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An American National Standard

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

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This standard has been approved for use by agencies of the U.S. Department of Defense.

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.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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

[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 and Piping Systems.

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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.

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

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 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:*

[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.

4.1.1.1 *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).
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.

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
		cast steel			ASTM A27/A27M, Gr. 65-35
	leaded tin bronze	leaded tin bronze	leaded tin bronze	leaded tin bronze	ASTM B584 (C93700)
	carbon steel	carbon steel	carbon steel		ASTM A53/A53M
Shafts	steel	steel			ASTM A434, Gr. 4140, Cl.BC
	carbon steel	carbon steel			AISI 1141
	stainless steel	stainless steel	stainless steel	stainless steel	ASTM A582/A582M (S41600) and ASTM A564/A564M Gr. 630 (S17400)
	alloy steel	alloy steel			ASTM A322
Rotors	cast gray iron	cast gray iron	cast gray iron		ASTM A159, Gr. G3500 or ASTM A48/A48M, Cl. 35-50 or 25-50
	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.
			stainless steel	stainless steel	ASTM A582/A582M (S41600)
	leaded tin bronze	leaded tin bronze	leaded tin bronze	leaded tin bronze	ASTM B584 (C93700)
Rotor housings, liners, and disks	cast gray iron	cast gray iron	cast gray iron		ASTM A159, Gr. G3500
	ductile iron	ductile iron	ductile iron		ASTM A536, Gr. 60-40-18
	stainless steel	stainless steel	stainless steel	stainless steel	ASTM A564/A564M, Gr. 630 (S17400)
	leaded tin bronze	leaded tin bronze	leaded tin bronze	leaded tin bronze	ASTM B584 (C93700)
Glands	tin bronze	tin bronze	tin bronze		ASTM B584 (C90300)
	stainless steel	stainless steel	stainless steel	stainless steel	ASTM A743/A743M, Gr. CF8M (J92900)
Bedplates and brackets	structural steel	structural steel	structural steel	structural steel	ASTM A36/A36M
	ductile iron	ductile iron			ASTM A395/A395M 5, Gr. 60-40-18
		carbon steel			ASTM A515/A515M
Timing gears	nitrided steel	nitrided steel	nitrided steel	nitrided steel[A]	ASTM A434, Gr. 4140, Cl.BC
		aluminum bronze			ASTM B150M (C63000)
			stainless steel	stainless steel	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)
	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
					SAE J 429, Gr. 5, 5.1, 8, or 8.1
O-rings and other elastomers	fluorocarbon (viton, fluorel, or equal)				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
	leaded tin bronze				ASTM B584 (C93700)
	thermoset plastic				None

[A] Outside of pumpage when separately lubricated.

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.

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 piece adapters (threaded and seal welded, or O-ring sealed to the pump case on one end and flanged on the other end) may be furnished to meet the flanged inlet and outlet requirement.

8.2 Pump cases shall be equipped with vent, drain, inlet, and outlet gauge connections. The connection shall be straight thread with an O-ring seal. Tapered pipe thread connections are prohibited. Small pumps do not require vent, drain, and gauge connections.

8.3 Materials for the pump shall be compatible with the fluid being pumped, and the operating parameters to be encountered including maximum pressure and temperature extremes stated in the ordering data.

8.4 Pumps shall be equipped with radial and thrust bearings as necessary to counteract any unbalanced forces in the pump and to ensure that the pump will operate satisfactorily in accordance with 7.2.

8.5 Bearings shall be securely fitted (by snap rings, shoulders, or other means) to prevent axial movement. Bearing housings shall be integral to the pump case or secured to the pump case in such a manner as to ensure alignment. Usage of bolts alone is not considered sufficient to ensure alignment.

8.6 Bearings may be sealed and self-lubricated or externally lubricated or may be lubricated by the liquid being pumped.

8.7 Rolling contact bearings shall be selected in accordance with AFBMA standards and shall have a minimum L10 life of 15 000 h as calculated in accordance with AFBMA Standard 9 or 11 as appropriate.

8.8 Pumps shall be equipped with mechanical shaft seals, in accordance with Specification F1511. The installation shall ensure that adequate circulation of liquid at the seal faces occurs to minimize deposit of foreign matter and provide adequate lubrication of the seal faces.

8.9 Mechanical seals shall be positioned or located on the shaft axially, by a positive means such as a stub, step, or shoulder positively located on the pump shaft. Set screws shall not be used to position seals or seal sleeves axially. An antirotation pin may be provided to prevent the mechanical seal-mating ring from rotating.

8.10 When required by the ordering data, the pump shall be equipped with a backup packing box. The design shall allow for installation of two or more rings of packing for use in the event of a mechanical seal failure. The packing rings shall be able to be inserted without having to remove the mechanical seal.

8.11 Pump head or end covers, or both, shall be located to the pump case by a means such as rabbet, dowels, or pilot to ensure proper alignment.

8.12 Rotors and timing gears shall be machined and positively secured in position to maintain required clearances and prevent undue wear.

8.13 Fasteners shall be selected from Table 1 taking into consideration temperature of operation, mechanical properties, and corrosion resistance.

9. Performance Requirements

9.1 Pumps shall deliver the rated capacity at 10-psia (69-kPa absolute) inlet pressure while operating at the parameters specified in the ordering data.

9.2 The maximum capacity of the pump shall not exceed the amount determined by the following formula:

$$Q_{max} = Q\left[1 + \frac{1}{1 + Q^{0.4}}\right] \quad (1)$$

where:

Q = rated capacity and

Q_{max} = maximum allowable capacity, at minimum viscosity. Q_{max} shall be rounded to the nearest whole number.

9.3 Capacity of all classes (except DH) pumps shall not be less than the value stated in 5.1.3 at the rated conditions, with minimum viscosity.

9.4 Class DH pumps shall meet the capacity requirements at 4000 SSU (863 centistokes) and shall not be damaged by continuous operation at 32 SSU (2 centistokes).

9.5 Class LM & LA pumps shall meet the capacity requirements at 130 SSU (27 centistokes) and driver horsepower shall be determined based on 4000 SSU (863 centistokes).

10. Painting and Coatings

10.1 *Painting*—External unmachined and nonmating machined surfaces shall be thoroughly cleaned and painted.

10.2 Painting external surfaces of nonferrous parts and components is not required but is permissible to avoid excessive masking. Identification and information plates shall not be painted or oversprayed.

11. Equipment Identification and Instruction Plates

11.1 Identification plates shall be made of brass or stainless steel and furnished on each pump unit.

11.2 Instruction plates shall be made of brass, stainless steel, or plastic when furnished on each pump unit.

11.3 Plates shall be secured to equipment with corrosion-resistant metallic fasteners.

11.4 Pump unit identification plates shall contain data as follows:

11.4.1 Manufacturer's name.

11.4.2 Manufacturer's model or type and size.

11.4.3 Service application.

11.4.4 Manufacturer's serial number.

11.4.5 Salient design characteristics if applicable.

11.4.5.1 Capacity.

11.4.5.2 Discharge pressure.

11.4.5.3 Pump rated speed (RPM).

11.5 Accessory units such as the driver, controller, pump, and gearbox, shall have an identification plate in accordance

with the applicable equipment specification. If not specified, the manufacturer shall use its commercial nameplate.

12. Testing Requirements

12.1 *General*—All equipment shall be tested in accordance with 12.2 and 12.3. The first unit of a new design or size shall be tested in accordance with 12.4 and 12.5.

12.1.1 Equipment for specified tests shall be provided by the manufacturer.

12.1.2 Acceptance of tests does not constitute a waiver of requirements to meet performance under specified operating conditions, nor does inspection relieve the manufacturer of his responsibilities.

12.1.3 The manufacturer shall maintain a complete log of the tests performed and shall prepare the required number of copies of the test report, certified as to correctness.

12.2 *Hydrostatic Test*—Pressure-containing parts shall be tested hydrostatically with liquid at a minimum of 1½ times the maximum allowable working pressure but at not less than 50-lb/in.^{2} (345-kPa) gauge. The hydrostatic test shall be considered satisfactory when no leaks are observed for a minimum of 5 min. Seepage past internal closures required for segmented casing testing and operating of the hydrostatic test pump to maintain pressure will be accepted.

12.3 *Mechanical Running Test*—The pump manufacturer shall conduct a test on all pumps to ensure that rated capacity is achieved at the rated condition. Such tests may be performed with other than the specified liquid if the viscosity is equal to the minimum viscosity for the class of pump being tested. A viscosity up to 50 SSU greater than the minimum viscosity may be used. Differential pressure may be measured in lieu of inlet pressure and discharge pressure.

12.4 *Performance Test*—The pump manufacturer shall operate a pump at the manufacturing facility or approved test facility to obtain complete test data when required by the ordering document (5.1.15). The pump shall be tested at rated speed, discharge pressure, viscosity, and 10-psia (69-kPa absolute) inlet pressure. The pump shall meet rated capacity at this condition and shall meet the airborne noise levels in 7.5. This test is normally required for new types, new designs, or new applications of pumps.

12.5 *Certified Data*—Certified performance data or curves shall be supplied when required, see 5.1.16.

13. Technical Documents

13.1 An outline or top drawing of the unit (pump and driver) shall be furnished. Length, width, height, mounting details, and connections shall be dimensioned.

13.2 Complete performance curves shall be furnished. The curves may be on graphs which can be printed on notebook size paper.

13.3 Pump drawings shall include a sectional assembly drawing. The sectional assembly drawing shall contain a complete list of materials or reference to a list of materials drawing, which shall be provided.

13.4 Brackets, bedplates, guards, couplings, identification plates, rotation arrows, and so forth shall be shown on the outline drawing.

13.5 Any subassembly made up of parts that require special alignment or assembly methods that cannot be disassembled, repaired, and reassembled onboard ship without the use of special tools and jigs shall be indicated as a subassembly in the list of material.

13.6 Drawings for driver and associated equipment shall be in accordance with their respective specifications.

13.7 The weight and center of gravity (calculated or actual) of the unit shall be indicated on the outline drawing.

13.8 Instruction books or technical manuals shall be prepared for each different type or size of pump installed. A single manual shall contain not more than one type or size of pump. However, when several pumps are installed in a ship that are identical except for type of driver, they may be included in a single manual.

13.9 Piece (item or find) numbers of parts referred to in technical manuals shall match the piece numbers shown on pump drawings.

13.10 Technical manuals shall contain reproductions of pump drawings.

13.11 Quantities of technical manuals shall be in accordance with the order.

14. Packaging and Preservation

14.1 Pumps, pump units, and accessories shall be packaged and preserved in accordance with Practice D3951, and the following:

14.2 *Preservation*—Items susceptible to deterioration or damage from environmental elements shall be preserved. Noncoated ferrous surfaces shall be preserved.

14.3 *Cushioning and Bracing*—Items susceptible to damage during shipment and handling shall be cushioned or shall be securely braced or blocked, or both, within the shipping container, to avoid damage.

14.4 *Container Marking*—Containers, boxes, or packages shall be clearly marked with the ship to address, contract or purchase order number, shipping point address, and item nomenclature.

15. Keywords

15.1 positive displacement pump; pump; rotary pump; shipboard pump

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements established by the U.S. Navy, Commander Naval Sea Systems Command (NAVSEA) shall apply when specified in the contract or purchase order. When there is a conflict between the specifications and this section, requirements of this section shall take precedence.

S1.1 Materials other than shown in Table 1 are considered exceptions and are subject to approval by NAVSEA.

S1.2 The pumps shall be capable of withstanding environmental vibration induced by shipboard machinery and equipment in the frequency range of 4 to 25 Hz and be in accordance with MIL-STD-167, Type 1. Maximum single frequency displacement (double amplitude) in the 4- to 15-Hz range is 0.060 in. (1.524 mm) and in the 16- to 25-Hz range is 0.040 in. (1.016 mm).

S1.3 The internally excited vibration levels of the pump shall be in accordance with MIL-STD-167, Type II and shall not exceed 0.003-in. (0.076-mm) displacement peak to peak during rated operation when readings are measured on the pump case near the coupling perpendicular to the pump shaft.

S1.4 At the conditions in Section 9, the airborne noise level of the pump unit shall meet the requirements in Table S1.1 (see MIL-STD-740-1).

S1.5 At the conditions in Section 9, the structureborne noise level of the pump unit shall meet the requirements in Table S1.2 (see MIL-STD-740-2).

S1.6 Pumps shall meet the requirements of MIL-S-901 HI (High Impact) Shock, Grade A.

S1.7 Mechanical shaft seals shall be in accordance with Specification F1511, including Supplement S1. An anti-rotation pin shall be provided for seal O-ring mating rings in shaft sizes 1 in. and larger, when the pump will be handling viscosus fluids over 130 ssu (27 centistrokes). Pin diameter and length shall be compatible with the slot in the ring.

S1.8 *Qualification Tests*—The first pump of each size, type, or design shall meet the following qualification tests. All tests shall be performed with the motor size required at rated condition as indicated in Section 9.

S1.9 *Performance Test*—The pump shall be tested at the conditions in Section 9 to demonstrate that the pump is capable of delivering the required capacity. Record all test data including electrical power input for comparision to performance retest results (see S1.15).

S.1.10 *Vibration Type II Test*—The pump shall be tested to demonstrate the ability to meet the requirements of S1.3. Record all test data, including electrical power input, for comparison to performance retest results (see S1.15).

S1.11 *Noise Tests*—The pump shall be tested to demonstrate the ability to meet the requirements of S1.4 and S1.5. Record all test data, including electrical power input, for comparison to performance retest results (see S1.15).

S1.12 *Vibration Type I Test*—The pump shall be tested to demonstrate the ability to meet the requirements of S1.2.

S1.13 *Shock Test*—The pump shall be tested to demonstrate the ability to meet the requirements of S1.6.

S11.14 *Endurance Test* —The endurance test shall consist of a running test of not less than 500 h of actual running time at rated condition. The 500 h shall be broken by at least three rest periods of 8 h or more each. A minimum of ten start-stop cycles shall be performed during the course of the test.

S1.15 *Performance Retest*—Upon completion of the tests in S1.9 through S1.14, repoeat the performance test (S1.9), the Vibration Type II test (S1.10), and the noise test (S1.11). Record all test data.

S1.16 *Test Reports*—A test report shall be submitted for each test conducted. Quantity and format as defined in the ordering data.

TABLE S1.1 Acceptable Octave Band Sound Pressure Levels (in dB re 20 µPa)

Octave Band Center Frequency, Hz								
31.5	63	125	250	500	1000	2000	4000	8000
91	88	85	82	79	76	73	70	67

TABLE S1.2 Acceptable Structureborne Vibratory Acceleration Acceptance Criteria in Adb re 10 μm/s^2 (Reference MIL-STD-740–2)

	Octave Band Center Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
Resiliently mounted pumps	85	88	90	93	95	98	100	103	105
Solidly mounted pumps	75	78	80	83	85	88	90	93	95