



Standard Specification for Rotary Positive Displacement Pumps, Ships Use¹

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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:²

[A27/A27M](#) Specification for Steel Castings, Carbon, for General Application

[A36/A36M](#) Specification for Carbon Structural Steel

[A48/A48M](#) Specification for Gray Iron Castings

[A53/A53M](#) Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

[A159](#) Specification for Automotive Gray Iron Castings

[A193/A193M](#) Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

[A194/A194M](#) Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

[A322](#) Specification for Steel Bars, Alloy, Standard Grades

[A354](#) Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners

[A395/A395M](#) Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures

[A434](#) Specification for Steel Bars, Alloy, Hot-Wrought or Cold-Finished, Quenched and Tempered

[A449](#) Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use

[A515/A515M](#) Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service

[A536](#) Specification for Ductile Iron Castings

[A563](#) Specification for Carbon and Alloy Steel Nuts

[A564/A564M](#) Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes

[A574](#) Specification for Alloy Steel Socket-Head Cap Screws

[A582/A582M](#) Specification for Free-Machining Stainless Steel Bars

[A743/A743M](#) Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application

[B150M](#) Specification for Aluminum Bronze, Rod, Bar, and Shapes [Metric] (Withdrawn 2002)³

[B584](#) Specification for Copper Alloy Sand Castings for General Applications

[D1418](#) Practice for Rubber and Rubber Latices—Nomenclature

[D2000](#) Classification System for Rubber Products in Automotive Applications

[D3951](#) Practice for Commercial Packaging

[F104](#) Classification System for Nonmetallic Gasket Materials

[F912](#) Specification for Alloy Steel Socket Set Screws

[F1511](#) Specification for Mechanical Seals for Shipboard Pump Applications

2.2 *ANSI Standard:*⁴

[B 16.5](#) Pipe Flanges and Flanged Fittings

2.3 *SAE Standards:*⁵

[AS 568A](#) Aerospace Size Standard for O-Rings

[J 429](#) Mechanical and Material Requirements for Externally Threaded Fasteners

2.4 *AMS Standard:*⁵

[3215](#) Acrylonitrile Butadiene (NBR) Rubber Aromatic Fuel Resistant 65-75

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁵ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

2.5 *ABMA Standards*:⁶

9 Load Ratings and Fatigue Life for Ball Bearings

11 Load Ratings and Fatigue Life for Roller Bearings

2.6 *AGMA Standard*:⁷

390.03 Gear Classification, Materials and Measuring Methods for Unassembled Gears

2.7 *API Standard*:⁸

676 Positive Displacement Pumps—Rotary

2.8 *Military Standards*:⁹

MIL-S-901

MIL-STD-167

MIL-STD-740

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 $\frac{2}{3}$ 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).

⁶ Available from American Bearing Manufacturers Association (ABMA), 2025 M Street, NW Suite 800, Washington, DC 20036, <http://www.abma-dc.org/>.

⁷ Available from American Gear Manufacturer's Association (AGMA), 500 Montgomery St., Suite 350, Alexandria, VA 22314-1581, <http://www.agma.org>.

⁸ Available from American Petroleum Institute (API), 1220 L. St., NW, Washington, DC 20005-4070, <http://api-ec.api.org>.

⁹ Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

4.1.1.5 *Type VIII*—Internal gear, internal rotary lobe.

4.1.1.6 *Type X*—Vane (sliding).

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 gauge (psig) or kilopascal (kPa) gauge.

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.

TABLE 1 Materials

Component	Class A, B, CD, G	Class CH, LM, LA	Class DD, DH	Class W	Specification (UNS)
Casings, heads, and covers	ductile iron	ductile iron	ductile iron		ASTM A395/A395M or A536 , Gr. 60-40-18
	ductile iron	ductile iron			ASTM A536 , Br. 80-55-06
Shafts	lead tin bronze	lead tin bronze	lead tin bronze	lead tin bronze	ASTM A27/A27M , Gr. 65-35
	carbon steel	carbon steel	carbon steel		ASTM B584 (C93700)
	steel	steel			ASTM A53/A53M
	carbon steel	carbon steel			ASTM A434 , Gr. 4140, Cl.BC
	stainless steel	stainless steel	stainless steel	stainless steel	AISI 1141
Rotors	alloy steel	alloy steel			ASTM A582/A582M (S41600) and ASTM A564/A564M Gr. 630 (S17400)
	cast gray iron	cast gray iron	cast gray iron		ASTM A322
					ASTM A159 , Gr. G3500 or ASTM A48/A48M , Cl. 35-50 or 25-50
Rotor housings, liners, and disks	ductile iron (80-55-06 only)	ductile iron			ASTM A536 , Gr. 60-40-18, 80-55-06, or 120-90-02
		alloy steel			AISI 4150 RS, H.T.
	lead tin bronze	lead tin bronze	lead tin bronze	lead tin bronze	ASTM A582/A582M (S41600)
	cast gray iron	cast gray iron	cast gray iron		ASTM B584 (C93700)
	ductile iron	ductile iron	ductile iron		ASTM A159 , Gr. G3500
Glands	stainless steel	stainless steel	stainless steel	stainless steel	ASTM A536 , Gr. 60-40-18
	lead tin bronze	lead tin bronze	lead tin bronze	lead tin bronze	ASTM A564/A564M , Gr. 630 (S17400)
	tin bronze	tin bronze	tin bronze		ASTM B584 (C93700)
Bedplates and brackets	stainless steel	stainless steel	stainless steel	stainless steel	ASTM A743/A743M , Gr. CF8M (J92900)
	structural steel	structural steel	structural steel	structural steel	ASTM A36/A36M
Timing gears	ductile iron	ductile iron			ASTM A395/A395M 5, Gr. 60-40-18
	nitrided steel	nitrided steel	nitrided steel	nitrided steel ⁴	ASTM A515/A515M
		aluminum bronze			ASTM A434 , Gr. 4140, Cl.BC
			stainless steel	stainless steel	ASTM B150M (C63000)
					ASTM A582/A582M (S41600)

THE FOLLOWING MATERIALS ARE APPLICABLE TO ALL CLASSES

Fasteners (studs, bolts, screws, nuts)	medium carbon alloy steel bolts				ASTM A193/A193M , Gr. B7
	medium carbon alloy steel nuts				ASTM A194/A194M , Gr. 7
	austenitic stainless steel (304/316)				ASTM A193/A193M , Gr. B8/B8M
	austenitic stainless steel (304/316)				ASTM A194/A194M , Gr. 8/8M
	medium carbon steel bolts and studs				ASTM A449 , Gr 1 (equivalent to SAE Gr 5)
	medium carbon steel nuts				ASTM A563 , Gr B (equivalent to SAE Gr 5)
O-rings and other elastomers	high-strength alloy steel bolts and studs				ASTM A354 , Gr. BD (equivalent to SAE Gr 8)
	high-strength alloy steel nuts				ASTM A563 , Gr. DH (equivalent to SAE Gr 8)
	alloy steel socket-head cap screws				ASTM A574
	alloy steel socket set screws				ASTM F912
	fluorocarbon (viton, fluorel, or equal)				SAE J 429, Gr. 5, 5.1, 8, or 8.1
	ASTM D1418 Class: FKM, AS 568A, ASTM D2000 Type and Class: HK				
Gaskets	plant and animal fiber				ASTM F104 , I.D. No. P 3313B
	fluorocarbon				ASTM D2000 Type and Class: HK, ASTM D1418 Class: FKM
Vanes and shoes	nitrile (Buna-N or equal)				AMS 3215
	lead tin bronze				ASTM B584 (C93700)
	thermoset plastic				None

⁴Outside of pumpage when separately lubricated.

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.

7.19 Inlet and outlet connections shall be indicated by a label plate attached to each flange.

8. Pump Design

8.1 Pump inlet and outlet connections shall be flanged. Steel case pump flanges shall be in accordance with ANSI B16.5 raised face. Cast gray iron and nonferrous material cases shall