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750.0	PUMPS AND DRIVERS
751.0	CODES AND STANDARDS
751.1	Standards of Hydraulic Institute, latest edition.
751.2	American Standard for Vertical Turbine Pumps, ASA B58.1, latest edition.
751.3	The Anti-Friction Bearing Manufacturer's Association, Inc. Standards Section 1 through 11, latest edition.
751.4	American Gear Manufacturer's Association Standard Practices.
751.5	American Society for Testing and Materials: latest ASTM Standards and Supplements.
751.6	American Standards Association Specifications, as follows: Unified Screw Threads Pipe Threads Cast Iron Pipe Flanges and Flanged Fittings, Class 125 Cast Iron Pipe Flanges and Flanged Fittings, Class 250 Steel Pipe Flanges and Flanged Fittings Applicable specifications from Section B18 - Bolts and Nuts.
751.7	General Specifications for Electric Motors, Section 502-9.
751.8	AMERICAN VOLUNTARY STANDARD "Centrifugal Pumps for Chemical Industry Use," as proposed by ASA Section Committee B-73.
751.9	For centrifugal type pumps in process service, American Petroleum Institute Standard 610, latest edition.
751.10	American Society of Mechanical Engineers Boiler and Pressure Vessel Code Section VIII, Unfired Pressure Vessels, latest edition.
751.11	American Society of Mechanical Engineers Boiler and Pressure Vessel Code Section IX Welding, latest edition.
751.12	Diesel Engine Manufacturers Association Standard Practices for Stationary Diesel and Gas Engines, latest edition.
751.13	Internal Combustion Engine Installation Practices for Internal Combustion Engines, latest edition.
751.14	For general purpose steam turbines, American Petroleum Institute Standard 615, latest edition.



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752.0 MATERIAL AND EQUIPMENT SPECIFICATIONS

752.1 General Specifications

- 752.1.1 Only new and best quality and type of materials shall be used. Castings shall be sound, free from shrink or blow holes, scale blisters and other similar defects. The surfaces shall be cleaned by manufacturer's standard methods. All casting burrs shall be filed or ground flush with the surface of the casting.
- 752.1.2 Pumps shall be provided with suitable means to facilitate disassembly of gasketed joints, such as eye bolts, lugs, jack screws, etc.
- 752.1.3 Any tools especially designed and required for the maintenance of the equipment shall be furnished by the pump manufacturer.
- 752.1.4 Units shall be suitable for outdoor installation and protected from freezing temperatures, if it is requested in data sheet.
- 752.1.5 All piping systems furnished by the manufacturer shall be fully assembled on the baseplate and firmly fixed to it, neatly arranged, close to and following the pump contour.
- Seal systems, winterizing piping and cooling water piping should be designed with the aim to minimize the amount of disassembly and reassembly when maintenance on pump is required.
- 752.1.6 Stuffing box glands shall be easily removable and must permit replacement of packing without removal or disassembly of any other part of the pump. All stuffing boxes shall be tapped for connection to a lantern ring.
- Where pumps require cooling water manifolds to gland or bearing housing, manifolds should be piped so that inlet and outlet headers can be drained and flushed, Ends of the headers should be Valved and not capped or welded.
- 752.1.7 Removable coupling guards shall be supplied and mounted. Guards shall be sufficiently heavy and rigid in design to avoid contact with coupling or shaft as a result of bodily contact. Guards must also conform to all applicable safety codes at the intended installation location.
- 752.1.8 Suction and discharge nozzles shall be flanged for pipe sizes two (2) inches (5.08 cm) and larger. Flanges shall conform to ANSI Standards; however, if the manufacturer's standard pattern entails 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. Screwed and seal welded companion flanges are not acceptable.



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- 752.1.9 All pump casings shall have suction flanges designed for the same pressure as discharge flanges. All pump casings handling flammable or toxic liquids shall have flanged suction and discharge nozzles. In other services bored and tapped nozzles are acceptable for sizes 1-1/2 inches (3.81 cm) and smaller.
- 752.1.10 Pressure casings shall be of such thickness as will be suitable for the specified design and test pressure and pumping temperature with 1/8 inch minimum corrosion allowance. The design pressure shall not be less than the maximum suction pressure plus the differential head at shutoff or not less than 15% over relief valve set pressure. Water jackets shall be designed for 85 psig (5.976 kg/cm²-g) and 125 psig (8.789 kg/cm²-g) test pressure.
- 752.1.11 Pipe threads shall be taper pipe threads conforming with ANSI Standards. Tapped openings for pipe threads shall conform with the American Standard for Steel Pipe Flanges and Flanged Fittings.
- 752.1.12 The back of all flanges shall be either spot-faced or full-faced parallel to gasket face for even seating of bolt heads or nuts.
- 752.1.13 Flange bolt holes shall straddle the horizontal and vertical centerlines.
- 752.1.14 All vent, lantern ring, case drain, or seal recirculation connections on pumps handling chemicals shall be 1/2 inch (1.27 cm) IPS minimum, 3/4 inch (1.905 cm) preferred. Pressure gauge connections are not required.
- 752.1.15 Casing vent and drain connections shall be plugged with solid plugs. Stainless steel plugs shall be used with cast iron casings; otherwise, the plugs shall be of the same metals as the casing material. Plugs shall have a shank at least 1-1/2 inch (3.81 cm) in length to permit the use of a pipe wrench.
- 752.1.16 A stainless steel nameplate shall be permanently attached to the pump and contain at least the following information:
- a. General Information.
 - Purchase Order Number
 - Purchaser's Item Number
 - Year of Manufacture
 - Serial Number of the Pump
 - Manufacturer's Name
 - Size and Type of Pump
 - (When applicable) Mechanical Seal Manufacturer's Identification Number.



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b. For Centrifugal Pumps.

Rated Capacity, gpm (lpm)
 Design Speed, rpm
 Rated Head, feet (meters)
 Design Pressure, psig (kg/cm²)
 Design Temperature, °F (°C)
 Hydrostatic Test Pressure, psig (kg/cm²)

c. For Reciprocating Pumps.

Rated Capacity, gpm (lpm)
 Rated Speed, rpm
 Maximum Allowable Liquid End Working Pressure, psig (kg/cm²)
 Design Pressure, psig (kg/cm²)
 Design Temperature, °F (°C)
 Hydrostatic Test Pressure, psig (kg/cm²)

d. For Rotary Pumps.

Design Suction Pressure, psig (kg/cm²)
 Design Discharge Pressure, psig (kg/cm²)
 Specific Gravity of Liquid to be Pumped
 Design Temperature, °F (°C)
 Hydrostatic Test Pressure, psig (kg/cm²)
 Driver HP and RPM (kilowatts and rpm)

752.1.18 Horizontal pumps shall be bolted and dowelled to baseplates by Vendor. Drivers which are mounted at the Vendor's shop shall not be dowelled.

752.1.19 Permissible variation from dimensional-outlines are as follows:

Nozzle faces to pump and shaft centerlines = $\pm 1/8"$ ($\pm .3175$ cm)

Baseplate anchor bolt holes to pump centerline = $\pm 1/4"$ ($\pm .635$ cm)

752.1.20 Vendor shall select and recommend the material for pump, drive, driver and auxiliary equipment. The material properties shall be compatible with the intended application to produce a long-life, low maintenance service. Copper and copper alloys will not be used in H₂S service.

752.1.21 Bearings housings shall be sealed against entrance of foreign liquids or materials.

Oil-lubricated bearings are required on horizontal pumps, and all pumps used in process service. Distribution of oil by oil rings or flingers is preferred to flood oiling. Thrust bearings for vertical pumps may be located in drivers.



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- 752.1.22 Constant-level oilers of 4 oz. (113.4 grams) capacity or larger shall be supplied for each bearing housing of oil-lubricated pumps.
- Bearing housings shall be tapped for a constant level oil feed regulator.
- 752.1.23 Threaded joints shall not be used inside the oil reservoir.
- 752.1.24 When forced feed lubrication is required, the manufacturer shall supply a complete system to circulate oil through all pump bearings. The system shall include a forced-feed oil pump, piping, filter, reservoir, oil cooler, pressure gauges and thermometers.
- 752.1.25 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 if combined with a mechanical oil seal. Bearing housing on vertical centrifugal pumps shall have adequate protection.
- 752.1.26 Bearing housings and stuffing boxes shall be water jacketed for all pumps operating at temperatures above 350°F (176.7°C) or if heavy thrust loads are encountered.
- 752.1.27 Anti-Friction bearings shall be in accord with Anti-Friction Bearing Manufacturer's Association Standards. All bearings shall be designed for two year minimum life in specified service with continuous operation at maximum radial and axial loads.
- 752.1.28 Couplings for centrifugal pumps operating at speeds above 3600 RPM, shall be continuous lubricated type unless specified otherwise in data sheet, or purchase order.
- 752.1.29 Flexible couplings DBZ with stainless steel discs, made of unbonded laminated layers of discs, shall be furnished and mounted by the pump vendor. Vertical inline pumps do not require flexible couplings. Where required for disassembly of the pump, spacer type couplings shall be furnished.
- 752.1.30 Direct connected equipment is preferred. If gear units are necessary, they shall be supplied as a part of the complete package, driver gear and driver equipment unless otherwise specified or agreed upon. The pump manufacturer shall be responsible for the complete package including all auxiliaries, lubrication, cooling and safety devices and all required calculations, static or dynamic.
- 752.1.31 Speed reduction gears shall be in accordance with AGMA Standards and in no case shall the rating be less than the driver nameplate rating



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(plus service factor) plus 10%. Epicyclic or parallel shaft type gears are acceptable.

- 752.1.32 Pumps, drive and drivers shall meet the OSHA requirement for maximum permissible noise levels.
- 752.1.33 Compliance with the provisions of these specifications does not relieve the contractors and/or suppliers of the responsibilities of furnishing material, equipment and accessories of proper design, mechanically suited to meet operating guarantees at the specified conditions.
- 752.2 Specifications for Centrifugal Pumps
- 752.2.1 Unless indicated otherwise on the data sheet, a horizontal pump is required. Vertical pumps shall be limited to services, where NPSH or head capacity limitations make a horizontal pump impractical. All horizontal pumps with two or more stages and all double suction pumps shall have the impellers mounted between bearings.
- 752.2.2 Horizontally split case pumps shall not be furnished if either of the following conditions is specified.
- a. Pumping temperature 350°F (176.7°C) or higher.
 - b. Flammable or toxic liquids with specific gravities less than 0.825.
- 752.2.3 A bracket or foot-mounted pump is acceptable. Centerline supported pumps may be supplied if the Vendor does not have a bracket or foot-mounted pump recommended for the service. Cantilever supported casings are not acceptable. Pumps must be designed for back removal of impeller from the casing.
- 752.2.4 For pumping temperatures below -20°F (-28.9°C), special carbon steels shall be used and shall conform to ASTM A352-60T. Alloy steels may be used if at the lowest pumping temperature the material has an impact strength of not less than 15 ft. lbs. (2.074 kg-m). (Charpy Keyhole Notch Test, ASTM E23.) Nonferrous alloys may also be used, subject to approval.
- 752.2.5 The inner casing of double-casing pumps shall be designed to withstand at least the specified maximum differential pressure or 50 psig (3.515 kg/cm²g), whichever is greater.

Cast iron cases are not acceptable for pumps in hydrocarbon service.



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752.2.6 Multi-stage vertically split centrifugal pumps for hydrocarbon service shall not be fitted with a balancing disk for compensating axial thrust. Allowed is individual balancing of impellers or incorporation of a balancing drum.

752.2.7 Each pump shall be provided with a cast-in or permanently attached direction-of-rotation arrow.

752.2.8 Any pump requiring maximum diameter impeller for the rated duty is unacceptable. The selected pump shall be of a size which will permit at least a five percent increase in head at rated flow by installing a new impeller.

752.2.9 Impellers of centrifugal pumps shall be statically balanced. Dynamic balance at not less than 1/2 rated speed is required for pumps in the following ranges:

- a. Above 1500 rpm with design capacity above 250 gpm (946 liters/min.) and impeller of over 6 inch (15.24 cm) diameter or having two (2) or more stages.
- b. Above 3000 rpm.

752.2.10 All impellers shall be keyed to their shafts except that "taper-lock" construction is acceptable in vertical pumps up to 200°F (93.3°C) pumping temperature. Pinning of impellers is not an acceptable method of attachment to shafting.

752.2.11 Impellers shall have renewable wearing rings. Minimum wearing-ring clearances shall be as follows, except the manufacturer shall give special consideration to clearances for pumps operating at temperatures above 400°F (204.4°C).

<u>Wear-Ring Diameter, Inches</u>	<u>Min. Diametral Clearance, Inches</u>
2 inches (5.08 cm)	0.010 inches (.0254 cm)
4 inches (10.16 cm)	0.016 inches (.04064 cm)
10 inches (25.4 cm)	0.021 inches (.05334 cm)

Clearance for intermediate sizes shall be determined by interpolation. Above clearances shall be increased by 0.005 inches (.0127 cm) when rings are made of 18-8 chrome-nickel, monel, or other material that tends to gall.

752.2.12 Auxiliary piping for balancing lines shall be suitable for the pumping temperature and pressure and the hydrostatic test. Piping material and corrosion allowance shall be equal to the casing material. Balancing lines for multi-stage pumps shall be made up with flanged joints; screwed unions and screwed flanges are not acceptable.



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- 752.2.13 Replaceable shaft sleeves to protect the shaft where it passes through the stuffing boxes are required. Shaft sleeves shall extend past the glands so that leakage between the sleeve and the shaft can be distinguished from leakage through the packing. Stub sleeves are acceptable on pumps with built-in seals.
- 752.2.14 Gland plates retaining mechanical seals shall have at least four (4) bolts. 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.
- 752.2.15 When mechanical seals are required they shall be manufactured by a vendor of proven design and shall be installed by pump manufacturer before shipment. Special consideration shall be given to mechanical seals in light hydrocarbon service with particular attention to avoid vaporization of pumped product across seal faces.
- 752.2.16 All mechanical seals shall have product recirculation to the seal faces. Requirements for heating or cooling of the flushing stream to the mechanical seal shall be indicated by Vendor on the specification sheet.
- All necessary piping and accessories required for proper operation of the mechanical seal shall be furnished by the pump manufacturer.
- 752.3 Specifications for Controlled Volume Metering Pumps
- 752.3.1 Metering pumps shall be plunger or diaphragm type. Diaphragm pumps shall be the hydraulically actuated type.
- 752.3.2 Continuous stroke adjustment is required. Such adjustment shall be manual by knob or wheel with capacity indicator, unless automatic capacity controls are called for on the individual pump specification sheet.
- 752.3.3 The capacity should follow as closely as possible a straight line relationship with stroke length.
- 752.3.4 When a diaphragm liquid end is used, means shall be provided in the pump to eliminate air binding of the liquid end. A built-in relief valve to relieve full capacity of pump and an automatic hydraulic make-up valve for the pump's hydraulic reservoir shall be included.
- 752.3.5 Guided, controlled travel, double ball check valves, or equivalent, on both suction and discharge shall be provided. Valve shall have renewable seats either screwed-in or shouldered.



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752.4 Specifications for Reciprocating Pumps

- 752.4.1 All piston pattern pumps shall be provided with removable liners. Liners 4 inches (10.16 cm) in diameter and smaller may be pressed in place. Liners over 4 inches (10.16 cm) in diameter shall be bolted. Liners held in by follower and set screw may be offered for Purchaser's approval for liners over 4 inches (10.16 cm) in diameter.
- 752.4.2 Piston rods shall be of the divided type.
- 752.4.3 Valve seats shall be renewable. On corrosive service, valve seats shall not be threaded.
- 752.4.4 Gaskets shall be one piece and shall be confined for operating pressure in excess of 250 psig (17.577 kg/cm²g).
- 752.4.5 Slide valves are acceptable for steam temperatures to 500°F (260°C). Above 500°F (260°C), piston type valves shall be used.
- 752.4.6 All components shall be suitable for a plunger loading based on the relief valve set pressure. Vendor shall indicate the maximum allowable plunger loading.
- 752.4.7 Minimum clearance pumps are required for all boiling paint liquids.
- 752.4.8 Solid plungers are preferred. Hollow plungers shall be water cooled for operating temperatures 450°F (232.2°C) and over.
- 752.4.9 Body and follower type pistons are preferred. Hollow pistons will be acceptable if properly vented. Snap ring types are preferred, but sectional rings with expander springs, tempered to hold tension under maximum operating temperatures, will be considered. Darcovacup pistons shall be used, whenever the operating temperatures are within their recommended temperature range.
- 752.4.10 Valves may be disc, ball or wing guided as recommended by manufacturer for each specific service.
- 752.4.11 Mechanical sight feed lubricators, complete with the necessary tubing and fittings, shall be furnished with direct acting pumps for lubrication of the steam valves and steam cylinder. When rods or plungers on the liquid end of direct acting or power pumps require lubrication, it will be indicated on the data sheet.
- 752.4.12 All gearing, cans, connecting rods, cranks, etc., required to obtain a reciprocating plunger action from the motor shall be housed in one enclosed drive unit. Exposed crankshafts are not acceptable.



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- 752.4.13 Vendor shall supply, subject to approval by owner, a process discharge relief valve for reciprocating pumps.
- 752.5 Specifications for Rotary Pumps
- 752.5.1 All rotating parts shall operate in dynamic and hydraulic balance, unless suitable bearings are provided to compensate axial thrusts.
- 752.5.2 Stuffing boxes shall preferably be integral with the pump casing or cover. Glands shall be easily removable and must permit replacement of packing without removal or disassembly of any other part of the unit.
- 752.5.3 Geared speed reducers or intergral gear motors may be used when it is necessary to drive pumps at less than standard electric motor speed.
- 752.5.4 When mechanical seals are not specifically required, Vendor may offer mechanical seals if this is standard material for the pump type and recommended for the service.
- 752.5.5 All mechanical seals shall have product recirculation to the seal faces. Requirements for heating or cooling of the flushing stream to the mechanical seal shall be indicated by Vendor on the specification sheet.

All necessary piping and accessories required for proper operation of the mechanical seal shall be furnished by the pump manufacturer.
- 752.5.6 Replaceable shaft sleeves to protect the shaft where it passes through the stuffing boxes are required. Shaft sleeves shall extend past the glands so that leakage between the sleeve and the shaft can be distinguished from leakage through the packing. Stub sleeves are acceptable on pumps with built-in seals.
- 752.5.7 Gland plates retaining mechanical seals shall have at least four (4) bolts. 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.
- 752.5.8 For pumping temperatures above 300°F (148.9°C), or services with heavy thrust loads, bearings shall be liquid cooled.
- 752.5.9 Removable relief valves are the preferred construction. Relief valves shall have replaceable seats, plugs and springs. Relief valve set pressure shall have easily adjusted set pressure with locking nuts or similar locking device.

Relief valve pressure setting mechanism shall be provided with screw cap with suitable provisions for wire seal.



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752.6 General Specifications for Motor Pump Drivers

752.6.1 Refer to Electrical and Instrumentation Standards for detailed master specifications.

752.6.2 Motors required as drivers for any pumps covered by this specification shall have horsepower ratings, including service factor, at least equal to the following percentage of pump rated brake horsepower:

<u>Motor Nameplate Ratings</u>	<u>Percent of Pump Rated Brake HP</u>
25 HP and less (18.647 KW)	125
30 HP through 75 HP (22.377 - 55.942 KW)	115
100 HP through 250 HP (74.590 - 186.474 KW)	110
Over 250 HP (186.474 KW)	Pump BHP plus 25 HP (18.6 KW)

The rated brake horsepower shall not exceed the motor nameplate rating. The rated brake horsepower is defined as the horsepower required when pumping the specified liquid at the differential head and rated capacity as shown on the specification sheet.

752.6.3 Reduction gears may be internal or external. Manufacturers shall advise model number and type of gears proposed.

752.6.4 Motor drivers with oil lubricated bearings shall be equipped with the same oilers supplied on the pumps.

752.6.5 Oil lubrication shall be continuous by a splash or force feed system.

752.6.6 Reduction gears may be internal or external. Manufacturers shall advise model number and type of gears proposed. Include the thermal and mechanical ratings, service factors and description of lubricating system.

752.7 General Specifications for Steam Turbine Pump Drivers

752.7.1 These specifications are intended to cover the minimum requirements for horizontal, vertical, condensing or non-condensing mechanical drive steam turbines where steam conditions will not exceed 850 psig pressure or 750°F total temperature or speed in excess of 12000 rpm.



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- 752.7.2 The API Specifications for mechanical drive steam turbines for General Refinery Services (API Standard 615) and the NEMA Standards Publication, Mechanical Drive Steam Turbines, SM-20, are a part of the specification except as may be modified herein.
- 752.7.3 Compliance with these specifications shall not relieve the Vendor of responsibility for proper design, workmanship and materials to meet the specified conditions.
- 752.7.4 Each turbine exhaust casing shall be provided with a Sentinel Valve set to relieve at the Maximum Sentinel Valve setting shown in Table I API Std. 615.
- 752.7.5 Manufacturer shall advise the maximum possible throttle or nozzle steam flow for purposed of sizing any safety valves to be applied by the purchaser.
- 752.7.6 Speed governors shall be in accordance with NEMA Standards Publication Mechanical Drive Steam Turbine (SM-20) of a class and range as specified on the Turbine Data Sheet.
- 752.7.7 Measuring, controlling or pilot components for hydraulic governors or the NEMA D class must have self-contained oil systems which are not a part of any other turbine lube or circulation system.
- 752.7.8 On special purpose turbines, trip-throttle valves, either separate or combined, shall be so arranged as to permit the slow gradual admission of steam when resetting following a trip shutdown.
- 752.7.9 All required auxiliary piping for cooling water, lubricating oil, hydraulic or pneumatic control, gland seal, drain and vent piping between points of use and common terminals shall be furnished by Vendor.
- 752.7.10 The auxiliary piping furnished shall include necessary block valves, regulating valves, instruments, flow fittings for each point served and gland and vent condensers.
- 752.7.11 A separate gland condenser with water or steam operated jet and necessary controls shall be furnished for connection to the glands of condensing turbines or labyrinth-sealed back pressure turbines. All such equipment to be mounted and piped by the Vendor.
- 752.7.12 Turbines shall be of the multi-stage, multiple valve type.
- 752.7.13 The following paragraph numbering follows the API Standard 615 check-list and each paragraph denotes an addition, exception, substitution or purchaser's choice as defined in the API checklist:



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- a. A special purpose turbine is not expected.
- b. Turbines shall be designed for installation out-of-doors and unprotected from the weather.
- c. Winterization of the turbines shall be provided.
- d. Vendor shall state the temperature of the exhaust steam during operation and the maximum allowable exhaust steam temperature during startup when turbine is running at low efficiency.
- e. Brass plugs shall not be used.
- f. The maximum use of flanges is preferred. Lube and control oil piping shall use socket welding fittings, except at equipment or valves which are available only with screwed connections. The use of back-up rings is not acceptable.
- g. Corrosion resistant oil drain lines are required and shall be Type 304 stainless steel.
- h. All piping shall be thoroughly cleaned of rust and weld spatter and properly protected on the inside prior to shipment. The procedure for performing this work shall be submitted for approval prior to proceeding with the work.
- i. When spare rotors are required for specific services, it will be indicated on the individual specification sheet.
- j. Turbines with labyrinth gland sealing shall be furnished with a vacuum device (steam jet educator).
- k. Carbon ring packing is not permitted for interstage sealing.
- l. Required control signals will be indicated on the individual specification sheet.
- m. Details of turbine response to control signals will be shown on the individual specification sheet.
- n. Requirements for hand controlled nozzle valves will be indicated on the individual specification sheets.
- o. All governor valve linkage connections shall be stainless steel.
- p. When standby oil pumps are required, details will be shown on the individual specification sheet. All parallel pumps shall be protected from backflow by a check valve on the discharge side.



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- q. The sentinel warning valve shall be set within the limits specified in Table I.
- r. Turbine drivers for main oil pumps shall be supplied with an over speed trip.
- s. Baseplates for the turbine or the turbine and gear unit shall be provided if specified. Medium size drivers and pumps will have a common baseplate, furnished by the pump manufacturer.
- t. Vendor shall factory insulate the turbine, when specified, with a readily removable painted metal jacket which is to cover the steam chest down to the exhaust end. The insulation shall maintain a jacket temperature below 165°F (73.9°C).

752.8 Preparation for Shipment

- 752.8.1 After completion of tests and inspection, all exterior parts of the unit, except machined surfaces, shall receive a shop coat of paint. Vendor's standard paint is acceptable. Protection of machined surfaces shall be as follows:
- a. Clean flange faces, shaft, and all other exposed surfaces of finished parts of machinery and coat with a suitable rust preventative.
 - b. All reservoirs, tanks, coolers, filters, bearing houses, piping, etc., with which lube oil comes in contact shall have clean surfaces and be flushed with a suitable rust preventative.
 - c. All oil lubricated bearings of pumps and drivers shall be flushed with a lubricant prior to shipment.
 - d. All internal surfaces of the pump shall be flushed with a suitable rust preventative. Particular care shall be given to the seal chamber.
 - e. Flange faces shall be covered with full diameter wood or metal blanks held in place by four full diameter bolts.
 - f. All tapped openings leading to any part of the pump that will contain the liquid pumped shall be fitted with threaded steel plugs. Alloy casings shall be provided with the plugs of the same material as the casing. Other tapped openings shall be plugged with the manufacturer's standard metal or plastic closures. Cast iron plugs shall not be used.



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g. All exterior openings to bearing and seal areas and to exposed surfaces of finished parts of machinery shall be covered with a waterproof tape, such as P.V.C., applied in a manner to prevent entrance of foreign matter.

- 752.8.2 Each pump and driver shall be properly identified as required by the Purchase Order.
- 752.8.3 Miscellaneous parts shall be tagged or marked with the Item Number, suitably boxed, firmly attached to the pump and shipped with the unit. Couplings and coupling guards shall be mounted for shipment.
- 752.8.4 Pump, driver, baseplate and all furnished attachments shall be shipped fully assembled with seal installed and no loose parts.
- 752.8.5 Suitable supports shall be provided for internal parts which might become damaged during shipment.
- 752.8.6 Centrifugal pumps provided with packing shall be shipped with packing separate for installation in the field. Centrifugal pumps with mechanical seals shall be shipped with the seals installed.
- 752.8.7 For metering or reciprocating pumps, test packing shall be removed and replaced with new packing with the gland followers finger tight. A spare set of packing shall be shipped loose.
- 752.8.8 Packing used in tests for rotary pumps shall be removed from the stuffing boxes.
- 752.9 Drawings and Other Data Required
- 752.9.1 Vendor will be required to supply eight sets of the following, unless otherwise specified:
- Certified outline drawings with all dimensions.
 - Complete assembly drawings showing all manufacturer's parts, numbers and assembly order.
 - Complete parts lists (bills of materials) with relevant drawings for identification of parts.
 - Recommended Spare Parts Lists, showing part no., description, recommended quantity, unit price; FOB vendor's plant, also name and address of vendor's area representative. Vendor must include a quotation for spare parts for commissioning and two years operation.



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- e. Foundation outline drawings.
- f. Characteristic curves, showing actual test data (vendor's test data sheets are not required).
- g. Complete and comprehensive operating manual for pump, drive, driver and auxiliary equipment. Also a comprehensive maintenance manual must be included.

752.9.2 Guarantees and Performance

- a. The complete pumping assembly shall be guaranteed for pressure, capacity and power consumption at the specified design operating conditions, water NPSH, and satisfactory application in all respects to the operating conditions specified on the specification sheet. Permissible variation from the specified performance is as follows:

	<u>Guarantee Point</u>	<u>Shutoff</u>
Differential head, 0-500 ft. (152.4 m)	Minus 2%, plus 5%	Plus or minus 10%
Differential head, Over 500 ft. (152.4 m)	Minus 2%, plus 3%	Plus or minus 8%
Efficiency	Minus 1/2 percent	
Brake Horsepower	Plus 4%	
Required HPSH	Plus 0	

- b. A performance test under these specified operating conditions may be conducted by Purchaser after startup. If a unit fails to perform as specified, Vendor shall repair, alter or replace the unit to meet the guarantees. Repairs, alterations or replacements shall be at Vendor's expense.
- c. Equipment, parts and materials which have defects, show improper fabrication or that are not in accordance with the requirements of this specification, shall be subject to rejection. They shall also be subject to rejection if such conditions are discovered after acceptance of the items at the manufacturer's plant.
- d. The guarantee period for replacement parts shall begin at the time the replacement part is installed.



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753.0 DESIGN CRITERIA

753.1 General Design Criteria

All pumps shall be designed to include the following considerations:

- a. Standard production models in all respects, for which patterns, dies and parts are stocked by manufacturer.
- b. Maximum interchangeability of parts between pumps furnished by a vendor.
- c. Ease of maintenance and accessibility.
- d. Where data presented on the data sheet conflicts with the requirements of this specification, the individual data sheet shall apply.
- e. For pumps handling liquids more viscous than water, the correction factors given in the latest edition of the standards of the Hydraulic Institute shall be used.
- f. In calculating the horse power rating for the pump driver, gear losses shall be included before any rating factors are applied.

753.2 General Design Criteria for Centrifugal Pumps

753.2.1 NPSH Required shall be lower than NPSH Available indicated on the specification sheet and must be based on water. NPSH correction factors shall not be applied. Where possible, Vendor shall quote a pump with an NPSH Required two (2) feet (.6 m) less than specified available NPSH.

753.3 Design Criteria for Reciprocating Pumps753.3.1 Speed

Maximum Allowable Piston Speed - Feet per minute (meters per minute) - for Directing Acting Pumps.



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Type Service

(See Below)

Stroke Length Inches (cm)	A	B	C	D	
6 (15.24)		19 (5.79)	50 (15.24)	37 (11.28)	58 (14.73)
8 (20.32)		28 (8.53)	58 (17.68)	43 (13.11)	65 (19.05)
10 (25.40)		33 (10.06)	64 (19.51)	47 (14.33)	72 (21.34)
12 (30.48)	38 (11.58)	68 (20.78)	50 (15.24)	77 (23.47)	
18 (45.72)	48 (14.63)	81 (24.69)	59 (17.98)	91 (27.74)	
24 (60.96)		54 (16.46)	90 (27.43)	65 (19.81)	100 (30.48)

A - Speed for light products, such as gasoline, butane and for all products above 450°F (232.2°C).

B - Speed for pumps handling products up to 1000 SSU viscosity maximum.

C - Speed for pumps handling products between 1000 SSU and 5000 SSU viscosity maximum.

D - Speed for pumps on cold water service Vendor shall recommend lower speeds if required by:

1. Specified NPSH available
2. More viscous liquid
3. Pump Design

53.3.2 Power Frame Units

Power frame pumps shall not be operated at more than 75% of their maximum allowable speed. Frame loading limitations, NPSH requirements packing life and overall maintenance problems must be considered in manufacturer's recommended speed of these units.

53.3.3 The following table lists the maximum mechanical efficiencies in percent of to be used in sizing steam piston diameters:

Mechanical Efficiency

Stroke in Inches	3	4	5	6	8	10	12	18	24
Stroke in cm.	7.62	10.16	12.70	15.24	20.32	25.4	30.48	45.72	60.96
Piston Pump	50	55	60	65	65	70	70	73	75
Plunger Pump	47	52	57	61	61	66	66	69	71



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- 753.3.4 Valve plate type piston pumps will be acceptable up to 250 psig (17.577 kg/cm²g) and 300°F (148.9°C).
- 753.3.5 Side pot type piston pumps will be acceptable up to 500 psig (35.154 kg/cm²g) and 750°F (398.9°C).
- 753.3.6 Plunger pumps shall be used for pressures greater than 500 psig (35.154 kg/cm²g) and for all temperature.
- 753.4 Design Criteria for Rotary Pumps
- 753.4.1 Rotary pumps shall operate at speeds recommended by the Vendor, as determined by the type pump, the viscosity and characteristics of the liquid and the pump inlet pressure, but shall not exceed 1800 RPM. Pumps that do not require timing gears may operate at higher speeds subject to purchaser's approval.
- 753.4.2 Pumps shall be designed for the specified capacity and pressure when handling fluid of the minimum viscosity specified. The brake horsepower required shall be based on handling fluid at the maximum viscosity.
- 753.4.3 Pump parts subject to substantial temperature changes shall be designed and supported to permit free expansion and contraction without resulting leakage, harmful distortion or misalignment.
- 753.5 Design Criteria for Steam Turbines
- 753.5.1 Turbines shall be sized for 105% speed and 110% horsepower required by the pump at the most stringent process conditions and with steam conditions as specified.



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754.0 INSTALLATION AND CONSTRUCTION

754.1 General

754.1.1 Rotating equipment will be installed in accordance with manufacturer's instructions and the following specifications. Where the manufacturer's instructions and these specifications are in conflict the manufacturer's instructions shall govern.

754.1.2 When rotating equipment is received with electric motors, and outdoor storage of more than one month is anticipated prior to start-up, the electric motors will be protected in accordance with Material Control Department Standards for protection of motors in extended storage.

754.1.3 Field responsibility is limited to installation, grouting and alignment. The owner will be responsible for furnishing and installing permanent packing, lubricating oils and greases.

754.1.4 The owner shall also be responsible for "running in" the driver and driven equipment.

754.1.5 Services of manufacturer's technical representatives shall be used to the fullest extent provided for in the specifications and/or purchase orders.

754.2 Installation

754.2.1 Rotating equipment bases will be supported for positioning and leveling on shims located as follows:

- a. For bases with four anchor bolts, one set of shims will be placed adjacent to each anchor bolt.
- b. For bases with six or more anchor bolts, two sets of shims will be placed adjacent to each anchor bolt, one on each side of the anchor bolt.

754.2.2 Unless manufacturer's instructions specify otherwise, equipment will be positioned and leveled within the following tolerances:

- a. Horizontal displacement of 1/8" in any direction.
- b. Elevations \pm 1/8".
- c. Flange face alignment to the horizontal or vertical plane 1/2 degree.



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- 754.2.3 The measurements for the positioning and leveling of mechanical equipment will normally be made on either the suction or the discharge flange, whichever is the larger in diameter.
- 754.2.4 If equipment and driver are supplied on a common base, the coupling between pump and driver will be disconnected prior to positioning and leveling. After positioning and leveling but prior to grouting, the equipment and driver coupling will be checked for horizontal, vertical and angular alignment.
- 754.2.5 If the equipment is supplied mounted on the base and the motor bed plate is not drilled for motor mounting, the equipment and base plate will be positioned, leveled and grouted prior to mounting the motor.
- 754.2.6 Grouting of the base plate will be undertaken in a manner to obtain full support under the base plate with no voids or air pockets.
- 754.2.7 All coupling alignment will be made using dial indicators. Solid couplings and pin type "flexible" couplings will be aligned within a total indicator reading of .0005 to .001 inch for both parallel and angular alignment.
- 754.2.8 Equipment and drivers will not be dowelled to bed plate unless specifically required by manufacturer's instructions.
- 754.2.9 After completion of the electrical installation to the motor, the direction of rotation of the motor will be determined by "bumping." Prior to checking the direction of rotation, the coupling between the motor and the equipment will be disconnected.
- 754.2.10 The piping that is connected to the equipment shall be free of contaminants and foreign objects. The inside of the piping shall be visually inspected for cleanliness before it is connected to the equipment. Some systems may require flushing or chemical cleaning.
- 754.2.11 Piping connections to machinery will be checked for proper fit and alignment after all welding and testing of work has been completed to insure that installed piping will not produce excessive loads on the machinery. Piping connections shall be broken and remade as part of this check. Piping shall be modified as necessary to meet acceptable alignment tolerances.
- 754.2.12 Temporary cone-type start-up strainers shall be installed in the pump suction and turbine inlet lines in accordance with vendor's recommendations.

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755.0 TESTS AND INSPECTION

- 755.1 The buyer and/or its customer reserve the right to inspect the material and/or equipment prior to shipment. Such inspection shall not relieve the Seller of his responsibility to meet all requirements of the Purchase Order. It is furthermore understood that it is Buyer's and/or Buyer's customer's privilege to waive inspection at point of material at destination. Payment does not constitute acceptance. If rejected, materials or equipment will be returned for credit or replacement at Seller's risk and Seller will pay all handling and transportation charges both ways. DO NOT SHIP UNLESS INSPECTION IS MADE OR WAIVED.
- 755.2 In cases where surface inspection of equipment is waived, it shall not relieve the manufacturer of conducting all TESTS called for in these specifications or purchase orders.
- 755.3 All pumps shall be given a non-witnessed hydrostatic test. Certification of the test results is required. The hydrostatic test pressure shall be least 1.5 times the maximum allowable working pressure or in the case of centrifugal or rotary pumps. The hydrostatic test pressure shall be at least 1.5 times the maximum discharge pressure which can be developed by the pump. All hydrostatic tests shall be maintained for a minimum period of 30 minutes. Large or heavy cases will require a longer time.
- 755.4 Mechanical seals may be used for the running tests but not for the hydrostatic test.
- 755.5 All pumps, motor and turbine drivers, gear unit and auxiliary equipment furnished by the pump vendor shall be given the manufacturer's standard shop running test. The pump and driver shall be mounted on the base plate and tested as a complete unit, unless otherwise approved by the Purchase. Certification of test results is required.
- 755.6 Spare rotors, if furnished, are to be installed and subjected to a mechanical running test. The tests required for general purpose turbines will be indicated on the individual specification sheet.
- 755.7 NPSH tests are not required, unless specifically indicated on the specification sheet or the NPSH indicated on the specification sheet; does not exceed the NPSH required by the Pump by at least one foot.
- 755.8 For centrifugal pumps, sufficient data shall be taken during these tests to permit plotting the following curves over the full pumping range: head-capacity, efficiency and brake horsepower.



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American Society of Mechanical Engineers (ASME)

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Section VIII

American Welding Society (AWS)

American Petroleum Institute (API)

6A - Wellhead Equipment
620 - Low Pressure Storage Tanks

American Iron and Steel Institute

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American National Standards Institute

A58
B16.5

American Society of Testing and Materials

A53	A204
A106	A516
A193	A285
A194	A335
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NOTE: Latest editions apply to all of the above.