.1 Priority rules

The subject of this specification shall satisfy, in descending order of priority, the requirements of:

- The local regulation, when applicable,
- The project's Job specification, when existing,
- TOTAL specifications,
- Other codes, standards and norms to which this specification refers.

In the event of conflicting requirements between the selected construction code and the other codes, norms and standards if stipulated by a particular contract, the most restrictive requirement shall apply.

B.2 Concession request

Any exemption from the requirements of this specification may be suggested by the General contractor or the Engineering company or the Manufacturer or Contractor, if he considers such exemption beneficial for reducing the cost and/or completion time, provided that it does not compromise the safety of personnel, service reliability, the cost effectiveness of the project in question or the regulatory requirements (when such regulations apply).

Exemptions must be submitted to the Entity acting as the Owner, Delegated Contracting Authority or Service Provider linked to the Owner by a Support Contract as a variant with the necessary justifications, and must receive the written approval of the Entity.

C Modified API 610 clauses

In this chapter, only the API 610 STANDARD clauses which have been deleted, completed (Addition), totally modified (Substitution) or partially modified (Clarification) by the present specification are mentioned. The other clauses of the API 610, which are not mentioned, remain applicable.

1 Scope (Clarification)

The purpose of this specification is to define the minimum requirements necessary for the design, construction, inspection, testing and supply of centrifugal pump and power recovery turbine sets, for services that TOTAL or the purchaser considers API 610 equipment is required. The equipment shall be manufactured in accordance with the requirements set forth in API 610 9th edition as amended by the present specification.

Pumps for services that do not require API Standard 610 equipment shall be proposed according to ISO 5199 or ANSI B73.1

Sealless pumps, according to API 685, shall be proposed as an alternative for hot, toxic or inflammable products and for products with a fire risk in the event of leakage.

2 Normative references (Clarification)

Unless otherwise specified, the base documents shall be the ISO publications and standards listed in this clause and the Bibliography.

The Codes, Standards and Specifications used shall be the latest edition, including all additions, revisions, supplements and interpretations that have been published prior to the purchase order

It is the Vendor's responsibility to bring to the attention of Total any amendments to those texts that appear after the purchase order, but prior to the delivery of the equipment,

Equipment shall conform to all Country, State and local requirements applicable to the equipment and the designated installation site.

In particular for equipment to be installed in Europe or if no local rules exist, the following directives are applicable:

- Machines 91/368EEC;98/37/EEC
- 'CE' Mark 93/68/EEC
- Pressure Equipment 97/23/EEC
- Atex 94/9EEC ; 99/92EEC

3 Terms and definitions

3.4 BEP (Substitution)

flow rate at which a pump achieves its highest efficiency when fitted with the selected impeller(s).

3.17 (Clarification)

When the pump has a heating jacket, the maximum allowable temperature of the casing shall be at least equal to the greater of the following values:

- the maximum specified temperature of the fluid being pumped,
- the maximum specified temperature of the heating fluid.

3.61 (Addition)

Head for vertical pumps

For double casing pumps (VS6, VS7), the head shall be calculated using the suction and discharge pressures converted to the same elevation.

For submerged pumps (VS1 to VS5) the head shall be calculated using the discharge pressure at the flange plus the height between minimum liquid level and the discharge flange center.

4.2.1 (Clarification)

Unless otherwise specified, pumps shall have SI dimensions and comply with applicable ISO standards.

5 Basic design

5.1.4 (Clarification)

When the specific gravity of the fluid being pumped is less than 1, at the pumping temperature, the vendor shall ensure that the pump and its accessories shall be able to operate without deterioration during the performance test with water. Performance tests at reduced speeds shall require TOTAL written approval prior to any purchase order.

5.1.6 (Clarification)

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 API 610 clause 5.1.6 Note) and to correct any head shortfall during testing, including the 2% tolerance per table 14.

For overhung impellers the tip speed of the selected impeller, at the rated operating point, shall not exceed 62 metre/sec.

5.1.10 (Clarification)

The NPSHR specified on the data sheets and the performance curve shall correspond to the rated impeller diameter.

The difference between the required NPSH (NPSHR) and the available NPSH (NPSHA) at the rated point shall be greater than 20% of the available NPSH (NPSHA).

The difference between the NPSHA and NPSHR shall not be less than 0.5 m throughout the allowable operating region of flow.

If the difference between the NPSHA and NPSHR is less than 1 meter at the rated point, or an inducer is proposed, the vendor shall provide in the proposal the test NPSH curve.

5.1.11 (Clarification)

The Vendor shall indicate, in the proposal, the value of the suction specific speed for the pumps proposed. Suction specific speeds, without inducer, shall be limited as indicated in the table below.

Suction specific speed $S=N(Q)^{0.5}/(NPSHR)^{0.75}$	Q in M ³ /sec,	Q in M ³ /hr	Q in USGPM
	NPSHR in Metres		NPSHR in ft
Maximum allowable (all pumps)	252	15100	13000
Maximum preferred	213	12780	11000
Maximum allowable for pumps handling liquefied gases, volatile liquids or containing dissolved gases	213	12780	11000

All proposals shall clearly indicate the use of an inducer, if necessary. The use of an inducer shall be subject to Purchaser approval.

5.1.12 (Clarification)

The proposal for such a pump shall also include:

- The water performance curve without corrections.
- The correction coefficients for efficiency, head and capacity in accordance with the Hydraulic Institute Standards.
- The expected performance curve with specified product
- The maximum expected power consumption (viscosity range, cold start up and normal operation).

5.1.13 (Clarification)

Pumps with a stable head/capacity curve (continuous head rise to shut-off) are required for all the applications.

For boiler feed pumps the head at the minimum continuous flow shall be at least 120% of the head at the rated operating point.

Pumps that are specified to operate in parallel shall have:

- a) The same shut off head, which shall be confirmed at the performance test. For each of the test points, of such pumps, 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.
- b) The head at 50% of rated operating point flow shall be at least 110% of the head at the rated operating point.

5.1.15 (Clarification)

Cooling water pumps, boiler feed water pumps and pumps handling a product containing dissolved gas, shall be selected such that the rated operating point is as close as possible to the BEP.

5.1.16 (Substitution)

For the pump skid, or any individual component, operating at full load, in a free field over a reflecting plane, the sound pressure level measured at any point on a surface 1 meter from the surface of the reference box shall not exceed 85 dBA. No positive tolerance will be allowed.

If a noise test is specified, ISO 3744 will be used as a basis for sound pressure measurement.

A parallelepiped measurement surface (ISO 3744 paragraph 7.3) shall be used for pump skids, The dimensions l_1 , and l_2 shall be the length and width of the pump skid and l_3 shall be the height from the underside of the skid to the top of the highest element of the pump train excluding cabling, piping and auxiliaries such as the barrier/buffer fluid reservoir. Background (K_1) and environmental corrections (K_2) may be applied.

Sound pressure measurements will be taken at each of the microphone positions indicated in ISO 3744 Annexe C as a minimum. The sound pressure measurement at each point will include twenty four 1/3rd octave band measurements (50 to 10000Hz) for calculation of the A weighted sound pressure level at that point and the detection of any narrow band noise.

Pumps and auxiliary components emitting narrow band noise are to be identified in the proposal and options to eliminate this noise will be presented. Initial detection of narrow band noise will be a subjective determination by the witness during test. If such a subjective detection is made, for the purpose of this specification, narrow band noise shall be considered present if any of the 1/3rd octave band sound pressure levels (dB) exceeds that of both of the 1/3rd octave bands on

each side of by 5 dB. Equipment found to emit narrow band noise during the test will not be accepted.

The sound power will be calculated per paragraph 8.6. for information and compared to that predicted.

As far as possible, standard motors with low noise levels shall be used.

5.1.19 (Clarification)

As a minimum bearing cooling shall be provided as follows:

Maximum pumping temperature T_m .	Cooling method
$T_m \leq 177^\circ\text{C}$	Air, if necessary
$177^\circ\text{C} < T_m < 260^\circ\text{C}$	Air + heat shield
$260^\circ\text{C} \leq T_m$	Water

5.1.23 (Clarification)

The arrangement of the equipment, including piping and auxiliaries shall be submitted to TOTAL for review and/or approval.

The vendor shall review and comment to Purchaser's piping drawings regardless of the application.

The vendor shall review and approve Purchaser's piping drawings when the difference between the NPSHA and NPSHR is less than 1 metre.

The vendor shall be present to observe a check of the piping, performed by parting the flanges after installation.

The vendor shall be present during the initial alignment of the pump and drive train.

5.1.26 (Clarification)

Any non-rotating maintenance part weighing more than 25 kg shall be fitted with permanent lifting lugs or equipped for removable lifting eyes.

5.1.30 (Clarification)

The Vendor shall include in his supply any protection necessary for the jobsite location and conditions.

5.1.31.g (Addition)

The Vendor shall specify the tightening torque for the casing joint bolting. Tightening torques are to be specified as "Dry" or "Lubricated". If lubricated, the type of lubrication is to be specified on the cross section drawing and/or in the manual.

5.1.32.a) (Addition)

The pump internal bolting shall be equipped with all-metallic self-locking nuts or tab washers.

5.1.32.b) (Addition)

Fasteners materials shall be in accordance with Table H1 except that:

- a) Carbon steel fasteners 12 mm diameter or smaller shall be replaced with 316L stainless steel fasteners.

- b) Non stainless-steel fasteners greater than 12 mm diameter shall be zinc plated and bichromated (Zn12/C/Fe) according to standard NF E 25-009, ASTM F871 or B633, and shall be painted.

5.2. (Clarification)

The pump types listed in Table 2 are not acceptable and shall not be proposed.

5. Pressure casings

5.3.2.a(Clarification)

The maximum discharge pressure shall be increased by the additional differential pressure developed when operating at the maximum specified relative density and at the most unfavourable specified operating condition.

5.3.2.d) (Addition)

Operating on water during the performance test if the discharge pressure at zero flow is higher than that specified in 5.3.2.a).

5.3.6 (Clarification)

All the parts of the pressure casings of type BB3 and BB5 pumps and the suction casing of type VS6 and VS 7 pumps shall be designed for the maximum allowable working pressure (MAWP) unless the suction casing is equipped with a relief valve (see 7.3.2.1).

5.3.7 (Clarification)

In the event that the data sheet specifies an erosive fluid the vendor shall propose an erosion allowance, coating or cladding or other technique to avoid degradation of the casing pressure rating due to erosion.

5.3.11 (Clarification)

Foot mounted pumps shall not be proposed.

5.4 Nozzles and pressure casing connections

5.4.2.1(Clarification)

Machined and studded connections are not allowed.

5.4.2.3(Clarification)

Facing for flanges shall comply with the specifications for the connecting piping.

5.4.2.4(Clarification)

If non-standard studs or bolts are required they shall be included in the vendors scope of supply.

5.4.3.1(Clarification)

Threaded casing auxiliary connections, that do not need to be disassembled, shall be seal welded except for cast iron casings.

5.4.3.3(Clarification)

Cylindrical threads shall not be used.

5.4.3.4(Clarification)

Auxiliary connections shall be supported per paragraph 6.5.1.5.

If gussets are chosen as a method of support, connections less than or equal to DN 40 (1½") shall be reinforced by two gussets at 90° to each other, each being at least 5mm thick and 35mm wide.

Tapped openings (when permitted) and SW connections shall be made in bosses of sufficient thickness that are an integral part of the casing casting.

Openings for auxiliary connections shall not be placed in high-speed flow areas.

Balance line piping and flanges and all auxiliary connection flanges on the pump pressure casing shall be of the same rating as the discharge flange.

5.4.3.5(Clarification)

"Connection welding" includes welding of any gussets.

5.4.3.6 (Substitution)

Pipe nipples screwed or welded to the casing should not be more than 150 mm (6 in) long and shall be a minimum of schedule 160 seamless for sizes DN 40 (1½ NPS) and smaller.

5.4.3.7(Clarification)

It is preferred that plugs be assembled dry. The use of any lubricant/sealant requires TOTAL written agreement after the vendor has demonstrated the compatibility of the chosen lubricant/sealant. The product specification shall be shown on the cross section drawing and in the manual.

PTFE tape shall not be used.

5.4.3.8. (Clarification)

Machined and studded connections on the casing shall only be used with TOTAL written agreement.

5.4.3.10. (Clarification)

All pumps will be fitted with drain connections that will completely drain the pump. If this requirement cannot be met the Vendor shall indicate, in the proposal, the amount of fluid that will remain and where it will remain. This information shall be clearly stated on the outline drawing and in the manual.

Drains and vents shall be equipped with a gate valve as close as possible to the pump casing while remaining easily accessible.

5.5 External nozzle forces and moments

5.5.5 (Clarification)

Annex F shall not be used without TOTAL written approval.

5.6 Rotors

5.6.5 (Clarification)

Shaft sleeves shall not be less than 3.2 mm thick. Seal sleeve thickness shall comply with API 682 clause 6.1.3.7.

5.6.8 (Clarification)

Plating of the shaft is not permitted on bearing surface areas, except for hydrodynamic bearings when used as a manufacturers standard. Machining errors shall not be corrected by plating.

5.7 Wear rings and running clearances

5.7.1 (Clarification)

The back wear rings may be deleted when necessary for sealing or thrust balance considerations provided the impact upon pump performance is clearly documented.

Integral impeller wear rings shall not be used without TOTAL approval.

Axially split multistage pumps, fitted with dynamically balanced rotors per clause 8.2.4.2.1, shall be equipped with two-piece casing wear rings, bearings and thrust bearings.

5.7.2 (Clarification)

The actual hardness of each wear surface shall be marked on the part and visible after assembly.

5.8 Mechanical Shaft Seals

5.8.1 (Clarification)

The proposed seal vendor's comments and exceptions to ISO 21049 Feb 2004 shall be submitted to the Purchaser as part of the proposal.

5.8.7 (Clarification)

Flush piping shall be provided with a ½" NPT plugged tee as a provision for future pressure measurement. This tee shall be between the flow control device or any other device (cooler, cyclone etc.) and the seal gland. If the pump is supplied with a pressure measurement drilling into the seal chamber, the tee is not required.

For between bearing pumps the seal flush piping shall be separate for each seal. If this is not possible it shall be stated in the proposal and the piping system shall be designed to avoid preferential flow.

5.8.9 (Substitute)

Seal chamber heating and cooling requirements shall be specified in the project specification.

5.8.12 (Addition)

The VENDOR shall ensure that the lubricant used to reassemble and/or protect the mechanical seal after pump testing and before shipping is compatible with the pumped product.

5.9 Dynamics

5.9.1 (Clarification)

For all pumps, any available critical speed data measured on identical pumps operating under similar conditions shall be included in the proposal.

In the absence of previous measured data, the Vendor shall provide the critical speed values calculated taking into account hydraulic effects.

Critical speeds shall always be verified on a test bench in the event of operation above the first critical speed.

An analysis of lateral critical speeds of each machine on the shaft line is required if :

- It is a contractual requirement.
- The rated power of the driver is greater than or equal to 1000 KW.
- The shaft line has more than three machines.
- There is a variable speed prime mover.

Supporting and surrounding structural elements that are in the Vendor's scope of supply shall not be excited by the pump when it is operating at any point in the allowable operating region.

5.9.2.1(Clarification)

The Vendor shall perform a torsional analysis of the entire shaft line in one of the following cases:

- It is a contractual requirement.
- The rated power of the driver is greater than or equal to 1000 kW.
- The shaft line has more than two machines.
- There is a variable speed prime mover.

The Vendor shall be responsible to obtain all necessary information from the suppliers of the other train components to perform this analysis. In the event that these suppliers are not the Vendor's own subcontractors, an agreement shall be reached during the contract negotiations.

5.9.2.2(Clarification)

When a torsional analysis is specified or required for any motor driven pump train, transient and steady state conditions shall be evaluated. 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.

5.9.2.6(Clarification)

The report will be supplied in all cases where a torsional analysis is carried out.

5.9.3.3(Clarification)

The FFT spectra shall be plotted and included in the pump test results.

5.9.3.6(Clarification)

The vibration values in tables 7 and 8 shall be of the maximum allowable and guaranteed values during testing and are applicable across the allowable operating region.

For workshop testing, the pump shall be well fastened to the test bench so that vibration measurements shall be valid and may be used as acceptance criteria. In the event that a pump fails to meet the vibration requirements due to the test bench installation, the Vendor shall demonstrate this by running the test again with an improved installation.

For pumps with flexible rotors, a real time recording of vibrations during deceleration shall be performed.

5.9.4.4(Clarification)

Impellers and balance pistons and similar rotating components shall be dynamically balanced to ISO 1940-1 grade G1. Clause 5.9.4.2 may be used if applicable.

5.10 Bearings and Bearing Housings

5.10.1.1 (Clarification)

Hydrodynamic radial and axial bearings are required if the energy density (kW.rpm) is greater than or equal to:

- 1,800,000 for pumping temperatures < than 300° C.
- 1,200,000 in other cases.

Ball and roller bearings shall have a basic rating L_{10th} per ISO 281 of at least 40,000 hours with continuous operation at rated conditions and at least 25,000 hours at maximum radial and axial

loads and rated speed. Bearing life calculations shall be supplied for each pump and shall include axial and radial loads across the operating range at design and two times design internal clearances.

5.10.1.2 (Clarification)

For hydrodynamic thrust bearings, the Vendor shall provide the following for TOTAL approval:

- Calculation of the axial thrust across the allowable operating region at design and two times design internal clearances.
- Maximum operating and ultimate capacities of the thrust bearing selected.

Gear type couplings are not accepted.

For onshore submerged vertical pumps only, the thrust bearing may be located in the drive motor. In this case, the pump Vendor shall be responsible for the bearing sizing which shall be according to clause 5.10.

5.10.1.4 (Clarification)

Deep-groove ball bearing cages shall be metallic.

Axial and radial fits and clearances, as well as any pre-load, shall be clearly indicated on the section drawing and in the manual.

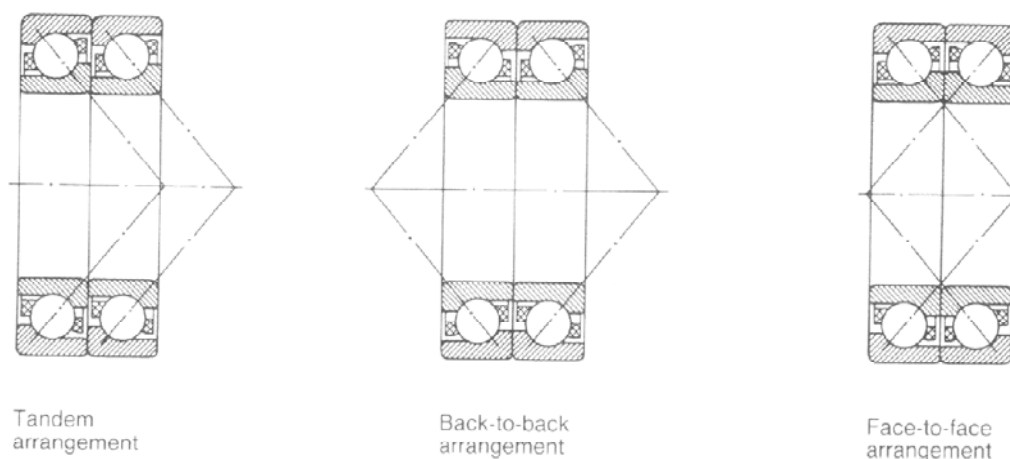
On offshore platforms, the radial bearing shall always be pre-loaded against the thrust bearing using conical spring washers. Cylindrical roller bearings and spherical roller bearings shall not be used for this reason.

5.10.1.5 (Clarification)

Ball thrust bearings shall be supplied with machined brass cages.

The installation of the thrust bearings shall be pictorially shown on the section drawing and in the manual. References to "X", "O" or "T" shall not be used unless accompanied by a drawing.

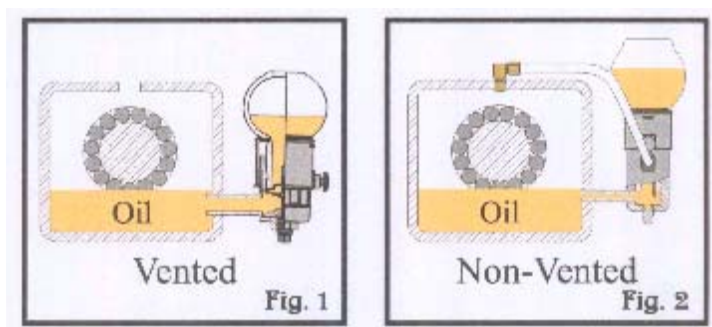
Bearing pairs



Paired angular contact bearings with rotor radial loads below the bearing manufacturers minimum radial load shall be fitted with pre-loaded thrust bearings. Thrust bearing pre-load shall be created by reduced internal axial clearances not by springs or shims.

5.10.2.2 (Clarification)

Constant level oilers shall be of the balanced or non-vented type.



The bearing casings of pumps driven by steam turbines and/or equipped with mechanical seals with a permanent steam quench, shall be equipped with a water trap in the lower half, with a visible level indicator.

This trap design shall be equipped with a drain valve with a safety lock (locked in the closed position).

5.10.2.7 (Clarification)

Replaceable labyrinth end seals shall be INPRO style "VBXX" vapour carrier type or purchasers approved equal.

5.10.2.8 (Clarification)

For US installations, unless otherwise specified on the Purchaser's requisition, pumps with anti-friction bearings shall be arranged for pure-oil mist lubrication.

5.10.2.11 (Clarification)

The probe types and methods of fixation shall be approved by TOTAL.

5.10.2.12 (Clarification)

This applies. These machined surfaces are required for each machine, including driver and any gear or speed variation unit. For equipment where this is not feasible such as the non-drive end of electric motors another system such as an extension bar shall be fitted to the bearing housing to permit vibration measurement.

5.10.2.13 (Addition)

Based on the specified site conditions, the Vendor shall indicate if oil heating is necessary. The Vendor shall provide any necessary oil heating system and bearing insulation. If the Vendor believes that such a heating system is not necessary, the Vendor will not be granted an operating limit due to low ambient temperature.

5.11 Lubrication

5.11.1 (Clarification)

"TOTAL" brand lubricants shall be used. The Vendor shall specify the type and quantity required.

5.11.4 (Clarification)

Rolling element bearings for pumps shall be oil lubricated. Grease lubricated bearings may be proposed only as an option and only if accompanied by a complete technical and commercial argument.

5.12 Materials

5.12.1.1 (Clarification)

Unless otherwise specified in the job specification Appendix 1 of this specification, which complements Table G1, applies.

The use of 12% Cr martensitic steels such as ASTM A 217 grade CA15 is prohibited for cast casings due to weld repair difficulties; only ASTM A 487 grade CA6NM steel may be used.

5.12.1.2 (Clarification)

Material substitutions after the order shall not be allowed without Purchaser's written approval.

5.12.1.6c. (Clarification)

For services conveying non-flammable or non-toxic liquids, grey cast iron is prohibited; ductile iron per ASTM A395 may be proposed.

5.12.1.8 (Substitution)

Unless otherwise specified in the job specification the Vendor shall supply material inspection certificates in accordance with ISO 10474 or EN 10204 standards for pressure casing parts, impellers and shafts. These certificates shall be, as a minimum, "3.1.B"

5.12.1.9 (Clarification)

In the event that the data sheet specifies an erosive fluid the vendor shall propose an erosion allowance, coating or cladding or other technique to avoid degradation of the mechanical strength or integrity of the rotating parts due to erosion.

5.12.2.1 (Clarification)

Purchaser shall be informed, in writing, whenever a proposed casting is to be the first one from a new set of patterns.

5.12.2.3.b (Clarification)

Welded or brazed repairs on ductile or Ni resist cast iron castings are prohibited.

Pressure containing, ductile or Ni resist cast iron parts shall not be repaired by plugging.

5.12.2.5. (Clarification)

Repair procedures shall be submitted for purchaser approval and each defect shall be located on a weld map.

5.12.3.1. (Clarification)

Weld procedures shall be submitted for purchaser's approval for all piping subject to wet sour service. This includes, but is not limited to, pump flush, vent and drain connections and piping.

5.12.3.3 (Clarification)

Casings composed of ductile or Ni resist cast iron elements welded together are prohibited.

The fabrication drawings with details of the welds, the complete welding dossier and the verification list shall be submitted to TOTAL for approval prior to manufacture.

All casing components manufactured according to this clause shall undergo a post-weld heat treatment regardless of dimensional stability requirements.

5.12.3.4.a (Clarification)

Weld neck flanges shall be used for non flammable or non hazardous nozzles.

5.12.3.4.d (Clarification)

Connection designs for fabricated pressure casings shall be approved by purchaser before fabrication commences.

5.12.3.4.e (Clarification)

All auxiliary connection welds, including any seal welds, shall undergo magnetic particle or liquid penetrant examination. If feasible a radiographic examination shall also be carried out to ensure correct fit-up of socket welded connections and thread engagement of seal welded NPT connections.

5.12.4.Low temperature (Clarification)

5.12.4.1 (Clarification)

When material is being selected for low temperature applications, the Purchaser shall take into consideration the temperature resulting from transient operations such as: line filling, first start up and draining of liquids that may be vaporized.

5.12.4.3 (Clarification)

Unless otherwise specified, impact testing shall be performed in accordance with EN 13445.

5.13.1 (Clarification)

Nameplates and rotation arrows shall be 316 stainless steel.

5.13.2 (Clarification)

Nameplates shall be in SI units except for units to be installed in the USA.

The year of the pump manufacture shall be included on the plate.

5.13.3 (Clarification)

For axially split pumps the serial number shall be stamped on each half. These markings shall remain legible after painting

6 Accessories

6.1 Drivers

6.1.1 (Clarification)

Electric motors shall comply with the project specifications.

6.1.2 (Clarification)

The Vendor shall clearly indicate any limitations or any special start up procedures resulting from the selection of supply elements.

Electric motor start up shall always be direct.

The data sheet shall specify those cases in which the pump starts up on an open circuit.

Unless otherwise specified, start up on an "open valve" shall assume start up on an open circuit and motors shall be sized accordingly.

6.1.3 (Clarification)

The nameplate rated power including service factor (if any) of electric motors shall be the greater of the two following values:

- Power determined as per API 610 table 11. The Rated power of the pump to be taken into account being the power absorbed at the rated point, plus the API allowances per Table 14

- Maximum power absorbed by the pump with the selected impeller at the maximum specified specific gravity, up to and including the end of the allowable operating region of the curve that was agreed prior to the order.

6.1.5 (Clarification)

Unless otherwise specified, motors for pumps with "open valve" or open circuit start up shall be capable of accelerating the pump to rated speed assuming maximum (usually end of curve) power at 80% voltage. The separation between the motor and pump speed torque curve shall never be less than 10% of the rated torque.

6.1.9 (Clarification)

Unless otherwise specified, gears with a rated power greater than 1000 KW shall comply with the API 613 "Special purpose gear unit for refinery service" latest edition. The proposal shall include the proposed gear vendor's comments and exceptions.

6.1.10 (Clarification)

Jackscrews shall be designed and placed in such a way as to allow level adjusting shims to be removed without disturbing other equipment.

When drive is by gas turbine, these jackscrews shall be on the pump.

6.1.11 (Addition)

Mechanically welded motor supports for VS type vertical pumps shall undergo a stress relieving heat treatment before machining.

6.2 Couplings and Coupling Guards

6.2.1 (Clarification)

The make and model of coupling shall be approved by TOTAL.

6.2.3 (Clarification)

Couplings not covered by clause 6.2.4 and operating at speeds of 3800 rpm or less and shall be component balanced to a quality that will satisfy an assembly balance check in accordance with ISO 10441 clause 12.4.2. If the residual unbalance of the assembly is greater than ISO 1940 grade 6.3 the individual components will be re-balanced until a satisfactory assembly balance check can be attained.

The different parts shall be identified and match marked after the successful residual unbalance check.

6.2.4 (Clarification)

Multistage pumps with hydrodynamic bearings or any pump with a rated speed greater than 3600 rpm shall be supplied with couplings that meet the requirements of API 671 latest edition.

6.2.5 (Clarification)

The coupling drawing will include coupling thermal growth data in millimetres per 100°C temperature rise. The vendor will ensure that the alignment data in the manual includes any coupling pre-stretch required due to thermal growth of casings and coupling.

Keys shall fill the keyway in the shaft and hub. Any part of the key protruding shall be machined flush with the shaft.

Prior to delivery the vendor shall establish, for purchaser witness, a balance dossier including all relevant balance certificates of rotors, shafts and couplings to demonstrate a consistent philosophy regarding filling keyways during balancing of the individual components by different suppliers.

Keys and half keys shall meet the requirements of ISO 8821:1989 including marking of keys and shaft ends with the applicable key convention.

6.2.6 (Clarification)

Shaft-end drawings indicating machining tolerances shall be included in the Operating, maintenance and technical data manual.

The assembly of half couplings shall be such that a temperature of less than 120° C is required for removal.

Locking by means of self-hardening products is prohibited.

Molybdenum bisulphide grease shall be applied to the ends of the shaft before fitting to avoid seizure.

Shaft ends shall not be set back in the bored area of the half couplings.

6.2.7 (Substitution)

Couplings and coupling to shaft junctures shall be rated for at least 1.5 times maximum driver power including any driver service factor.

6.2.13 (Clarification)

If the Vendor is not responsible for the driver this clause applies. Otherwise the Vendor is responsible for the couplings and shall install the driver coupling-hub during the pre-alignment of the train in the plant.

6.2.14 (Clarification)

If not otherwise specified, guard allowable access dimensions shall be according to ISO 14120.

Coupling guards shall be non-sparking.

6.3 Baseplates

6.3.1. (Substitution)

The drain pan shall be sloped at least 1:100 towards the pump end.

As a minimum, EN 10025 S235 J2G3 steel shall be used. The option of impact testing shall be taken for ambient temperature below –20°C.

Welds shall be subject to 100% Dye Penetrant per table 13 inspection standards.

Baseplates made from cast iron or folded or stamped plate are unacceptable.

6.3.3 (Addition)

The baseplate design shall include a minimum of 4 machined surfaces positioned to allow the baseplate to be levelled (laterally and longitudinally) without having to disassemble any equipment. These surfaces are to be machined at the same time as the pump and driver mounting pads and left unpainted but protected from corrosion.

Unless otherwise specified, pump pedestals shall be supplied with water-cooling when the temperature of the pumped fluid is greater than or equal to 250° C. If the project specification specifies no pedestal cooling and the temperature of the fluid is greater than 250°C, provision for cooling shall be supplied.

Other methods, such as heat shields and pump-feet thermal barriers, may be acceptable if accompanied by a suitable reference list.

6.3.5 (Clarification)

The manufacturer shall pre align the train in the factory, with the baseplate clamped in position and level at each of the machined surfaces (3.3.1.3 above). Clamps will be at the anchor bolt positions.

6.3.6 (Clarification)

If, due to piping restraints, the Purchaser requires that the pump accept higher forces and moments than those listed in table 4, the baseplate shall undergo a stiffness test and the pump feet shall be dowelled at the vendor's works.

The stiffness test may be substituted by a calculation or a test report of previously witnessed test of a similar pump/chassis combination. If the type of calculation or test report is not clarified before the order a stiffness test shall be included in the scope of supply.

6.3.9 (Clarification)

All baseplates will be epoxy grouted. Baseplate grouting holes will be accessible without removing the machinery.

6.3.13 (Clarification)

Unless otherwise specified all baseplates will be mounted with grouting.

6.3.14.(Clarification)

All drive train components shall be fitted with transverse and axial alignment jackscrews. The lugs shall be attached in such a way that they do not interfere with the installation or removal of the shims.

6.3.15 (Clarification)

When base frame fixing holes are made in a non-parallel profiled wing, tapered shims shall be welded onto the wing at each anchor bolt position.

6.3.19 (Clarification)

The use of undercut anchor bolts is prohibited.

6.3.20 (Clarification)

Vendor shall supply lifting diagram(s) and procedure(s) including definition of the length and rating of required slings. The design of the lifting system shall allow lifting without removal or damage to any skid-mounted component. If a spreader bar is required to lift the complete skid, without removal or damage to components, it shall be included in the Vendor's scope of supply.

6.3.21.(Addition)

For double casing vertical pumps weighing more than 100 kg, the base plate shall be equipped with levelling jackscrews. Machined surfaces shall be supplied for verification that the pump train is vertical. Horizontal positioning screws shall be provided.

The base plates and/or the support cages shall include lifting lugs.

The casing flanges shall be separate from the base plate to allow for the use of stud bolts.

6.4. Instrumentation

6.4.1.1. (Addition)

Temperature indicators shall be dial type and meet the following requirements:

- a) Heavy-duty corrosion resistant construction.
- b) Bimetallic type.

- c) 100mm (4.5") minimum diameter or, 150 mm (6") minimum diameter if at a distance greater than 2 metres from the nearest walkway. If no walkway exists the baseplate edge shall be used as a reference.
- d) Black printing on white background.
- e) Orientating "every angle" dial.
- f) Where maximum temperature limits allow liquid filled for vibration attenuation.

Vibration damping liquid filled pressure gauges shall be supplied regardless of location. Liquid filled pressure gauges shall be automatically temperature compensated. Other proprietary damping methods may be offered with suitable experience demonstrated.

6.4.2 Vibration, position and temperature detectors

6.4.2.1(Clarification)

Pump bearing housings of two-stage and multi-stage pumps with hydrodynamic thrust bearings shall be furnished with provisions for four accelerometers and their enclosures per API 670.

6.4.2.2(Clarification)

Unless otherwise specified, pump bearing housings of multi-stage pumps with hydrodynamic thrust and journal bearings shall be furnished with provisions for two, purchaser's approved, radial vibration probes in each bearing housing, and three axial position probes at the thrust bearing end of each machine. The mounting provisions shall be in accordance with API 670 latest revision.

If vibration and/or axial position probes are included in the order the probe cables shall include a positive and proven "anti-wicking" feedthrough design to prevent oil from migrating from the bearing housing into the cable conduit and junction box.

6.4.2.3(Clarification)

Hydrodynamic thrust and/or radial bearings shall be fitted with at least one dual bearing-metal temperature element in each bearing. Unless otherwise specified, RTD elements shall be used. The elements and their mounting and calibration shall be in accordance with API 670 latest edition.

Such equipment shall be calibrated and used during shop testing.

Temperature element cables shall include a positive and proven "anti-wicking" feedthrough design to prevent oil from migrating from the bearing housing into the cable conduit and junction box.

6.5 Piping and appurtenances

6.5.1.1(Clarification)

Auxiliary piping systems shall comply with the project piping specification. If no piping specification is called for, Total specification SG RM PVA 101 Refinery Piping Material Classes shall apply.

Regardless of piping specification or class, the minimum wall thickness for piping $\leq$ DN 40 (1½") shall be schedule 160 for carbon steel piping and schedule 80S for stainless steel piping.

6.5.1.3(Clarification)

If screwed connections are acceptable to the applicable piping specification they shall be sealed welded except for connections to the housing or cover of the mechanical seal.

Screwed piping damaged by self-gripping wrenches will be refused.

Welders shall be approved according to EN 287 using procedures according to EN 288 or ASME IX where local regulations allow.

6.5.1.4(Clarification)

Unless otherwise specified in the data sheet, the reservoir support structure shall be attached to the baseplate.

6.5.1.5(Clarification)

Casing auxiliary connections and piping within the skid limits shall be such that:

- a) Forces and moments exerted by off-skid connecting pipework are absorbed by the supports and not the connection at the casing.
- b) The combination of casing connection, piping and support can accept a load in any direction of 1000 N without damage or permanent deflection.
- c) The natural frequency of any length (distance between supports) of piping shall be such that that length of piping does not resonate while the pump is operating.
- d) Piping to the seal gland shall be supported such that the screwed connections into the gland are not subject to forces due to expansion, vibration or other movement of the piping or auxiliary equipment to which that piping is attached.

The vendor may chose to meet this requirement by the use of gussets (see paragraph. 5.4.3.4) or pipe supports or a combination of both.

If supports are chosen these supports must allow the pipe lengths to expand and contract without causing loads on the casing connections.

To ensure satisfactory accessibility, Vendor shall supply, in sufficient time, drawing(s) of equipment and piping layout for review by the Purchaser. Fabrication of baseplate and piping shall not commence until agreement has been reached regarding an acceptable layout. Approval of layout will not alleviate the vendor of his responsibilities to meet the applicable specifications.

6.5.1.6(Clarification)

Drains and vents shall be equipped with a gate valve. If the specification for the piping connected to the pump calls for double block valves, this requirement shall apply to vent and drain valves. If a pump has several drains or vents each shall have a separate valve.

After the gate valve, pump casing drains shall be run to a manifold and then to the skid edge terminating with a flanged connection.

Unless otherwise specified, for pumps specified for liquids that are toxic or inflammable or have a pumping temperature greater than 60°C, each vent shall have a flanged connection after the gate valve. This connection shall be routed to a closed drain or flare system.

For other liquids, each vent shall have a connection after the gate valve for disassembly and then be run to the drain pan. The end of the pipe shall be fitted with a flange and blind flange in accordance with the applicable piping specification.

6.5.1.7(Clarification)

Flange fasteners on stainless steel piping shall be stainless steel.

6.5.2 Auxiliary process piping

6.5.2.1(Clarification)

Auxiliary process piping arrangements shall conform to API 610 Appendix B, unless modified by the project specification.

Vendor shall supply the expected seal chamber pressure and a calculation to demonstrate that this seal chamber pressure will be maintained to within the limits set in ISO 21049.

6.5.2.2(Clarification)

Auxiliary process fluid piping class shall be that of the pump discharge piping. The discharge pipe class shall be specified on the data sheet.

6.5.2.3(Clarification)

When the pump casing is 12% chromium, the auxiliary process fluid piping shall be in 316L or 321stainless steel.

6.5.2.6(Clarification)

Vent and drain connections shall always be fitted with valves, see 6.5.1.6.

6.5.2.8(Clarification)

Union connectors may only be used for piping containing flammable or hazardous fluids when it can be demonstrated that flanges cannot be used. The acceptance of any union connectors shall be subject to TOTAL written approval.

Screwed piping into mechanical seal glands shall be straight and provided with Lap joint flanges at the connection with the piping package.

Screwed piping into mechanical seal glands shall be such that self-gripping wrenches need not be used. Screwed piping damaged by such wrenches is not acceptable.

6.5.3 Cooling water piping

6.5.3.1(Clarification)

The positioning of cooling water piping shall be such that the water enters at the bottom and exits from the top of the cooling chambers.

6.5.3.4(Clarification)

The cooling line to each element (bearing, seal, etc) shall include a lockable flow control valve. Block and bypass valves shall be supplied by others. The Vendor-Purchaser interface shall be flanged.

6.5.4. Lubricating oil line (Addition)

Piping, connections and flanges shall be in AISI-TP 316 L stainless steel.

6.6 Special tools (Clarification)

6.6.1 Clarification)

If special tools are required for any assembly or disassembly, Vendor shall demonstrate to Purchaser witness the contractual set of tools in use on the contractual equipment. This may be a witness point during assembly or test or a separate demonstration.

7. Inspection, testing and preparation for shipment

7.1. General

7.1.4. (Addition)

The Vendor shall supply with the proposal the inspection/quality control plan listing all inspection operations for the equipment taking into account the project specification requirements. This plan, with the Purchaser comments, shall constitute the inspection program.

The Vendor's bid shall clearly state any tests the Vendor cannot carry out.

7.1.6 (Clarification)

This section applies. The checklist shall be signed and dated by both the Vendor and Purchaser representatives prior to release of the equipment for expedition.

The API 682 checklist shall be signed and dated by the Vendor representative and shall be available for review at the same time as the pump checklist.

7.2. Inspection

7.2.2.1(Clarification)

For equipment requiring post weld heat treatment, final non-destructive testing of welds shall be carried out after heat treatment.

7.3. Testing

7.3.1 General

7.3.1.2(Clarification)

Detailed test procedures, in accordance with this clause, are required for all pumps.

7.3.1.6(Addition)

If shop tested equipment is damaged before contractual delivery, the equipment shall be retested, after any repairs, to a level to be decided by the Purchaser.

7.3.2 Hydrostatic tests

7.3.2.1(Substitution)

The Hydrostatic test pressure of all pressure containing components as defined in 3.42 shall be at least 1.5 times the MAWP of the discharge flange.

The casing bolt tightening torques used shall be recorded on the test report and shall agree with those on the cross section drawing and in the manual.

If a relief valve is supplied (see 5.3.6) for a double casing vertical pump the hydrostatic test pressure of the suction casing shall be 1.5 times the relief valve setting.

Any apertures in the pump casing that are used for locating or fixing internal parts from the exterior of the pump shall be plugged with the actual fixing device and gasket system during the hydrostatic test, a dummy plug shall not be acceptable.

7.3.2.3(Clarification)

For components made of austenitic stainless steel, a recent chemical analysis specifying the chloride content of test liquids shall be provided. If the chloride content exceeds 25 ppm or if a recent test cannot be provided, flushing with distilled water shall be performed immediately after testing in the presence of the Inspection Authority.

7.3.2.4(Clarification)

The duration of the hydrostatic test shall be one (1) hour.

7.3.2.5(Clarification)

This paragraph applies; the test liquid used shall be kerosene oil or include a wetting agent for any of the conditions listed.

7.3.3 Performance tests

7.3.3.1(Clarification)

The performance test shall be carried out according to ISO 9906:1999 grade 1 but with acceptable performance tolerances according to API 610 9th ed. Table 14 and speeds according to clause 7.3.3.3 c).

The performance test shall be carried out with all the sealing equipment and accessories called for in the order connected. As a minimum this shall include seal flush/barrier/buffer piping and reservoirs (as applicable).

If the driver has sufficient power to drive the pump to the end of the pump curve during the performance test and the efficiency and power factor curves are available, a complete unit test is preferred. If not the performance test shall be carried out with a calibrated test stand motor.

7.3.3.2(Clarification)

The test data taken at each point shall include the seal chamber pressure. Seal chamber pressure shall meet the requirements of ISO 21049:2004 clause 6.1.2.14 at each test point.

7.3.3.2.b (Clarification)

The need for substitute seals shall be notified in the proposal.

7.3.3.2.c (Clarification)

Except for during the clause 7.3.3.2.d seal test, containment seal and quench drains shall be left open or unplugged during the performance test.

7.3.3.2.d (Clarification)

A leak test of the containment seal(s) of pumps fitted with Arrangement 2 or 3 seals shall be carried out as outlined in Appendix 2 to this specification. The aim of this test is to ensure containment seal integrity after assembly on the shaft. Alternative test procedures that achieve the same aim may be proposed.

Any seal leakage during test shall require the assembled pump and seal to be re-run to demonstrate satisfactory seal performance. Such a re-run shall be subject to a witness by the purchaser's inspector.

7.3.3.2.g (Clarification)

Any detectable leak, regardless of contract liquid or test liquid, shall be cause for rejection.

7.3.3.2.i (Addition)

If, because of its length, a vertical pump may not be tested completely assembled, a proposal for a special testing procedure must be included in the bid. Any length tested must include at least two intermediate bearings.

7.3.3.3.d (Clarification)

All difficulties encountered abnormalities and incidents during testing, including internal preliminary testing, shall be noted on the test report.

7.3.3.4.a (Clarification)

When applicable (see 5.9.1) predicted critical speeds shall be confirmed during the test.

7.3.3.4.c (Clarification)

For pumps destined for parallel operation the conditions of paragraph 5.1.13 shall be verified.

7.3.3.5(Clarification)

Unless otherwise specified, all pumps shall be disassembled for inspection upon completion of satisfactory performance testing.

The points below shall be verified:

- bearings
- impeller diameters
- verification of functional clearances
- hardness and marking of the hardness of wear rings
- condition and fixing of wear rings
- identification and verification of two-part components (such as the casing wear rings, central bearing, constriction bushing, etc.).
- Conformity of mechanical seals.

Except for OH2 pumps or pumps requiring special drying procedures the pump shall be re-assembled and mechanically tested for 1 hour to demonstrate a successful re-assembly.

7.3.3.5.a & b (Substitution)

Any modification of the pump to improve mechanical or hydraulic performance will require that the modified part is re-balanced (if applicable) and the applicable mechanical and/or performance tests shall be repeated.

No sharpening of vanes is allowed without prior written agreement by Total.

7.3.4.2.1 (Substitution)

NPSHR shall be determined at each test point except shut-off and a curve shall be plotted.

The NPSHR curve plotted from this test shall not deviate from the predicted curve by more than 5% of the predicted curve value.

7.4 Preparation for shipment

7.4.3.1(Clarification)

Anti-corrosion protection shall be applied immediately after final testing and drying. Any dispensation from this requirement necessitates written agreement by Total. Anti-corrosion protection of the entire pump assembly shall allow for on-site start-up without disassembly and cleaning and shall ensure the perfect conservation of the exterior for at least six (6) months.

The characteristics of the protective product(s) shall be included in the installation, operation and maintenance manual. An airtight package containing a copy of this data and cross-section drawings of the pump(s) and mechanical seals shall accompany the equipment.

If a pump cannot be completely drained (see clause 5.4.3.10) the vendor shall explain in the proposal how it will be drained and dried prior to protection for shipment.

7.4.3.2(Clarification)

Unless otherwise specified, the paint system shall be the vendor's standard for an ISO 12944:1998 category C5-I corrosive environment. The paint system shall be supplied for approval by Total.

7.4.7 (Addition)

Pump sets shall be delivered uncoupled.

8 Specific Pump types

8.1.1.1(Addition)

Type OH2 pumps shall have a first dry lateral critical speed at least 20% above the maximum continuous speed.

8.1.1.2.a (Addition)

After component balancing, the impeller and coupling hub shall be mounted on the shaft and the residual unbalance of the rotor/coupling hub assembly will be measured at the two bearing planes. If, at either plane, the measured unbalance is greater than ISO 1940 G6.3 the components shall be disassembled and reworked individually to reduce the residual unbalance of the assembly to below G6.3. No attempt shall be made to obtain the G6.3 residual unbalance of the complete assembled rotor by balancing the assembly or the coupling on the rotor.

8.2.2.3(Clarification)

Impellers for all multistage pumps shall be individually secured against axial movement in either direction. Vendor shall submit, in the proposal, a drawing showing attachment method.

8.2.5.2.4 (Clarification)

The thrust bearing size shall be reviewed by Purchaser.

8.2.6.1(Clarification)

If a pressurized lubrication system is specified it shall include, as a minimum, the equipment specified in figure B10 and Table B.1 of API 610 and shall be submitted for review by Total prior to the purchase order.

8.2.6.2(Clarification)

Oil side pressure shall always be higher than water side pressure.

8.2.7.5(Clarification)

Hydrodynamic bearings shall be removed and inspected after test.

8.3.8.3.2 (Clarification)

A minimum of four alignment-positioning screws shall be provided for each drive train component regardless of weight.

8.3.8.3.3 (Clarification)

Pumps shall be provided with separate sole plates with 25 mm (1") minimum radius corners for bolting and grouting to the foundation.

8.3.10.5 (Clarification)

Vendor shall detail in his offer how shaft sleeve wear will be controlled considering the specified pumped.

8.3.13.2 (Clarification)

See clause 5.3.6.

8.3.13.5 (Clarification)

The suction will be supplied with a drain, piped to the surface.

9 Vendor's data

9.1.3. Meetings (Addition)

The Vendor shall be aware that there may be pre-commitment, coordination and design audit meetings as deemed necessary by the Purchaser. These meetings shall be considered part of any purchase order.

9.2 Proposals

9.2.3 f. (Clarification)

Unless otherwise specified a detailed price list (with details of individual prices) according to table 18 shall be supplied in the proposal.

9.2.3 l.(Addition)

The Vendor shall provide a reference list covering at least two (2) similar installations. The pumps proposed as references shall have operated satisfactorily for more than 2 years.

A general reference list with all types of pumps and operating conditions is unacceptable unless similar examples are clearly indicated.

9.2.4 Curves

Performance curves shall be for the selected impeller diameter(s) as well as maximum and minimum diameters.

9.3 Contract data

Annex L

L.2.1.1 (Clarification)

Dimensional outline drawing shall include lifting details detailing sling ratings and lengths and any spreader bar or lifting beam requirements. This data may be supplied as a separate drawing.

Appendix 1

Material selection guide for Centrifugal Pumps.

This table is in addition to API 610 table G1.

Service	Temperature Range (°C)	Material Class	note
Fresh water, condensate, cooling tower water	< 100	I-1 or S-1	1
Brackish or Briny cooling water	< 80	I-2	2
Boiler feed water ph > 7	<120 120 to 170 > 170	S-1 S-5 C-6	
Boiler feed water (other cases)	All	C-6	
Foul water and hydrocarbons containing these waters	< 120 120 to 170	S-3 S-6	3
Non corrosive hydrocarbons & liquefied gases	>-20 to <200	S-1	
Non corrosive hydrocarbons	200 to 290 > 290	S-5 S-6	
Corrosive hydrocarbons containing Chlorides and/or Sulfides (DAT, HDT, DGO...)	< 150 150 to 260 > 260	S-5 S-6 C-6	3
Caustic (sodium hydroxide) concentration < 20 % weight)	< 60 60 to 90	S-1 S-3	3 4
MDEA stock solutions	< 120	S-1	
DEA, MDEA lean (in H2S) solutions	< 120	S-1	4
DEA, MDEA rich (in H2S) solutions	< 80	S-1	4
De-aerated sea water	< 60	A8	5
Sea water (other cases)	< 60	Duplex	

Notes

- 1) Pressure casing in SG ductile iron. (EN 1563).
- 2) Pressure casing in Ni resist ductile iron (ASTM A 439)
- 3) Impeller in Ni resist ductile iron (ASTM A 439)
- 4) All welds shall be stress relieved
- 5) Type 316L with Mo > 2.5 %

Appendix 2

During the pump performance test the following seal test shall be carried out.

Flush plans 52, 53A, B, C, & 54

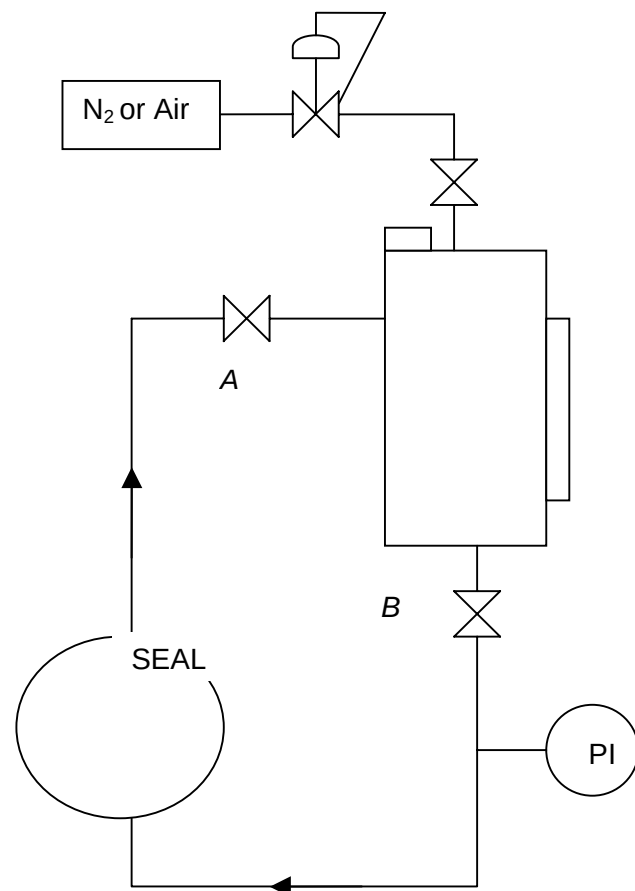
Temporary valves shall be fitted to allow the buffer/barrier circuit to be isolated from the reservoir or accumulator with a pressure gauge to permit verification of buffer/barrier circuit pressure. The pressure gauge full-scale reading shall not be greater than 2.5 times the pressure used for the test. A controlled Nitrogen or Air supply shall be made available at the reservoir. For plan 54 systems a test arrangement to simulate this procedure shall be proposed.

Static Test, pump not running.

- 1) The reservoir shall be filled to its normal operating level and pressurized to the primary seal maximum allowable reverse differential pressure.
- 2) The containment seal chamber and primary seal chamber shall be vented and full of liquid.
- 3) Close valves A and B.
- 4) Monitor the pressure indicated for 2½ minutes.
- 5) Turn the pump slowly by hand 1½ turns in the direction of rotation and repeat 4 above.
- 6) The test shall be considered satisfactory if the pressure measured does not decrease.

Dynamic test, pump running.

- 1) The pump shall be operating at its rated point.
- 2) Valves A and B will be open.
- 3) The reservoir level shall be checked to be at its normal operating level and for plan 52, shall be pressurized to the maximum allowable containment seal operating pressure or the maximum allowable primary seal reverse differential pressure, which ever is reached first. For Arrangement 3 flush plans the system shall be pressurized to the maximum allowable barrier fluid operating pressure.
- 4) Close valves A and B for 5 seconds maximum or until the pressure rises due to increasing containment seal chamber temperature.
- 5) Open valves A and B rapidly.
- 6) The test shall be considered satisfactory if the pressure measured does not decrease.



Flush plans 71,72,75 & 76

If not already included in vendor's scope of supply, a valve shall be fitted to the containment seal vent and drain connections and a calibrated PI and FI shall be installed in the buffer gas supply line.

Static Test, pump not running.

- 1) Close the containment seal vent and drain valves.
- 2) Pressurize the containment seal chamber to the primary seal maximum allowable reverse differential pressure.
- 3) Monitor the flow for 2½ minutes.
- 4) Turn the pump slowly by hand 1½ turns in the direction of rotation and repeat 3 above.
- 5) The test shall be considered satisfactory if the flow measured is less than the containment seal predicted design static flow at the pressure used.

Dynamic test, pump running.

- 1) Procedure as for the static test, without action 4).
- 2) The test shall be considered satisfactory if the flow measured is less than the containment seal predicted design dynamic flow at the pressure used.

Flush plan 74

Static and dynamic tests

- 1) The test set up shall include the contract Plan 74 instrumentation or, if agreed by purchaser, a test equivalent. The gas barrier outlet shall be fitted with a valve.
- 2) The valve at the gas barrier outlet shall be closed.
- 3) The barrier gas pressure shall be increased to the maximum allowable barrier gas pressure.
- 4) Monitor the flow for 5 minutes turning the shaft slowly in the direction of rotation after 2½ minutes during the static test.
- 5) The test shall be considered satisfactory if the flow measured is less than the maximum predicted design flow at the pressure and condition (static or dynamic) used.

STATIC TEST		Test fluid	CS seal chamber test pressure	Test time	Acceptation criteria	flush plan	Remarks	
2CW-CW (liquid/liquid) unpressurized	Water	N ₂ or air	Max allowable primary seal reverse differential pressure	5 minutes	Zero pressure drop during test period	52	Add valves “A” & “B” & PI and test per text.	
2CW-CS (liquid/gas) unpressurised	N ₂ or air				Max allowable primary seal reverse differential pressure	Max design static buffer fluid flow of CS at pressure used	71,72,75,76	If plans 75 or 76 are used without plan 72 or if plan 71 is used. CSV and CSD are to be valved and a test N ₂ or air supply and PI shall be fitted to GBI and test per text.
2NC-CS(liquid/gas) non contact primary unpressurised								
3CW-FB, BB, FF (liquid/liquid) pressurized	Water	N ₂ or air	Max allowable Barrier fluid operating pressure		Zero pressure drop during test period	53A,B C,54	Add valves “A” & “B” & PI and test per text.	
3NC-FB,BB,FF (gas/gas) pressurized	N ₂ or air				Max design static barrier fluid flow at pressure used	74	If necessary a test valve shall be fitted to GBO and test per text	
DYNAMIC TEST								
2CW-CW (liquid/liquid) unpressurized	Water	N ₂ or air	Max allowable containment seal operating pressure or max allowable primary seal reverse differential pressure	5 seconds maximum	Zero pressure drop during test period	See above		
2CW-CS(liquid/gas) unpressurised	N ₂ or air			5 minutes	Max design dynamic buffer fluid flow of CS at pressure used			
2NC-CS (liquid/gas)non-contact primary unpressurised								
3CW-FB,BB,FF (liquid/liquid) pressurized	Water	N ₂ or air	Max allowable Barrier fluid operating pressure	5 seconds maximum	Zero pressure drop during test period			
3NC-FB,BB,FF (gas/gas)non-contact primary pressurized	N ₂ or air			5 minutes	Max design dynamic barrier fluid flow at pressure used			