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Standard Specification for Rotary Positive Displacement Pumps, Commercial Ships Use[1]

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1. Scope

1.1 This specification defines the requirements applicable to design and construction of rotary positive displacement pumps for shipboard use. The classes of service are shown in Section 4.

1.2 This specification will not include pumps for hydraulic service or cargo unloading applications.

2. Referenced Documents

2.1 *ASTM Standards:*

A 27/A 27M Specification for Steel Castings, Carbon, for General Application[2]
A 36/A 36M Specification for Structural Steel[3]
A 48 Specification for Gray Iron Castings[2]
A 53 Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless[4]
A 159 Specification for Automotive Gray Iron Castings[2]
A 193/A 193M Specification for Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service[4]
A 194/A 194M Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service[4]
A 322 Specification for Steel Bars, Alloy, Standard Grades[5]
A 354 Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners[6]
A 395/A 395M Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures[2]
A 434 Specification for Steel Bars, Alloy, Hot-Wrought or Cold-Finished, Quenched and Tempered[5]
A 449 Specification for Quenched and Tempered Steel Bolts and Studs[6]
A 515/A 515M Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate and Higher Temperature Service[3]
A 536 Specification for Ductile Iron Castings[2]
A 563 Specification for Carbon and Alloy Steel Nuts[6]
A 564/A 564M Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Bars and Shapes[7]
A 574 Specification for Alloy Steel Socket-Head Cap Screws[6]
A 582/A 582M Specification for Free-Machining Stainless and Heat-Resisting Steel Bars[7]
A 743/A 743M Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion-Resistant for General Application[2]
B 150 Specification for Aluminum Bronze Rod, Bar, and Shapes[8]
B 584 Specification for Copper Alloy Sand Castings for General Applications[8]
D 1418 Practice for Rubber and Rubber Lattices— Nomenclature[9]
D 2000 Classification System for Rubber Products in Automotive Applications[10]
D 3951 Practice for Commercial Packaging[11]
F 104 Classification System for Nonmetallic Gasket Materials[10]
F 593 Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs[6]
F 912 Specification for Alloy Steel Socket Set Screws[6]
F 1511 Specification for Mechanical Seals for Shipboard Pump Applications[12]

2.2 *ANSI Standard:*

B 16.5 Pipe Flanges and Flanged Fittings[13]

2.3 *SAE Standards:*

AS 568A Aerospace Size Standard for O-Rings[14]
J 429 Mechanical and Material Requirements for Externally Threaded Fasteners[14]

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[2] *Annual Book of ASTM Standards*, Vol 01.02.
[3] *Annual Book of ASTM Standards*, Vol 01.04.
[4] *Annual Book of ASTM Standards*, Vol 01.01.
[5] *Annual Book of ASTM Standards*, Vol 01.05.
[6] *Annual Book of ASTM Standards*, Vol 15.08.
[7] *Annual Book of ASTM Standards*, Vol 01.03.
[8] *Annual Book of ASTM Standards*, Vol 02.01.
[9] *Annual Book of ASTM Standards*, Vol 09.01.
[10] *Annual Book of ASTM Standards*, Vol 09.02.
[11] *Annual Book of ASTM Standards*, Vol 15.09.
[12] *Annual Book of ASTM Standards*, Vol 01.07.
[13] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.
[14] Available from Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096.

2.4 *AMS Standard:*
3215 Acrylonitrile Butadiene (NBR) Rubber Aromatic Fuel Resistant 65-75[14]
2.5 *AFBMA Standards:*
9 Load Ratings and Fatigue Life for Ball Bearings[15]
11 Load Ratings and Fatigue Life for Roller Bearings[15]
20 Bearing Interchange Guide[15]
2.6 *AGMA Standard:*
390.03 Gear Classification, Materials and Measuring Methods for Unassembled Gears[16]
2.7 *API Standard:*
676 Positive Displacement Pumps—Rotary[17]
2.8 *Military Standards:*
MIL-S-901[18]
MIL-STD-167[18]
MIL-STD-740[18]

3. Terminology

3.1 *Definitions:*

3.1.1 *capacity*—the quantity of fluid actually delivered per unit of time at the rated speed, including both the liquid and dissolved or entrained gases, under stated operating conditions. In the absence of any gas or vapor entering or forming within the pump, the capacity is equal to the volume displaced per unit of time, less slip.

3.1.2 *capacity, maximum*—the quantity of fluid delivered that does not exceed the limit determined by the formula in 9.2.

3.1.3 *displacement*—the volume displaced per revolution of the rotor(s). In pumps incorporating two or more rotors operating at different speeds, the displacement is the volume displaced per revolution of the driving rotor. Displacement depends only on the physical dimensions of the pumping elements.

3.1.4 *dry operation*—a brief run during priming or stripping with suction and discharge lines unrestricted and pump chamber wet with liquid but pumping only air or vapor available from the suction.

3.1.5 *efficiency, mechanical*—the ratio of the pump power output (hydraulic horsepower) to the pump power input (brake horsepower) expressed in percent.

3.1.6 *efficiency, volumetric*—the ratio of the pump's capacity to the product of the displacement and the speed expressed in percent.

3.1.7 *fuel, clean*—fuel purified for direct use.

3.1.8 *fuel, dirty*—fuel before purification which may contain water and some solids.

3.1.9 *net positive inlet pressure available (NPIPA)*—the total inlet pressure available from the system at the pump inlet connection at the rated flow, minus the vapor pressure of the liquid at the pumping temperature.

3.1.10 *net positive inlet pressure required (NPIPR)*—the net pressure above the liquid vapor pressure at rated flow and pumping temperature and at the pump inlet connection required to avoid performance impairment due to cavitation.

3.1.11 *pressure, cracking*—sometimes called set pressure, start-to-discharge pressure, or popping pressure—the pressure at which the relief valve just starts to open. This pressure cannot be determined readily if the relief valve is internal to the pump and it bypasses the liquid within the pump.

3.1.12 *pressure, differential*—the difference between discharge pressure and inlet pressure.

3.1.13 *pressure, discharge*—the pressure at the outlet of the pump. Discharge pressure is sometimes called outlet pressure.

3.1.14 *pressure, inlet*—the total pressure at the inlet of the pump. Inlet pressure is sometimes called suction pressure.

3.1.15 *pressure, maximum allowable working*—the maximum continuous pressure for which the manufacturer has designed the equipment (or any part to which the term is referred) when handling the specified fluid at the specified temperature. This pressure should not be greater than ⅔ of the hydrostatic test pressure of the pressure containing parts.

3.1.16 *rated condition*—defined by discharge pressure, inlet pressure, capacity, and viscosity.

3.1.17 *rotary pump*—a positive displacement pump consisting of a casing containing gears, screws, lobes, cams, vanes, shoes, or similar elements actuated by relative rotation between the drive shaft and the casing. There are no inlet and outlet valves. These pumps are characterized by their close running clearances.

3.1.18 *slip*—the quantity of fluid that leaks through the internal clearances of a rotary pump per unit of time. Slip depends on the internal clearances, the differential pressure, the characteristics of the fluid handled and in some cases, the speed.

3.1.19 *speed, maximum allowable (in revolutions per minute)*—the highest speed at which the manufacturers' design will permit continuous operation.

3.1.20 *speed, minimum allowable (in revolutions per minute)*—the lowest speed at which the manufacturers' design will permit continuous operation.

3.1.21 *speed, rated*—the number of revolutions per minute of the driving rotor required to meet the rated conditions.

3.1.22 *suction lift*—a term used to define a pump's capability to induce a partial vacuum at the pump inlet.

3.1.23 *temperature, maximum allowable*—the maximum continuous temperature for which the manufacturer has designed the equipment (or any part to which the term is referred) when handling the specified fluid at the specified pressure.

4. Classification

4.1 Pumps will be classified as follows:
4.1.1 *Types*:
4.1.1.1 *Type II*—Screws with timing gears.
4.1.1.2 *Type III*—Screws without timing gears.
4.1.1.3 *Type IV*—Impellers with timing gears.
4.1.1.4 *Type V*—External gear (spur, helical, herringbone, lobe).
4.1.1.5 *Type VIII*—Internal gear, internal rotary lobe.
4.1.1.6 *Type X*—Vane (sliding).

[15] Available from Anti-Friction Bearing Manufacturers Association, 1101 Connecticut Ave. N.W., Suite 700, Washington, DC 20036.
[16] Available from American Gear Manufacturers Association, 1901 N. Fort Myer Dr., Suite 1000, Arlington, VA 22209.
[17] Available from American Petroleum Institute, 1801 K St., N.W., Washington, DC 20226.
[18] Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

4.1.1.7 *Type XI*—Sliding shoe.

4.1.2 *Classes*:

4.1.2.1 *Class A*—Aqueous film forming foam, AFFF.

4.1.2.2 *Class B*—Bromine.

4.1.2.3 *Class CD*—Clean distillate fuel, viscosity 32 to 100 SSU (2 to 21 centistokes) (for example, jet fuel, JP-5, fuel).

4.1.2.4 *Class CH*—Clean heavy fuel, viscosity 100 to 1500 SSU (21 to 325 centistokes) (propulsion fuel).

4.1.2.5 *Class DD*—Dirty distillate fuel, viscosity 32 to 100 SSU (2 to 21 centistokes) (for example, transfer, stripping, purifier feed, leak-off).

4.1.2.6 *Class DH*—Dirty heavy oil, viscosity 32 to 4000 SSU (2 to 863 centistokes) (for example, waste oil, transfer, stripping, purifier feed, drains).

4.1.2.7 *Class G*—Gasoline, aviation gasoline, gasohol.

4.1.2.8 *Class LM*—Lube oil, viscosity 130 to 4000 SSU (27 to 863 centistokes) (for example, propulsion, SSTG, control, L.O. service).

4.1.2.9 *Class LA*—Auxiliary L.O. 130 to 4000 SSU (27 to 863 centistokes) service and L.O. transfer.

4.1.2.10 *Class M*—Miscellaneous.

4.1.2.11 *Class W*—Heavily contaminated seawater, viscosity 32 to 4000 SSU (2 to 863 centistokes) (bilge stripping, oily waste transfer).

5. Ordering Data

5.1 The ordering activity shall provide manufacturers with all of the following information:

5.1.1 Title, number, and date of specification,

5.1.2 Type and classification, see Section 4,

5.1.3 Capacity in gallons per minute or litres per minute at rated discharge pressure,

5.1.4 Discharge pressure in pound-force per square inch gage (psig) or kilopascal (kPa) gage.

5.1.5 Airborne noise levels (if different than 7.5),

5.1.6 Viscosity (only if different than Section 4),

5.1.7 Mounting configuration (vertical, horizontal),

5.1.8 Driver type (motor, turbine, engine, attached),

5.1.9 Driver characteristics or specifications, or both,

5.1.10 Relief valve cracking pressure and full-flow bypass pressure,

5.1.11 Packaging and boxing requirements (immediate use, domestic; storage, domestic; overseas),

5.1.12 Quantity of pumps,

5.1.13 Quantity of drawings,

5.1.14 Quantity of technical manuals,

5.1.15 Quantity of test reports,

5.1.16 Performance test, if required,

5.1.17 Certified data required, and

5.1.18 Instruction plates and locations, if required.

6. Materials

6.1 Pump component parts shall be constructed of the materials shown in Table 1.

6.2 Materials other than shown in Table 1 are considered exceptions and are subject to approval by the purchaser before usage.

7. General Requirements

7.1 Pumps shall be designed for a 20-year service life.

7.2 Pumps shall be capable of sustained operation during inclinations up to 45° in any direction.

7.3 The pumps shall be capable of withstanding environmental vibration induced by shipboard machinery and equipment in the frequency range from 4 to 25 Hz.

7.4 The internally excited vibration levels of the pump shall not exceed 0.003-in. (0.00762-mm) displacement peak to peak during rated operation when readings are measured on the pump case near the coupling perpendicular to the pump shaft.

7.5 At normal operating conditions, the airborne noise level of the pump shall not exceed 85 dBA.

7.6 The pump driver (electric motor, air motor, turbine, hydraulic motor, diesel engine, attached) shall be as specified in the ordering data. The driver shall be sized for maximum flow at the relief valve full-flow bypass pressure, at maximum viscosity. If a two-speed motor is specified for high-viscosity Class LM applications, the motor size shall be based on power required at low speed, which is used during cold startup.

7.7 If a reduction gear is required between the driver and the pump, it shall be provided by the pump manufacturer. Reduction gears shall meet the requirements of AGMA 390.03. Gears shall be AGMA Class 7 or better, pinions shall be AGMA Class 8 or better, and bearings shall be designed for a L10 life of 15 000 h.

7.8 Horizontal pumps may be mounted on a common horizontal bedplate with the driving unit or mounted directly to the driver. Vertical pumps may be mounted with a bracket to the driving unit or mounted directly to the driver.

7.9 All pump units shall incorporate guards over couplings, belts, and other external rotating parts.

7.10 The mounting arrangement shall be sufficiently rigid to assure alignment is maintained between the pump and the driver in accordance with the conditions in 7.2, 7.3, and 8.1.

7.11 Seating surfaces of mounting bedplates, bracket mounting plates, or other mounting arrangements shall be machined.

7.12 Mounting bedplates, brackets, and plates shall be provided with holes of sufficient size and quantity to assure adequate attachment to shipboard foundation or mounting structure.

7.13 Vertical units with face mounted motors shall be arranged so there are four (4) possible orientations of motor driver to pump. Other drivers are to be oriented in accordance with the ordering information.

7.14 Vertical units that are motor driven shall be assembled with the conduit box mounted over the pump inlet flange, unless otherwise specified.

7.15 Couplings between the pump and the driver shall be keyed to both shafts.

7.16 Alignment between the pump and the driver shall not exceed 0.005-in. (0.13-mm) offset and 0.0005-in./in. (0.01-mm/mm) angularity.

7.17 An external (separate) relief valve shall not be provided with the pump unless otherwise specified. The purchaser shall provide the cracking pressure and the fullflow bypass pressure of the system relief valve to the pump manufacturer.

7.18 Direction of rotation shall be indicated by an arrow cast into the pump or by a label plate attached to the pump.