



Standard Specification for Rotary Positive Displacement Pumps, Commercial 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:

A 27/A 27M Specification for Steel Castings, Carbon, for General Application²

A 36/A 36M Specification for Carbon Structural Steel³

A 48 Specification for Gray Iron Castings²

A 53 Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless⁴

A 159 Specification for Automotive Gray Iron Castings²

A 193/A 193M Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service⁴

A 194/A 194M Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service, or Both⁴

A 322 Specification for Steel Bars, Alloy, Standard Grades⁵

A 354 Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners⁶

A 395/A 395M Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures²

A 434 Specification for Steel Bars, Alloy, Hot-Wrought or Cold-Finished, Quenched and Tempered⁵

A 449 Specification for Quenched and Tempered Steel Bolts and Studs⁶

A 515/A 515M Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate— and Higher-Temperature Service³

A 536 Specification for Ductile Iron Castings²

A 563 Specification for Carbon and Alloy Steel Nuts⁶

A 564/A 564M Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes⁷

A 574 Specification for Alloy Steel Socket-Head Cap Screws⁶

A 582/A 582M Specification for Free-Machining Stainless Steel Bars⁷

A 743/A 743M Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion-Resistant for General Application²

B 150 Specification for Aluminum Bronze Rod, Bar, and Shapes⁸

B 584 Specification for Copper Alloy Sand Castings for General Applications⁸

D 1418 Practice for Rubber and Rubber Lattices— Nomenclature⁹

D 2000 Classification System for Rubber Products in Automotive Applications¹⁰

D 3951 Practice for Commercial Packaging¹¹

F 104 Classification System for Nonmetallic Gasket Materials¹⁰

F 593 Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs⁶

F 912 Specification for Alloy Steel Socket Set Screws⁶

F 1511 Specification for Mechanical Seals for Shipboard Pump Applications¹²

2.2 ANSI Standard:

B 16.5 Pipe Flanges and Flanged Fittings¹³

2.3 SAE Standards:

¹ This specification is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.11 on Machinery.

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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, 25 W. 43rd St., 4th Floor, New York, NY 10036.

AS 568A Aerospace Size Standard for O-Rings¹⁴
 J 429 Mechanical and Material Requirements for Externally Threaded Fasteners¹⁴

2.4 *AMS Standard:*

3215 Acrylonitrile Butadiene (NBR) Rubber Aromatic Fuel Resistant 65-75¹⁴

2.5 *AFBMA Standards:*

9 Load Ratings and Fatigue Life for Ball Bearings¹⁵

11 Load Ratings and Fatigue Life for Roller Bearings¹⁵

20 Bearing Interchange Guide¹⁵

2.6 *AGMA Standard:*

390.03 Gear Classification, Materials and Measuring Methods for Unassembled Gears¹⁶

2.7 *API Standard:*

676 Positive Displacement Pumps—Rotary¹⁷

2.8 *Military Standards:*

MIL-S-901¹⁸

MIL-STD-167¹⁸

MIL-STD-740¹⁸

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.

¹⁴ Available from Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096.

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.

4.1.1.4 *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).

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.

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 A 395 or A 536 , Gr. 60-40-18
	ductile iron	ductile iron			ASTM A 536, Br. 80-55-06
Shafts	lead tin bronze	lead tin bronze	lead tin bronze	lead tin bronze	ASTM A 27, Gr. 65-35
	carbon steel	carbon steel	carbon steel		ASTM B 584 (C93700)
	steel	steel			ASTM A 53
	carbon steel	carbon steel			ASTM A 434, Gr. 4140, Cl.BC
Rotors	stainless steel	stainless steel	stainless steel	stainless steel	AISI 1141
	alloy steel	alloy steel			ASTM A 582 (S41600) and ASTM A 564 Gr. 630 (S17400)
	cast gray iron	cast gray iron	cast gray iron		ASTM A 322
Rotor housings, liners, and disks	ductile iron (80-55-06 only)	ductile iron			ASTM A 159, Gr. G 3500 or ASTM A 48, Cl. 35-50 or 25-50
		alloy steel			ASTM A 536, Gr. 60-40-18, 80-55-06, or 120-90-02
	lead tin bronze	lead tin bronze	stainless steel	stainless steel	AISI 4150 RS, H.T.
	cast gray iron	cast gray iron	lead tin bronze	lead tin bronze	ASTM A 582 (S41600)
Glands	ductile iron	ductile iron	ductile iron		ASTM B 584 (C93700)
	stainless steel	stainless steel	stainless steel	stainless steel	ASTM A 159, Gr. G 3500
Bedplates and brackets	lead tin bronze	lead tin bronze	lead tin bronze	lead tin bronze	ASTM A 536, Gr. 60-40-18
	stainless steel	stainless steel	stainless steel	stainless steel	ASTM A 564, Gr. 630 (S17400)
Timing gears	structural steel	structural steel	structural steel	structural steel	ASTM B 584 (C93700)
	ductile iron	ductile iron	ductile iron	ductile iron	ASTM B 584 (C90300)
Fasteners (studs, bolts, screws, nuts)	nitrided steel	nitrided steel	nitrided steel	nitrided steel ^A	ASTM A 743, Gr. CF8M (J92900)
		aluminum bronze	stainless steel	stainless steel	ASTM A 36
O-rings and other elastomers	medium carbon alloy steel bolts	medium carbon alloy steel bolts			ASTM A 395, Gr. 60-40-18
	medium carbon alloy steel nuts	medium carbon alloy steel nuts			ASTM A 515
	austenitic stainless steel (304/316)	austenitic stainless steel (304/316)			ASTM A 434, Gr. 4140, Cl.BC
	austenitic stainless steel (304/316)	austenitic stainless steel (304/316)			ASTM B 150 (C63000)
Gaskets	medium carbon steel bolts and studs	medium carbon steel bolts and studs			ASTM A 582 (S41600)
	medium carbon steel nuts	medium carbon steel nuts			
Vanes and shoes	high-strength alloy steel bolts and studs	high-strength alloy steel bolts and studs			
	high-strength alloy steel nuts	high-strength alloy steel nuts			
Fasteners (studs, bolts, screws, nuts)	alloy steel socket-head cap screws	alloy steel socket set screws			ASTM A 193, Gr. B 7
	alloy steel socket set screws				ASTM A 194, Gr. 7
O-rings and other elastomers	fluorocarbon (viton, fluorel, or equal)				ASTM A 194, Gr. B8/B8M
					ASTM A 194, Gr. 8/8M
Gaskets	plant and animal fiber				ASTM A 449, Gr 1 (equivalent to SAE Gr 5)
	fluorocarbon				ASTM A 563, Gr B (equivalent to SAE Gr 5)
Vanes and shoes	nitrile (Buna-N or equal)				ASTM A 354, Gr. BD (equivalent to SAE Gr 8)
	lead tin bronze				ASTM A 563, Gr. DH (equivalent to SAE Gr 8)
Gaskets	thermoset plastic				ASTM A 574
					ASTM F 912
Vanes and shoes					SAE J429, Gr. 5, 5.1, 8, or 8.1
					ASTM D 1418 Class: FKM, AS 568A, ASTM D 2000 Type and Class: HK
Gaskets					ASTM F 104, I.D. No. P 3313B
					ASTM D 2000 Type and Class: HK, ASTM D 1418 Class: FKM
Vanes and shoes					AMS 3215
					ASTM B 584 (C93700)
Gaskets					None

THE FOLLOWING MATERIALS ARE APPLICABLE TO ALL CLASSES

^AOutside of pumpage when separately lubricated.

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 be in accordance with ANSI B16.5 flat face, unless otherwise stated in the ordering data. Flanged connections shall meet the requirements in API Standard 676, Paragraph 2.4.7. Spool