

MATERIAL AND EQUIPMENT STANDARD
FOR
CENTRIFUGAL PUMPS FOR GENERAL SERVICES

CONTENTS :

PAGE No.

0. INTRODUCTION	3
1. SCOPE	4
2. REFERENCES	4
3. CONFLICTING REQUIREMENTS.....	4
4. UNITS	5
5. DEFINITIONS	5
6. DESIGN	5
6.1 General	5
6.2 Pressure Casing.....	6
6.3 Nozzles and Pressure Casing Connections	6
6.4 Rotating Elements.....	7
6.5 Wear Rings	7
6.6 Shaft and Shaft Sleeves	8
6.7 Mechanical Seals	8
6.8 Stuffing Boxes for Packing.....	9
6.9 Bearing and Bearing Housings.....	10
6.10 Vibration and Balance	11
6.11 Noise Control.....	11
6.12 Materials	11
6.13 Nameplates	12
7. ACCESSORIES	12
7.1 Drivers	12
7.2 Coupling and Guards.....	13
7.3 Baseplates and Mountings.....	14
7.4 Auxiliary Systems	14
7.5 Instrumentation	15
7.6 Special Tools.....	16
8. INSPECTION AND TEST.....	16
8.1 General	16
8.2 Hydraulic Tests	16
8.3 Performance Tests.....	16
8.4 Net Positive Suction Head Test.....	17

8.5 Inspection	17
9. PREPARATION FOR SHIPMENT.....	17
10. VENDOR'S DATA	18
10.1 Proposals.....	18
10.2 Drawings	19
10.3 Curves	20
10.4 Data	20
11. GUARANTEES	21
11.1 Performance	21
11.2 Mechanical.....	22

APPENDICES:

APPENDIX A CENTRIFUGAL PUMP DATA SHEET	23
APPENDIX B PIPE COMPONENT NOMINAL SIZE	24
APPENDIX C PIPE FLANGES PRESSURE-TEMPERATURE RATING.....	25

0. INTRODUCTION

The object of this Standard specification is to provide related requirements for medium duty centrifugal pumps for water and general services.

Throughout this Standard specification, the API Standard 610, 7th Edition has been referred to in many clauses and it shall be considered as an important part of this Standard specification.

This Standard shall be used in conjunction with centrifugal pump data sheet, (See Appendix A).

1. SCOPE

1.1 This Standard specification covers the minimum requirements for centrifugal pumps generally in water services, for use in refinery services, chemical, petrochemical and gas plants and where applicable in production, exploration and new ventures.

This Standard is not applicable for pumps in hydrocarbon and heavy duty services.

1.2 Compliance by the pump manufacturer with the provisions of this Standard does not relieve him of the responsibility of furnishing pumps and accessories of proper design, mechanically suited to meet operating guarantees at the specified service conditions.

1.3 Selected equipment shall be in all respect, well within the range of the manufacturer proven experience, and shall not involve the use or application of any prototype design or components.

Vendors offering shall be a unit of duplicate size and design which has a successful record of proven service at operating condition similar to those specified. An installation list shall be submitted upon request. In the event no similar unit is available, the vendor may offer an alternative with a detailed explanation of where the offering differs from his field proven equipment.

1.4 No deviations or exceptions from this Standard shall be permitted without written approval of the Company. Intended deviations shall be separately listed by the vendor and supported by reasons thereof for purchasers consideration.

2. REFERENCES

In addition to the standards specified in clause 1.5 of API Std. 610, 7th edition, the latest edition of the following standards, codes, or specifications shall to the extent specified herein, form a part of this Standard:

API (AMERICAN PETROLEUM INSTITUTE)

610	"Centrifugal Pumps for General Refinery Services"
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IPS (IRANIAN PETROLEUM STANDARDS)

M-EL-132	"Induction Motors"
M-PM-240	"General Purpose Steam Turbine"
M-PM-290	"Reciprocating Internal Combustion Engines"
E-SF-900	"Noise and Vibration Control"

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

6708	"Pipe Components Definition of Nominal Size"
7268	"Pipe Components Definition of Nominal Pressure"

3. CONFLICTING REQUIREMENTS

In the case of conflict between documents relating to the inquiry of order, the following priority of documents (which ever more stringent realized by the Company) shall apply:

- First priority : Purchase order and variations thereto.
- Second priority : Data sheets and drawings.

- Third priority : This Standard specification.

All conflicting requirements shall be referred to the purchaser in writing. The purchaser will issue confirmation document if needed for clarification.

4. UNITS

The International System of Units (SI) in accordance with IPS-E-GN-100 shall be applied, unless otherwise specified.

5. DEFINITIONS

In addition to the terms defined in clause 1.4 of API Std. 610, 7th Edition, for the purpose of this Standard the following definitions shall hold:

5.1 Specific Speed

The effect of suction lift on a centrifugal pump is related to its head, capacity and speed which shall be intended to furnish a unit that matches the requirements at the highest possible efficiency and prevention of any cavitation specially when intending for pump probable future growth. The Specific Speed shall be calculated from formula shown on page 12 of the Hydraulic Institute Standards, 14 th. edition.

5.2 Suction Specific Speed

An index of pump suction operating characteristics determined at the best efficiency point with the maximum diameter impeller.

5.3 Pipe Sizes

The international nomenclature diameter nominal written as DN 15, 20, 25, 32, 40, etc. has been used for pipe size in accordance with ISO 6708-1980 and Appendix E in this standard specification.

5.4 Pressure Temperature Ratings

The international nomenclature pressure nominal written as PN 20, 50, 68, 100, 150, etc. has been used for flange ratings in accordance with ANSI / ASME B 16.5 1981 ISO 7268 1983 and Appendix F of this Standard Specification.

6. DESIGN

6.1 General

6.1.1 Process operating conditions are shown on the individual pump data sheet.

6.1.2 All equipment covered by this specification shall be designed for outdoor operation.

6.1.3 Vertical pumps shall be limited to services where NPSH or head capacity limitations make a horizontal pump impractical.

6.1.4 Bracket, foot, mounted units are acceptable unless specified otherwise on the individual pump data sheet.

6.1.5 Centerline mounting shall be considered.

6.1.6 The impeller diameter shall be such that at least a 5 percent increase in head at the rated capacity can be obtained by installing a larger diameter impeller of the same pattern.

6.1.7 Pumps having the rated capacity point to the right of the peak efficiency point on the Head-Capacity curves for the impeller diameter proposed are not acceptable.

6.1.8 The correction factor given in the latest edition of "The Hydraulic Institute Standards" shall be considered.

6.1.9 Pumps shall have head capacity curves rising continuously to shutoff. Head rise to shutoff shall be at least 10%.

6.1.10 Specific speed shall be calculated and stated in proposal.

6.1.11 The suction specific speed at the best efficiency point (BEP) shall be calculated and stated in proposal.

Formula given in API 610 std. 7th. Edition, Clause 1.4 shall be used.

6.1.12 Pumps that have a suction specific speed greater than 13000 (Metric) are not acceptable and will not be considered.

6.1.13 Two stage overhung pumps; single stage overhung pumps with 381 mm and larger impeller at speed over 1500 rpm; single stage, double suction, overhung pumps and pumps of "built-in" seal design (no conventional stuffing box) are not acceptable and will not be considered.

6.2 Pressure Casing

6.2.1 Pressure casings shall be of such thickness as will be suitable for the maximum discharge pressure at pumping temperature and hydrostatic test pressure at ambient temperature, with a 3 mm minimum corrosion allowance. Areas of double case (barrel) and horizontal multistage (three or more stage) pumps normally subjected to suction pressure need not be designed for discharge pressure.

When two or more vertical canned pumps are connected to a common discharge system, the suction can shall be designed for not less than maximum discharge pressure.

6.2.2 The design stress used for any given materials shall not be in excess of the values given in Section VIII, division 1 of the ASME Code, for the same material. For cast materials, the factor specified in the Code shall be applied.

6.2.3 Pressure casings furnished of forged steel, rolled and welded plate, or seamless pipe with welded cover shall comply with the applicable rules of Section VIII, Division 1, of the ASME Code. Manufacturer's data report forms and stamping, as specified in the Code, are not required.

6.2.4 Pumps shall be provided with suitable means to facilitate disassembly of gasketed joints, such as eye bolts, lugs, jack screws, etc.

6.2.5 Adequate clearance shall be provided at bolting locations to permit the use of socket or box wrenches.

6.2.6 Flange bolt holes shall straddle the horizontal and vertical centerlines.

6.2.7 The use of tapped holes in pressure parts shall be minimized.

6.2.8 Internal bolting shall be of a material fully resistant to corrosive attack by the pumped liquid.

6.2.9 For pumps handling fluids likely to solidify, provision shall be made for heating the casing and stuffing box. Where large heat inputs to the pump are required on a continuous basis, steam jacketing is required. Otherwise, steam tracing and lagging are acceptable.

6.3 Nozzles and Pressure Casing Connections

6.3.1 Opening for pipe sizes of DN 32, DN 65, DN 90, DN 125 shall not be used.

6.3.2 Suction and discharge nozzles shall be flanged. One and two stage pumps shall have suction and discharge flanges of equal rating.

6.3.3 Pumps shall be furnished with flanged suction and discharge nozzles integral with the casing. Flanges shall conform to ANSI Standards, however, if the manufacturer's standard pattern offers a flange thickness and diameter greater than that of the rating specified the heavier flange may be furnished, but it shall be faced and drilled as specified.

6.3.4 Flanges shall conform to ANSI B16.1, B16.5 or B16.42 where applicable.

6.3.5 Cast Iron flanges shall be flat faced and shall have a minimum thickness of PN 40 for ANSI B16.1 for size DN 200 and smaller.

6.3.6 Flanges shall be full or spot faced on the back and shall be designed for through bolting.

6.3.7 All horizontal pumps shall be provided with a drain connection.

6.3.8 All pumps shall be provided with a vent connection unless the pump is made self venting by the arrangement of nozzles.

6.3.9 Connections to the pump casing shall be at least DN 15 for pumps with discharge nozzle opening DN 50 and Smaller. For DN 80 nozzle opening and larger at least DN 20 shall be provided, except that connections for seal flush piping and lantern rings may be DN 15 without regard to pump size.

6.3.10 Connections welded to the casing shall meet the material requirements of the casing, including impact values.

6.3.11 Nipples shall be seamless Schedule 160 and not more than 150 mm in length.

6.3.12 Tapped openings not connected to piping shall be plugged with rounded plug furnished in accordance with ANSI B16.11 dimensionally and shall meet the material requirements of the casing.

6.3.13 All connections shall be suitable for the hydrostatic test pressure of the region of the casing to which they are attached.

6.3.14 Pressure gage connection shall be provided if specified.

6.4 Rotating Elements

6.4.1 Impellers shall be closed type and constructed as single piece casting unless specified otherwise.

6.4.2 Pinning of the impeller is not acceptable. All impellers shall be keyed to their shafts except that "Taperlock" construction is acceptable in vertical pumps up to 93°C pumping temperature.

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

6.5 Wear Rings

6.5.1 Renewable wear rings shall be furnished on both the casing and impeller unless specified otherwise.

6.5.2 Minimum wearing ring clearance shall be as follows:

Wear Ring Diameter, mm	Min. Diametral Clearance mm
-----	-----
50	0.25
100	0.40
150	0.45
250	0.55

Clearance for intermediate sizes shall be determined by interpolation. Above clearance shall be increased by 0.175 mm, when rings are made of 18-8 Chrome Nickel, Monel, or other material that tends to gall.

6.6 Shaft and Shaft Sleeves

6.6.1 Shafts shall be of ample size to transmit the maximum torque required under any specified operating conditions, including requirements of clause 6.1.6 of this standard. Shafts shall also be capable of continuously withstanding all stresses that result from supported weights, thrusts, and starting.

6.6.2 Shafts shall be machined and finished throughout their length so that the total indicated runout is not more than 0.025 mm.

6.6.3 Replaceable shaft sleeves to protect the shaft where it passes through the stuffing boxes are required on all pumps. Shaft sleeves shall extend beyond the outer face of the gland (seal plate).

The shaft sleeve diameter through stuffing boxes shall be made in increments of 3 mm.

6.6.4 The surface finish of the shaft or sleeve through the stuffing box and at rubbing contact housing seals shall not exceed a roughness of 0. 8µm.

6.6.5 Pump shaft or shaft sleeve runout, as measured by a dial indicator at the stuffing box face, shall not exceed 0.05 mm.

6.6.6 Dynamic shaft deflection under the worst conditions of load shall not exceed 0.05 mm maximum at the face of the stuffing box.

6.7 Mechanical Seals

6.7.1 All pumps shall be equipped with mechanical seals unless otherwise noted on the individual pump data sheet. The pump manufacturer shall be responsible to obtain a full guarantee from the seal manufacturer for the seals provided.

6.7.2 All mechanical seals shall be of the single, inside hydraulically balanced design unless otherwise specified on the individual pump data sheet.

Built-in or integral type mechanical seals are unacceptable, except for "close coupled" pumps.

Vertical pumps with mechanical seals shall have a vent connection on the box or flush piping located to assure fluid at the seal face before start-up.

6.7.3 The design and materials of the seal component parts shall be suitable for the specified service conditions and maximum discharge pressure, complying following clauses 6.7.3.1 to 6.7.3.4.

6.7.3.1 Springs shall be Alloy 20 or 316 S. S. except that metal bellows, where used, shall be of seal manufacturer's recommended material for the service.

Metal bellows shall have a corrosion rate less than 0.05 mm per year.

6.7.3.2 Gland plate gasket shall be of the pressure sealing type (o ring, spiral wound metallic etc.) and capable of withstanding the full temperature of the pumped fluid.

6.7.3.3 Metal seal ring shall not have sprayed overlay in place of solid face.

6.7.3.4 Temperature limits on mechanical seal gaskets shall be as follows:

	Min. Temp.	Max. Temp.
Fluorocarbons	-100°C	+232°C
Buna-N	-40°C	+121°C
Neoprene	-17°C	+93°C
Viton	-17°C	+204°C
Metal bellows	No Limit	No Limit

6.7.4 Mechanical seal materials and construction features may be coded by use of five figure classification system; (see Appendix H, table H-1 of API Std. 610, 7th edition for sequence).

6.7.5 For service above 150° Jackets or cooling inserts shall be provided on seal chambers, unless metal-bellows type mechanical seals are used.

6.7.6 Bellows type seals with all metallic parts shall be used for hot services where liquid is clean, and dead-end operation is preferred.

6.7.7 Seal gland plates shall be of stainless steel material.

Gland plates retaining mechanical seals shall have at least four bolts.

6.7.8 The gland plate shall have a throttle bushing to restrict the flow to atmosphere in the event of a seal failure.

6.7.9 Quench type seal gland plates with ½ inch minimum NPT vent and drain connections are not required unless specified on the individual pump data sheet.

6.7.10 When flushing of the mechanical seal is required, the type of flushing and any requirements for heating or cooling of the flushing liquid will be specified on the individual data sheet with a plan number code as described in Appendix D of API Std. 610, 7th edition.

6.7.11 For dirty services and/or where purchaser specify, cyclone separator shall be provided. Non metallic cyclone separators are not acceptable.

6.7.12 Single mechanical seals, when flushed, shall have the stuffing box or seal gland plate arranged so that the flush liquid is directed to the seal mating faces.

6.7.13 Heat exchangers used for cooling mechanical seal flushing streams shall have 12.7 mm OD minimum size tubing of one piece, without welded, brazed or soldered joints, for the process liquid.

6.7.14 Pumps, when furnished with mechanical seals, having two stuffing boxes and all vertical pumps shall be equipped with outside drive cartridge type mechanical seals.

6.7.15 The seal chamber shall be provided with an internal or external vent to permit complete venting of the chamber before start-up.

6.8 Stuffing Boxes for Packing

6.8.1 Unless otherwise approved by Company, all stuffing boxes shall be integral with pump casing or cover. If bolted stuffing boxes are used, the design shall be such as to maintain alignment. The stuffing box on all packed pumps shall be provided with a lantern ring with inlet outlet connections.

- 6.8.2** Stuffing boxes shall have not less than six rings of packing plus the lantern rings.
- 6.8.3** Renewable type throat bushings are required.
- 6.8.4** Stuffing box glands shall be easily removable and must permit replacement of packing without removal or disassembly of any other part of the pumps.
- 6.8.5** The stuffing box on all packed pumps shall have provision for seal cages for the introduction of a cooling medium directly into the packing. Inlet and outlet connections shall be provided for the seal cage.
- 6.8.6** For services above 150°C cooling jackets shall be provided on stuffing boxes of packed pumps.
- 6.8.7** Glands shall preferably be made with completely enclosed bolt holes. Slotted holes open at one side, are acceptable only if studs are provided for securing glands.
- 6.8.8** When pump packing is furnished, it shall be packaged separately for installation in the field.
- 6.8.9** A drain shall be provided on vertical pumps so that no liquid can collect in the driver support piece.

6.9 Bearing and Bearing Housings

- 6.9.1** Anti-friction bearings shall be in accordance with the "Anti Friction Bearing Manufacturer's Association Standards".

All bearings shall be designed for 20000 hours minimum life in specified service with continuous operation at maximum radial and axial loads.

- 6.9.2** Horizontal pump bearings shall be arranged for oil lubrication unless otherwise specified on the individual pump data sheet.
- 6.9.3** Thrust bearings for vertical pumps may be located in the drivers.
- 6.9.4** Oil lubricated pumps shall be equipped with a 120 ml (minimum) Trico or equal optimatic glass bottle oiler (with guards).
- 6.9.5** Bearing housing closures of the labyrinth-slinger type are required on horizontal pumps at each point where the shaft projects through a bearing housing, except that a mechanical oil seal is acceptable at the coupling end of the bearing housing. A non-labyrinth type slinger is acceptable on the stuffing box end of a bearing housing combined with a mechanical oil seal. Bearing housings on vertical centrifugal pumps shall have equally adequate protection.
- 6.9.6** Bearing housings shall be water jacketed for all pumps handling liquids at temperatures above 175°C.
- 6.9.7** Bearing oil temperature shall not exceed 82°C based on specified operating conditions and specified ambient temperature.
- For temperatures above 82°C cooling coil or system shall be provided.
- 6.9.8** Anti-friction bearings shall be retained on the shaft and fitted into housings in accordance with the requirements of AFBMA standard 7; however, the device used to lock ball thrust bearings to the shaft shall be restricted by a nut with a tongue-type lock washer.
- 6.9.9** Except for the angular contact type, anti-friction bearings shall have a loose internal clearance fit equivalent to AFBMA symbol 3, as defined in AFBMA standard 20. Single or double row bearings shall be of the Conrad type (no filling slots).
- 6.9.10** Hydrodynamic bearings in special case shall be considered and design shall be according to API Std. 610 7th Edition.

6.10 Vibration and Balance

6.10.1 Major parts of rotating elements such as impellers and balancing drums, shall be individually statically balanced.

6.10.2 In addition to the static balance, impellers shall be dynamically balanced. Dynamic balance at not less than ½ rated speed is required for pumps in the following ranges:

- a) At speeds over 1500 rpm if rated capacity exceeds 57m³/h, and impeller diameter is more than 150 mm.
- b) At speeds over 1500 rpm for two or more stages.
- c) At speeds over 3000 rpm.

6.10.3 Pumps shall be operated smoothly throughout their speed range in reaching rated speed.

6.10.4 Peak-to-peak vibration of horizontal pumps with anti-friction bearings and sleeve bearings and vertical pumps with integral antifriction bearings at rated speed and at a capacity of ± 10 percent from rated capacity shall be limited to the values stated in the following table:

SPEED		VIBRATION PEAK TO PEAK μm	
(rpm)	(rev/s)	ANTI FRICTION BEARINGS ⁽¹⁾	SLEEVE BEARING ⁽²⁾
1500 AND BELOW	25 & BELOW	65	50
1501 TO 4500	25-75	40	35
4501 TO 6000	75-100		25
OVER 6000	OVER 100		20

(1) Measured on bearing housing

(2) Measured on the shaft

6.10.5 For vertical pumps operating at 3000 rpm and over, the pump shaft or shaft-sleeve runout, as measured by a dial indicator immediately above the stuffing box or mechanical seal, and when the pump is turned by hand, shall not exceed 0.05 mm total indicator reading.

6.11 Noise Control

6.11.1 The noise measuring, tests and limits of all equipment supplied shall be in accordance with IPS-E-SF-900.

6.11.2 Sound tests shall be made with the pump operating at rated speed and rated kW.

6.11.3 Unless otherwise specified, the following limits shall be met at any measuring location 1 m from the equipment surface:

Pump	87 dB
Pump + driver	90 dB

6.12 Materials

6.12.1 Materials shall conform to the applicable material specification which are described in Appendices H and K of API Std. 610, 7th Edition.

6.12.2 Castings shall be sound, free from shrink or blow holes, scale blisters and other similar defect. The surfaces shall be cleaned by manufacturer's standard methods.

6.12.3 The repair of leaks and defects in pressure castings by the use of plastic or cement compounds is unacceptable.

6.12.4 Welding of piping, pressure containing parts, and wetted parts, as well as any weld repairs, to such parts, shall be performed and inspected in accordance with Section VIII, Division 1, and Section IX of the ASME code.

6.12.5 The vendor shall be responsible for the review of all repairs and repair welds to ensure that they are properly heat treated and nondestructively examined for soundness and compliance with the applicable qualified procedures.

6.12.6 Attachment of suction and discharge nozzles shall be by means of full fusion, full penetration welds. Dissimilar metal weldments are not allowed.

6.12.7 All welds shall be heat treated in accordance with the method described in section VIII, Division 1, UW-40, of the ASME code.

6.12.8 Mechanical seal gaskets compatible with the pumped fluid shall be provided.

6.12.9 Fabricated castings shall be post heat treated in accordance with Section VIII, division 1, of the ASME code.

6.13 Nameplates

6.13.1 A corrosion resistant nameplate shall be permanently attached to the pump and contain the following information:

- Equipment item number
- Manufacturer's name
- Serial number of pump
- Size and type of pump, and weight
- Rated capacity
- Specific gravity
- Speed, in RPM
- Casing hydrostatic test pressure
- Working temperature range
- Head

The text on nameplates shall be in English and unless otherwise specified, the data in SI.

6.13.2 Each pump shall be provided with a cast-in or permanently attached direction of rotation arrow. Welding is not permitted.

7. ACCESSORIES

7.1 Drivers

The type of driver will be specified by the purchaser. The driver shall be sized to meet the maximum specified operating conditions including bearing, mechanical seal, external gear, and coupling losses, as applicable, and shall be in accordance with applicable specifications, as stated in the inquiry and order. The driver shall be suitable for satisfactory operation under the utility and site conditions specified by purchaser.

7.1.1 Electric motors

7.1.1.1 All induction motors supplied by the pump Manufacturer shall be in strict accordance with requirements of IPS-M-EL-132.

7.1.1.2 Motors for vertical pumps shall be solid shaft type.

7.1.1.3 Furnished drivers and gears for vertical pumps shall be designed to carry the maximum thrust (up and down) which the pump may develop during starting or stopping or while operating at any capacity.

7.1.1.4 Motors required as drivers for any pumps covered by this specification shall have mechanical power (hp) ratings, including service factor, at least equal to the following percentage of pump rated brake kW.

Motor Nameplate Ratings	Percent of Rated Brake kW
-----	-----
19 kW & Less	125
22.5-56 kW	115
75 kW & over	110

However, the rated brake mechanical power shall not exceed the motor nameplate rating.

Where it appears that this will lead to unnecessary oversizing of the driver, and alternate quotation may be submitted for Purchaser's consideration, Figures are based on pumped liquid not water.

7.1.1.5 Motor drivers for pumps specified on individual pump data sheets as operating in parallel or without discharge control valves shall have a nameplate rating not less than the maximum brake kW required by the pumps with the furnished diameter impeller.

7.1.2 Steam turbine

Unless specifically required for special purpose turbine, all steam turbine supplied by the pump Manufacturer shall be in strict accordance with IPS-M-PM-240 "General purpose Steam Turbines".

7.1.4 Reciprocating Internal combustion engines

Reciprocating internal combustion engines, shall be in accordance with IPS-M-PM-290.

7.2 Coupling and Guards

7.2.1 Unless otherwise specified on the individual pump data sheet, metal, flexible, spacer type, couplings shall be furnished.

7.2.2 In all cases, the pump manufacturer shall mount pump half couplings.

7.2.3 Removable metal coupling guards shall be supplied and mounted in accordance with OSHA Standard. Guards shall be sufficiently heavy and rigid in design to avoid contact with coupling or shaft as a result of bodily contact.

7.2.4 The coupling shall be dynamically balanced when the coupling size-speed relationship is such that balancing is recommended by the coupling manufacturer.

7.2.5 Coupling shall be properly keyed in place and cylindrical pits shall be light enough to permit easy and rapid removal of hub in the field without the need for heating.

7.2.6 The spacer shall have a nominal length of at least 125 mm and shall permit removal of the coupling bearings, seal, and rotor as applicable, without disturbing the driver or connecting piping.

7.2.7 Couplings and coupling-to shaft junctures shall be rated for at least the maximum driver mechanical power including any rotor service factor.

7.2.8 The couplings for vertical pumps with slide shaft drivers without integral thrust bearings shall be of the rigid adjustable type.

7.2.9 On vertical and vertical in-line pumps equipped with mechanical seals, the coupling shall be a spacer type.

The spacer shall be of sufficient length to permit replacement of the seal assembly, including the sleeve, without removal of driver.

7.3 Baseplates and Mountings

7.3.1 Horizontal pumps, except, integral motor pumps shall be furnished with cast iron or steel, drain rim baseplate. The baseplate shall be extended (length and width) for the pump, driver and all accessories, e.g. cooler(s), oil reservoir, without overhang, except that motor driver conduit boxes may extend beyond the baseplates.

7.3.2 Connection for the drain shall be tapped DN 25 minimum NPT in the raised lip at the pump end and shall be so located as to allow complete drainage. The pan or upper surface of the baseplate shall be sloped 1:120 toward the drain end.

7.3.3 Bases shall have at least two (2) grout holes not less than 100 mm in diameter where practical and located so that the base can be grouted in place without removal of pump, driver, or any auxiliaries. Grout holes shall be arranged so that the pumped fluid will not accumulate over the open grout. Adequate vent holes shall be provided to insure a complete distribution of grout.

7.3.4 Driver support pads on baseplates shall be machined flat.

7.3.5 All vertical in-line pumps shall be provided with a flat surface at the bottom of the case.

7.3.6 Shaft centerlines of turbine driven pumps shall be sufficiently raised on the baseplate to permit the piping of the turbine steam inlet end drain and leak-off connections.

7.4 Auxiliary Systems

Auxiliary systems are defined as piping systems that are in the following services:

- a) Auxiliary process fluids.
- b) Steam
- c) Cooling water
- d) Lubricating oil

7.4.1 Auxiliary system shall comply with the requirements of Appendix D of API Std. 610, 7th Edition.

7.4.2 Cooling water, gland oil, lube oil, and recirculating piping systems, including all accessories such as gages, orifice and valves, shall be furnished by the pump Manufacturer fully assembled and installed on the pump.

7.4.3 The piping shall be designed and arranged for easy disassembly to permit maintenance and cleaning, and shall be properly supported to prevent vibration and damage.

The temperature and pressure rating of the auxiliary piping handling pumped fluid shall be not less than the pump case maximum discharge pressure at the maximum pumping temperature.

7.4.4 Auxiliary piping connection shall be plugged with solid plugs. Carbon steel plugs shall be used with cast iron casings; otherwise, the plugs shall be of the same metal as the casing material. Plugs shall have a shank to permit the use of a pipe wrench.

7.4.5 The minimum size of any connection of piping shall be DN 15.

7.4.6 Connections, piping, valves, and fittings with sizes DN 32, DN 65, DN 90, and DN 125 shall not be used.

7.4.7 The piping shall be arranged for flow through the jacket, coolers and glands as noted on the individual pump data sheet with a letter code described in Appendix D of API Std. 610, 7th Edition. The piping inlet and outlet connections shall be located at the pump suction nozzle edge of the baseplate.

7.4.8 Auxiliary process fluid piping includes vent and drain lines, balance lines, product flushing lines, and lines for injection of external fluids.

7.4.9 On steam piping, threaded joints are permitted on cast iron equipment and instruments.

7.4.10 The Pump Manufacturer shall state on the individual pump data sheet the quantity of cooling water required by each pump.

7.4.11 Cooling water jackets or housing shall be designed in accordance with clause 2.1.21 of API Std. 610, 7th Edition.

7.4.12 Tubing connections shall be Crawford Swagelok or equal. Tubing fittings and ferrules shall be 18 Cr-8Ni stainless steel.

7.4.13 Copper tubing and brass fittings are unacceptable.

7.4.14 Tapped openings and piping threads shall conform to ANSI Standards.

7.4.15 Carbon steel piping shall be pickled. Stainless steel tubing and piping shall be cleaned with a suitable solvent. The above cleaning shall be performed at the pump Manufacturer's shop prior to assembly on the pumping unit.

7.5 Instrumentation

7.5.1 Temperature gages

7.5.1.1 Dial type temperature gages shall be heavy duty and corrosion resistant. They shall be at least 125 mm in diameter and bimetallic or mercury filled. Black printing on a white background is standard for gages.

7.5.1.2 The sensing elements of temperature gages shall be in the flowing liquid.

7.5.2 Thermowells

7.5.2.1 Temperature gages that are in contact with flammable or toxic liquids or that are located in pressurized or flooded lines shall be furnished with separatable threaded solid bar thermowells at least 20 mm in diameter and shall be of AISI Standard Type 300 Stainless steel or another material more compatible with the liquid.

7.5.3 Pressure gages

Pressure gages shall be furnished with AISI Standard type 316 stainless steel bourdon tubes and stainless steel movements, 100 mm dials, and DN 15 NPT male alloy steel connections.

7.5.4 Vibration, position and temperature detectors

7.5.4.1 For equipment with hydrodynamic bearings, provision shall be made for mounting radial-vibration, axial position, and one-event-per revolution probes in each machine.

7.5.4.2 The hydrodynamic thrust and radial bearings shall be fitted with bearing metal temperature detectors.

7.5.4.3 The detectors and their mountings shall be in accordance with API-670 latest edition.

7.6 Special Tools

7.6.1 When special tools and fixtures are required to disassemble, assemble, or maintain the unit, they shall be included in the quotation and furnished as part of the initial supply of the machine. For multiple unit installations, the quantity can be agreed upon.

7.6.2 The special tools shall be packaged in separate, rugged boxes and marked "special tools". Each tool shall be stamped or tagged to indicate the item number and intended use.

8. INSPECTION AND TEST

8.1 General

8.1.1 Purchaser reserves the right to shop inspect purchased equipment. Purchaser's inspectors shall have entry to the portions of Manufacturer plants where work or testing on the purchased equipment is being performed. Manufacturer shall arrange for his subcontractors also to comply with these requirements, and shall furnish Purchaser with pertinent information on subcontractors, schedules, and the equipment components involved when requested.

8.1.2 Manufacturer shall notify Purchaser not less than 15 days prior to the date equipment will be ready for inspection or test.

8.2 Hydraulic Tests

8.2.1 Each pressure casing shall be hydrostatically tested with water at ambient temperature. The minimum test pressure shall be 1½ times the maximum allowable casing pressure.

8.2.2 Cooling water jackets shall be hydrostatically tested at 800 kPa g (8 barg) minimum.

8.2.3 All hydrostatic tests shall be maintained for a minimum period of 30 minutes. Certification of tests results is required.

8.3 Performance Tests

8.3.1 Each pump shall be given a performance test on water at a temperature less than 66°C.

8.3.2 Test speeds shall be at the rated speed of the pump, as shown on the individual pump data sheet.

8.3.3 Certified test curves are required. Curves shall be drawn from the test data obtained for the purchased pump and shall include Head, Efficiency, and Brake mechanical power recalculated to the proper specific gravity plotted against capacity.

8.3.4 Each pump shall be checked for acceptable vibration limits during the factory running and performance test.

8.3.5 Mechanical seals shall be used during the running tests but are not required for the hydrostatic test.

8.4 Net Positive Suction Head Test

8.4.1 Where net NPSH is below 500 mm a witnessed suppression test shall be carried out.

8.4.2 Suppression test shall be carried out in a closed loop as shown on Page 74, Figure 49, of the Standards of Hydraulics Institute 14th. edition. Alternates to this method may be acceptable when mutually agreed prior to placement of the purchase order.

8.5 Inspection

8.5.1 Equipment shall be subjected to inspection by a representative of the purchaser.

8.5.2 Any rejection made by the inspector, based on inspection or tests, will be final.

8.5.3 The following information shall be given to the inspector upon request for all purchase orders:

- a) Evidence, such as purchase specification or bills of materials to establish that major parts are of specified materials.
- b) Copies of Manufacturer's unpriced purchase orders to all subsuppliers.
- c) Copies of shop test data for the purchased pump.

9. PREPARATION FOR SHIPMENT

9.1 The equipment shall be prepared for shipment after all testing and inspection have been completed and the equipment has been approved by the purchaser.

9.2 "Preparation for shipment" shall be in accordance with Manufacturer's standards and as noted herein. The Manufacturer shall be solely responsible for the adequacy of the "Preparation for Shipment" provisions employed with respect to materials and application and to provide equipment to their destination in "ex-works" condition when handled by commercial carriers.

9.3 Connections furnished on the purchased pump shall be impression stamped to agree with Manufacturer's connection table listed on the general arrangement drawing. Tagging in lieu of stamping is only acceptable where the connections because of size or geometry can not be impression stamped.

9.4 Pump with seals installed, driver, baseplate and all furnished auxiliaries (except spacers and coupling bolts) shall be shipped fully assembled. Coupling spacers and bolts shall be separately boxed and securely attached to the baseplate.

9.5 Manufacturer shall provide the following minimum preparation, described in clauses 9.5.1 to 9.5.15 for shipment and packing features on all equipment:

9.5.1 Manufacturer's standard cleaning and painting procedures for the pumping temperatures specified on the individual pump data sheets are acceptable.

9.5.2 All equipment shall be packed, securely anchored (skid mounted when required) and protected for the shipment method called for in the purchase order.

9.5.3 Each item shall be identified with its item number. Tags shall be corrosion resistant metal and impression stamped, "Item No...." tags shall be attached to each component with wire. This tag is in addition to the equipment nameplate.

9.5.4 Miscellaneous parts shall be tagged or marked with the tag item number for which they are intended. All such parts shall be suitably boxed, firmly attached to the main item and shipped with the unit.

- 9.5.5** All flanged openings shall be protected with metal coverplates to prevent damage during shipment. Covers shall be a minimum of 5 mm thick and shall be installed with a full size gasket using a minimum of four (4) full diameter bolts.
- 9.5.6** Threaded openings shall be provided with steel caps or round head steel plugs in accordance with ANSI B16.11. The caps or plugs shall be of material equal to or better than of the pressure casing. Nonmetallic caps are not allowed.
- 9.5.7** All instruments and valves including auxiliary systems must be securely mounted and/or supported to eliminate damage during shipment, storage, operation and maintenance.
- 9.5.8** Exposed finished and machined surfaces, including bolting, shall be given a coating of rust inhibiting compound. Internal metal surfaces shall be sprayed or coated with a suitable rust preventative prior to shipment.
- 9.5.9** Bearings, bearing housings, and oil systems including reservoirs, coolers, filters and piping shall be thoroughly cleaned.
- 9.5.10** Mechanical seal assemblies shall be fully protected from rusting and entry of moisture and dirt.
- 9.5.11** Equipment containing insulating oils, anti-freeze solutions or other fluids shall be suitably tagged at openings to indicate the nature of the contents, and shipping and storage precautions.
- 9.5.12** One complete set of the installation, operation and maintenance instructions in addition to the number called for in the purchase order shall be packed in the boxes or crates with the equipment.
- 9.5.13** For packed pumps, prior to shipment, the packing used during running tests shall be removed. Two sets of new and unused packing shall be shipped with the pump, properly identified, but not installed.
- 9.5.14** Metal lube oil filter elements shall be cleaned prior to shipment. Non metallic filter elements shall be replaced prior to shipment and a spare set of non metallic filter elements shall be shipped with the unit.
- 9.5.15** Pumps shall not be doweled to the baseplate in Manufacturer's shop prior to shipment.

10. VENDOR'S DATA

10.1 Proposals

Vendor's proposal shall include the information specified in items a through m.

- a) An individual price and delivery schedule for each equipment item number.
- b) The length of time required for certification of all information, drawings, etc.
- c) Preliminary outline dimension drawing, (double case vertical pumps must show the length of the outer case).
- d) Typical cross sectional drawing.
- e) Centrifugal pump performance curves which include differential head, efficiency, water NPSHR, and brake mechanical power (hp) all expressed as functions of capacity.

These curves shall be extended to at least 125 percent of capacity at peak efficiency.

The head capacity curve for maximum diameter impeller(s) shall be shown. The minimum continuous stable/thermal flow shall also be specified.

Where fluids more viscous than water are specified, the viscous curve must be drawn along with the water curve.

Viscosity corrections shall be made in accordance with the correction factors given in the latest edition of the "Standards of the Hydraulic Institute".

Manufacturer's published performance test curves are acceptable except when viscosity correction factors are used. When applicable, manufacturer shall state viscosity correction factors used to determine corrected head capacity and efficiency.

The eye areas of the first stage impeller identification number shall also be noted on the curve.

- f)** Details of proposed pressure lubrication systems including lube oil schematic when required.
- g)** Completed purchaser's data sheets.
- h)** Preliminary outline dimensional drawings of electric motors.
- i)** Preliminary outline dimensional drawings of steam turbines.
- j)** Preliminary outline dimensional drawings of reciprocating combustion engines.
- k)** Preliminary outline drawing of speed changers with completed purchaser's data sheets.
- l)** Two years & start up priced list of recommended spares.
- m)** Special hand tools necessary as per clause 7.6 of this Standard shall be described with separate prices for consideration.
- n)** The delivery data specifying fixed number of calendar days from the receipt of the written order.

10.2 Drawings

10.2.1 Approval of drawings shall not relieve Manufacturer of any responsibility in meeting the requirements of specifications nor shall such approval be considered as permitting deviations from specifications or purchaser order requirements, unless specifically agreed to in writing.

10.2.2 All drawings and data submitted must be identified with the purchaser's order number and equipment tag number.

10.2.3 Prior to final drawing submittal, the manufacturer shall add to his drawings notes and data requested by the purchaser. This is required since these drawings are used by the purchaser in the field for erection and installation. Also, these drawings are incorporated into the purchaser's bound documents for the ultimate users record.

10.2.4 Outline drawings per following clauses 10.2.4.1 to 10.2.4.6 shall be furnished.

10.2.4.1 Certified correct dimensional drawings of completely, assembled units, which shall show:

- a)** Identification data for pump, coupling and driver.
- b)** Rotation.
- c)** Weight.
- d)** Adequate dimensional data to permit the design of foundation, piping and wiring connection.
- e)** Location of motor junction box(es).
- f)** Piping connection identified, with the size, rating, and facing indicated.
- g)** Clearance required for disassembly and maintenance.

10.2.4.2 Auxiliary connections listed on the composite outline drawing identified as follows:

- a)** Not furnished this order.
- b)** Not drilled this order.

- c) Plugged, requires field piping by purchaser.
- d) Plugged, not required this order.
- e) Piped by manufacturer.

10.2.4.3 The composite outline drawing shall also reference any supplementary drawings required to complete the pump auxiliary piping. Seal flushing and cooling water piping, identified by the applicable API plan or code is acceptable.

10.2.4.4 Certified correct dimensional drawings or specified components of the drive train shall be supplied.

10.2.4.5 A cross sectional drawing (without dimensions) which identifies parts and a listing of the parts which agree with the equipment furnished shall be supplied.

10.2.4.6 A general arrangement and layout of auxiliary piping to show its approximate location and routing relating to the major components shall be furnished. A material list must be shown on the drawing.

10.2.5 Schematic drawings of auxiliary system:

- a) Shall include and identify all components by make, type, size, capacity, pressure rating, materials and the like, as applicable.
- b) Shall show the seal in cross section with parts numbered and identified. Installation and setting dimensions shall be shown.

A bill of material must be included on the drawing. Stuffing box shall be fully dimensioned.

- c) Shall describe installation, operating and maintenance procedures for all equipment, auxiliaries and instruments furnished by the manufacturer and any sub suppliers.

10.3 Curves

10.3.1 The certified test curve shall be drawn from actual test data obtained for the purchased pump and shall include head, brake mechanical power (hp) (recalculated to proper specific gravity), and efficiency plotted against capacity.

10.3.2 The water NPSH curve shall be included, drawn from actual test data if a NPSH test was specified; otherwise a representative curve may be substituted and labeled "Typical" or "Catalog Curve".

10.3.3 The curve shall include the maximum and minimum diameters of the impeller supplied, eye area of the first stage impeller, identification number of the impeller, and pump serial number. Viscosity correction, if applicable; shall be indicated.

Note:

Manufacturer's test data is not required.

10.3.4 The vendor shall provide full information to enable completion of the data sheets, first for "as purchase" and then for "as built". This should be done by the vendor correcting and filling out the data sheets and shipping copies to the purchaser.

10.4 Data

10.4.1 Vendor shall provide lubrication schedule including all equipment furnished by the manufacturer and show:

- a) Recommended lubricant for use during break-in and normal operation, to meet purchaser requirements. NIOC, Exxon or Shell oils only to be specified.

- b) Method of application of the lubricant.
- c) Quantity of initial fill.
- d) Quantity of lubricant shipped with initial order.
- e) Recommended break in period of initial application.
- f) Recommended time between change of lubrication.
- g) Refill quantities and quality if different from initial change.
- h) Technical specification of each lubricant to be used including ISO viscosity grade number, etc.
- i) Expected annual consumption.
- j) Note any special lubrication precautions, or detailed lubrication considerations to be observed on the equipment.

10.4.2 The parts list shall include all equipment furnished by the manufacturer and sub-supplier and shall show pattern, stock or production drawing numbers, materials of construction and quantities of items required per pump.

The list shall completely identify each part so that parts interchangeability with other equipment furnished by the same manufacturer may be determined. Standard purchased items shall be identified by the original manufacturer's numbers.

10.4.3 Recommended spare parts list shall be submitted including price and delivery in addition to the standard data required on the complete parts list. It shall be noted that this list will generally be required promptly and in time to permit ordering and delivery of spare parts prior to field start up).

10.4.4 A certification by the Manufacturer test engineer(s) shall be submitted, that the equipment has been tested and performed satisfactorily.

11. GUARANTEES

11.1 Performance

The complete pumping assembly shall be guaranteed for satisfactory mechanical and hydraulic performance at all operating conditions specified on the data sheets, including the range between minimum continuous stable flow and rated flow.

Permissible variation from the specified performance is as follows:

	Guarantee Point -----	Shutoff -----
Differential head 170 m	Minus 2%, Plus 5%	Minus 10%, Plus 1%
Differential head over, 170 m	Minus 2%, Plus 3%	Minus 8%, Plus 8%
Efficiency	Minus ½ point of efficiency	
Brake mechanical power(hp)	Plus 4%	
Required NPSH	Plus 0%	

11.2 Mechanical

If any defect or malperformance occur during the period of 12 months after the equipment start up, the vendor shall make all necessary alterations, repairs, and replacements free of charge, fob factory. Field labor charges, if any, shall be subject to negotiation between vendor and purchaser.

APPENDICES

APPENDIX A

DATA SHEET

CENTRIFUGAL PUMP FOR GENERAL SERVICES

SHEET NO. _____ REV. _____
 JOB NO. _____ DATE _____
 BY _____ CHK'D _____
 P.Q. NO. _____

NOTE: ☐ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER
☐ BY MANUFACTURER

APPLICABLE TO PROPOSALS ☐ PURCHASE ☐ AS BUILT ☐

FOR _____ SITE _____					UNIT _____ SERVICE _____	
NO. PUMPS REQ'D _____		NO MOTORS REQ'D _____		ITEM NO. _____	PROVIDED BY _____	MTD BY _____
NO TURBINES REQ'D _____		ITEM NO. _____		PROVIDED BY _____	MTD BY _____	
PUMP MFR _____		SIZE AND TYPE _____		SERIAL NO. _____		

OPERATING CONDITIONS, EACH PUMP				PERFORMANCE	
LIQUID _____	M ³ /HR at PT, NOR _____	RATED _____	DISCH. PRESS. KPa _____	PROPOSAL CURVE NO. _____	
P.T.C. NOR _____	MAX _____	SUCT. PRESS. KPa _____	RATED _____	RPM _____	NPSHR (WATER) M _____
SPGR at PT _____		DIFF. PRESS. KPa _____		EFF. _____	BKW RATED _____
VAP. PRESS. at PT, KPa, A _____		DIFF. HEAD M _____		MAX. BKW RATED IMP _____	
VIS at PT, cS _____	CP _____	NPSHA, M _____		MAX. HEAD RATED IMP _____	
CORR/EROS. CAUSED BY _____		HYD. KW _____		MIN. CONTINUOUS M ³ /HR _____	
				ROTATION (VIEWED FROM CPLG END) _____	

CONSTRUCTION					SHOP TESTS	
NOZZLES _____	SIZE _____	RATING _____	FACING _____	LOCATION _____	<input type="checkbox"/> NON-WIT. PERF.	<input type="checkbox"/> WIT. PERF.
SUCTION _____					<input type="checkbox"/> NON-WIT. HYDRO	<input type="checkbox"/> WIT. HYDRO
DISCHARGE _____					<input type="checkbox"/> NPSH REQ'D	<input type="checkbox"/> WIT. NPSH
CASE - MOUNT <input type="checkbox"/> CENTERLINE <input type="checkbox"/> FOOT <input type="checkbox"/> BRACKET <input type="checkbox"/> VERT. (TYPE) _____					<input type="checkbox"/> SHOP INSPECTION	
- SPLIT <input type="checkbox"/> AXIAL <input type="checkbox"/> RAD. TYPE VOLUTE <input type="checkbox"/> SGL <input type="checkbox"/> DBL <input type="checkbox"/> DIFFUSER					<input type="checkbox"/> DEMANT. & INSP. AFTER TEST	
- PRESS: <input type="checkbox"/> MAX. ALLOW. _____ KPa, G <input type="checkbox"/> _____ °C <input type="checkbox"/> HYDRO TEST _____ KPa, G					<input type="checkbox"/> OTHER _____	
- CONNECT: <input type="checkbox"/> VENT <input type="checkbox"/> DRAIN <input type="checkbox"/> GAGE						
IMPELLER DIA. (mm) <input type="checkbox"/> RATED _____ <input type="checkbox"/> MAX. _____ <input type="checkbox"/> TYPE _____						
MOUNT: <input type="checkbox"/> BETWEEN BRGS <input type="checkbox"/> OVERHUNG <input type="checkbox"/> NO OF STAGES _____						
BEARINGS - TYPE: <input type="checkbox"/> RADIAL <input type="checkbox"/> THRUST _____						
LUBE: <input type="checkbox"/> DRING OIL <input type="checkbox"/> FLOOD <input type="checkbox"/> OIL MIST <input type="checkbox"/> FLINGER <input type="checkbox"/> PRESSURE						
COUPLING: <input type="checkbox"/> MFR _____ <input type="checkbox"/> MODEL _____						
DRIVER HALF MTD BY: <input type="checkbox"/> PUMP MFR <input type="checkbox"/> DRIVER MFR <input type="checkbox"/> PURCHASER						
PACKING: <input type="checkbox"/> MFR & TYPE _____ <input type="checkbox"/> SIZE/NO. OF RING _____						
MECH. SEAL: <input type="checkbox"/> MFR & MODEL _____ <input type="checkbox"/> API CLASS CODE _____						
<input type="checkbox"/> MFR CODE _____						

AUXILIARY PIPING				VERTICAL PUMP	
<input type="checkbox"/> Q.W. PIPE PLAN _____	<input type="checkbox"/> CU, <input type="checkbox"/> S.S., <input type="checkbox"/> TUBING, <input type="checkbox"/> PIPE			PIT OR SUMP DEPTH M _____	
<input type="checkbox"/> TOTAL COOLING WATER REQ'D M ³ /HR _____	<input type="checkbox"/> SIGHT FL. REQ'D _____			MIN. SUBMERGENCE REQ'D M _____	
<input type="checkbox"/> PAKING COOLING INJECTION REQ'D: <input type="checkbox"/> TOTAL M ³ /HR _____	<input type="checkbox"/> KPa, G _____			COLUMN PIPE: <input type="checkbox"/> FLANGED <input type="checkbox"/> THREADED	
<input type="checkbox"/> SEAL FLUSH PIPE PLAN _____	<input type="checkbox"/> O.S. <input type="checkbox"/> S.S. <input type="checkbox"/> TUBING <input type="checkbox"/> PIPE			LINE SHAFT: <input type="checkbox"/> OPEN <input type="checkbox"/> ENCLOSED	
<input type="checkbox"/> EXTERNAL SEAL FLUSH FLUID _____	<input type="checkbox"/> M ³ /HR _____	<input type="checkbox"/> KPa, G _____		BRGS: <input type="checkbox"/> BOWL _____ <input type="checkbox"/> LINE SHAFT _____	
<input type="checkbox"/> AUXILIARY SEAL PLAN _____	<input type="checkbox"/> O.S. <input type="checkbox"/> S.S. <input type="checkbox"/> TUBING <input type="checkbox"/> PIPE			BRG LUBE: <input type="checkbox"/> WATER <input type="checkbox"/> OIL <input type="checkbox"/> GREASE	
<input type="checkbox"/> AUX. SEAL QUENCH FLUID _____				FLOAT & ROD O.C.S. <input type="checkbox"/> S.S. <input type="checkbox"/> BRZ <input type="checkbox"/> NONE	
				FLOAT SWITCH <input type="checkbox"/> _____	
				PUMP THRUST, Kg <input type="checkbox"/> UP <input type="checkbox"/> DOWN _____	

MOTOR DRIVER				APPROX. WT. PUMP & BASE (Kg)	
KW _____	RPM _____	FRAME _____	VOLTS/PHASE/CYCLES _____	MOTOR _____	(Kg)
MFR _____	BEARINGS _____	LUBE _____		TORQUE _____	(Kg)
TYPE _____	INSUL _____	FULL LOAD AMPS _____		ENGINE _____	(Kg)
ENC. _____	TEMP. RISE, °C _____	LOCKED ROTOR AMPS _____			
O.VHS O.VSS _____	VERT. THRUST CAP. Kg _____	MTR. ITEM NO. _____			

APPENDIX B

PIPE COMPONENTS-NOMINAL SIZE

The purpose of this Appendix is to establish an equivalent identity for the piping components nominal size in Imperial System and SI System.

TABLE B - 1

Nominal Size		Nominal Size		Nominal Size		Nominal Size	
DN (1)	NPS (2)	DN	NPS	DN	NPS	DN	NPS
15	½	100	4	500	20	1000	40
20	¾	125	5	600	24	1050	42
25	1	150	6	650	26	1100	44
32	1¼	200	8	700	28	1150	46
40	1½	250	10	750	30	1200	48
50	2	300	12	800	32	1300	52
65	2½	350	14	850	34	1400	56
80	3	400	16	900	36	1500	60
90	3½	450	18	950	38	1800	72

1) Diameter Nominal,mm

2) Nominal Pipe Size, inch

APPENDIX C
PIPE FLANGES-PRESSURE-TEMPERATURE RATING

The purpose of this Appendix is to establish an equivalent identity for the pipe flange nominal pressure temperature ratings in Imperial System and SI System.

TABLE C - 1

PN (1)	ANSI RATING CLASS
20	150
50	300
68	400
100	600
150	900
250	1500
420	2500

1) Pressure Nominal, bar