



# Standard Specification for Sealless Lube Oil Pump with Oil Through Motor for Marine Applications<sup>1</sup>

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<sup>ε1</sup> NOTE—The Keywords Section was editorially added in November 2014.

## 1. Scope

1.1 This specification defines the requirements applicable to design, construction and testing of sealless, rotary positive displacement pumps with oil-through motors for ship lubricating oil service. The complete pump and motor assembly is referred to as canned lube oil pump (CLP). This specification applies to CLPs pumping oil with a SAE rating of 20–50.

1.2 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

- A27/A27M Specification for Steel Castings, Carbon, for General Application
- 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 Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
- A216/A216M Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
- A395/A395M Specification for Ferritic Ductile Iron

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- Pressure-Retaining Castings for Use at Elevated Temperatures
- A449 Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
- 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
- B23 Specification for White Metal Bearing Alloys (Known Commercially as “Babbitt Metal”)
- B148 Specification for Aluminum-Bronze Sand Castings
- B152/B152M Specification for Copper Sheet, Strip, Plate, and Rolled Bar
- B187M Specification for Copper Bar, Bus Bar, Rod and Shapes [Metric] (Withdrawn 2002)<sup>3</sup>
- B271 Specification for Copper-Base Alloy Centrifugal Castings
- B505/B505M Specification for Copper Alloy Continuous Castings
- B584 Specification for Copper Alloy Sand Castings for General Applications
- D2000 Classification System for Rubber Products in Automotive Applications
- D3951 Practice for Commercial Packaging
- F912 Specification for Alloy Steel Socket Set Screws
- F1510 Specification for Rotary Positive Displacement Pumps, Ships Use

### 2.2 ASME/ANSI Standards:<sup>4</sup>

- ASME/ANSI B16.5 Pipe Flanges and Flanged Fittings

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>4</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

2.3 *Hydraulic Institute Standards*.<sup>5</sup>

ANSI/HI 3.6 Rotary Pump Tests

2.4 *AISI Standards*.<sup>6</sup>

1018 Carbon Steel

1045 Carbon Steel

1141 Carbon Steel

1144 Carbon Steel

4140 Chromium-molybdenum steel

4150 Chromium-molybdenum steel

4340 Nickel-chromium-molybdenum steel

2.5 *AIA Standards*.<sup>7</sup>

NASM 17829

2.6 *API Standards*.<sup>8</sup>

API Standard 676 Positive Displacement Pumps—Rotary

### 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.2 *canned lube oil pump unit*—a unit, which when assembled as a pump and motor, is completely sealed from leakage to the environment. Lubrication and cooling of motor bearings and primary cooling of motor windings and insulation are achieved by circulating a portion of the fluid being pumped (oil) through the motor.

3.3 *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, motor bearing lubrication and motor cooling flows.

3.4 *displacement*—the volume of fluid displaced per revolution of the rotor(s).

3.5 *rated condition point*—the required capacity at speed, pressure, viscosity and power as specified by the purchaser.

3.6 *slip*—the quantity of fluid that leaks through internal clearances of a pump per unit of time.

### 4. Classification

4.1 Pumps will be classified as follows:

4.1.1 *Type II*—Screws with timing gears.

4.1.2 *Type III*—Screws without timing gears.

4.1.3 *Type X*—Vane (sliding).

4.1.4 *Type XI*—Sliding shoe.

4.2 *Motor Types*—Oil-through type that uses the oil to cool the motor and lubricate the bearings.

### 5. Ordering Information

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

<sup>5</sup> Available from Hydraulic Institute, 6 Campus Drive, First Floor North, Parsippany NJ 07054-4406, <http://www.pumps.org>.

<sup>6</sup> Available from American Iron and Steel Institute (AISI), 1140 Connecticut Ave., NW, Suite 705, Washington, DC 20036, <http://www.steel.org>.

<sup>7</sup> Available from Aerospace Industries Association of America, Inc. (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209-3928, <http://www.aia-aerospace.org>.

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

5.1.1 Title, name and date of specification.

5.1.2 Type and size (see Section 4).

5.1.3 Oil to be pumped (for example, 2190 TEP SAE 40).

5.1.4 *Operating Conditions*—Single speed, two-speed, or variable speed. (See 9.1.)

5.1.5 Capacity in gallons per minute or litres per minute at rated discharge pressure at specified operating condition.

5.1.6 Discharge pressure in pound-force per square inch gauge (psig) or kilopascal (kPa) gauge at specified operating condition.

5.1.7 Inlet pressure conditions (NPIPA).

5.1.8 Oil Viscosity and temperature for minimum and maximum operating conditions.

5.1.9 External motor cooling oil supply, if required. (See 9.4.)

5.1.10 Mounting configuration (vertical, horizontal).

5.1.11 Relief valve cracking pressure. (See 9.1.)

5.1.12 Airborne noise level (if different than 7.4).

5.1.13 Packaging and boxing requirements (immediate use, domestic; storage, domestic; or overseas).

5.1.14 Quantity of pumps.

5.1.15 Quantity of drawings.

5.1.16 Quantity of technical manuals.

5.1.17 Quantity of test reports, if required. (See Section 10.)

5.1.18 Certified test data, if required. (See 10.3.)

5.1.19 IACS (International Association of Classification Societies) classification with applicable notions, if required.

5.1.20 *Motor Characteristics:*

5.1.20.1 *Voltage/Phase/Frequency:*

5.1.20.2 *Duty*—Continuous.

5.1.20.3 *Ambient Temperature*—50°C.

5.1.20.4 *Enclosure*—Totally enclosed, oil through.

5.1.20.5 *Insulation*—Class F, (vacuum pressure impregnation (VPI)).

5.1.20.6 *Conduit Box Orientation*—See 7.6.

### 6. Material

6.1 Materials of principal pump components shall be in accordance with Table 1.

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

6.2 Materials of principal motor components shall be in accordance with Table 2.

6.2.1 Materials other than shown in Table 2 are considered exceptions and are subject to approval by the purchaser before usage.

### 7. General Requirements

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

7.2 CLPs shall be capable of withstanding external vibration in the frequency range of 4 to 25 Hz.

7.3 The internally excited vibration levels (displacement, peak to peak) of the CLP shall not exceed the following:

**TABLE 1 Materials of Principal Pump Components**

Application	Material	Specification
Casings, Covers (Pressure Boundary)	Nodular Iron	ASTM <b>A395/A395M</b> , GR. 60-40-18 or ASTM <b>A536</b> , GR. 65-45-12
	Bronze	ASTM <b>B505/B505M</b> , <b>B271</b> , or <b>B584</b> , UNS C93200 or C93700
	Cast Steel	ASTM <b>A27/A27M</b> , GR. 65-35 or ASTM <b>A216/A216M</b> , GR. WCB
	Aluminum Bronze	ASTM <b>B148</b> , UNS C95400
Rotor(s), Shaft(s)	Alloy Steel	AISI 4150 RS or AISI 4140-4150
	Gray Iron	ASTM <b>A159</b> , GR. G3500 or continuous cast equivalents
	Nodular Iron	ASTM <b>A536</b> , GR. 80-55-06 or continuous cast equivalents
	Carbon Steel	AISI 1045, 1141 or 1144
	Bronze	ASTM <b>B505/B505M</b> , <b>B271</b> or <b>B584</b> , UNS C93200 or C93700
	Stainless Steel	ASTM <b>A564/A564M</b> , UNS S17400
		ASTM <b>A582/A582M</b> , UNS S41600
Rotor Housings or Cylinder Liners, Bushings, Thrust Elements, Discs	Bronze	ASTM <b>B505/B505M</b> , <b>B271</b> or <b>B584</b> , UNS C93200 or C93700
	Gray Iron	ASTM <b>A159</b> , GR. G3500 or continuous cast equivalents
Hex Head Cap Screws	Steel/Babbitt	AISI C1018-12L15/ASTM <b>B23</b> , ALLOY 2
	Aluminum Bronze	ASTM <b>B148</b> , UNS C95400
	Steel	ASTM <b>A449</b> , TYPE I or SAE J429, GR. 5
	Alloy Steel	ASTM <b>A574</b>
	Steel	ASTM <b>A194/A194M</b> , GR. 2H
	Alloy Steel	ASTM <b>A563</b> , GR. DH or SAE GR. 8
Hex Nuts, Slf Lkg	Steel, Zn Plated	NASM 17829 / MS17829
Socket Set Screws	Alloy Steel	ASTM <b>F912</b>
Studs	Alloy Steel	ASTM <b>A193/A193M</b> , GR. B7
O-Rings	Fluorocarbon	ASTM <b>D2000</b> , TY. HK

**TABLE 2 Materials of Principal Motor Components**

Application	Material	Specification
Frame	Nodular Iron	ASTM <b>A395/A395M</b> , GR. 60-40-18 or ASTM <b>A536</b> , GR. 65-45-12
Housings	Nodular Iron	ASTM <b>A395/A395M</b> , GR. 60-40-18 or ASTM <b>A536</b> , GR. 65-45-12
Shaft	Alloy Steel	AISI 4340
Ball Bearings	Steel	CID A-A-59585
Bearing Caps	Steel	CID A-A-59584
Shrink Ring	Steel	Commercial
Rotor Bar	Copper	ASTM <b>B187M</b>
Rotor End Ring	Copper	ASTM <b>B152/B152M</b>
Rotor Core Plate	Elec. Sheet Steel	Commercial
Stator End Plate	Steel	Commercial
Stator Core Plate	Elec. Sheet Steel	Commercial
Hex Head Cap Screws	Steel	ASTM <b>A449</b> , TYPE I or SAE J429, GR. 5
Hex Socket Head Cap Screws	Alloy Steel	ASTM <b>A574</b>
Lock Washers	Steel	Commercial

RPM (SYN)	Displacement, Peak to Peak, Mils
3600	0.7
1800	1.4
1200	1.8
900	2.2
600	2.6

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

7.5 CLPs shall be designed such that no damage will result from reverse rotations of at least a one-minute duration with no restriction in flow of oil to or from the CLP.

7.6 Unless otherwise specified, vertical CLPs shall be assembled with the conduit box mounted over the pump outlet

flange. Conduit box cable entrance shall be oriented downward, unless otherwise specified. Horizontal pumps shall specify orientation of conduit box.

7.7 The connection between the motor shaft and the pump rotor shall be splined or consist of a rigid connection.

7.8 To facilitate and maintain alignment, the motor bracket to pump joint shall be rabbetted.

7.9 Motor bracket to pump joint shall be o-ring sealed.

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

7.11 An internal or separate relief valve is not required to be provided with the CLP.

## 8. Pump Design

8.1 Pump inlet and outlet connections shall be flanged. Pump flanges shall mate to ASME/ANSI B16.5 pipe flanges. Cast iron and non-ferrous material case flanges shall be flat face, unless otherwise stated in the ordering data. Flanged connections shall meet the external forces and moments requirements in API Standard 676. 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 Pumps of capacity 100 gpm and greater shall be equipped with vent, drain, inlet, and outlet gage connections. Where threaded connections are used they shall be straight thread with O-ring seal. Tapered pipe thread connections are prohibited. Small capacity pumps (under 100 gpm) do not require vent, drain, and gage connections.

8.3 Pumps shall be designed to counteract radial and axial thrust loads encountered during operation.

8.4 Pumps shall be self-priming and capable of removing air from the suction lines.

8.5 Pumps shall be designed to handle up to 8 % entrained air.

## 9. Motor Design

9.1 Motors may be single speed, two-speed or single speed with a variable speed drive to support pump operation at various temperatures and viscosities. Single speed motors shall be sized for the maximum flow at the system relief valve cracking pressure at maximum viscosity. If a two speed motor is specified, rating of the low speed winding shall be based on power required at the low speed with maximum viscosity oil during cold startup. The high speed winding rating shall be based on power required at pump rated conditions. Motors driven by variable speed drive units should be sized so that the motor can support pump cold start-up operation and normal rated condition operation without overloading the motor.

9.2 Motors shall be rated for continuous duty for all ratings.

9.3 Motors shall be equipped with a high point fill connection for filling the CLP unit with oil at initial start-up and a low point drain connection. Where threaded connections are used they shall be straight thread with O-ring seal. Tapered pipe thread connections are prohibited.

9.4 A method to supply cooling and lubricating oil to the motor and motor bearings must be provided. The cooling oil shall be supplied by either internal pump passages or an external system connection. When an external cooling method is chosen, supplier shall provide motor cooling oil pressure, temperature and flow requirements to the purchaser. Where threaded connections are used they shall be straight thread with O-ring seal. Tapered pipe thread connections are prohibited.

9.5 Motors shall be equipped with an inspection cover, o-ring sealed, for verification of direction of shaft rotation.

9.6 The motor enclosure shall contain the cooling/lubricating oil pressure. Where external cooling flow is provided, the cooling oil shall be provided at a maximum of 20 psig.

9.7 Motor bearings shall be lubricated by the pumping fluid.

## 10. Test Requirements

10.1 *General*—All equipment shall be tested in accordance with 10.2.

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

10.2 *Hydrostatic Test:*

10.2.1 Each pump casing shall be tested hydrostatically to a minimum of 150 percent of discharge pressure (see 5.1.6). 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.

10.2.2 Each motor shall be tested hydrostatically at 50 PSIG. This test may be accomplished by testing the complete CLP.

10.3 *Certification Data and Testing*—Certified performance test data shall be supplied when required. (See 5.1.18.)

10.3.1 *Mechanical Running Test*—The manufacturer shall conduct a test on each CLP to ensure that rated capacity is achieved at the rated condition. Such tests may be performed with other than the specified liquid and with viscosity up to 50 SSU greater than the minimum specified viscosity. Differential pressure may be measured in place of specified inlet and discharge pressures.

10.3.2 *Performance Test*—When required and as specified by the ordering document, the manufacturer shall operate a CLP at the manufacturing facility or approved test facility to obtain complete mechanical, hydraulic and electrical test data. The pump shall meet rated capacity at this condition and shall meet the airborne noise levels in 7.4.

## 11. Technical Documentation

11.1 Unless otherwise specified, each pump shall include an instruction book that shall be composed of the following:

11.1.1 CLP description;

11.1.2 Installation instructions;

11.1.3 Operating instructions;

11.1.4 Maintenance procedures (including complete pump disassembly and assembly);

11.1.5 Outline dimension drawing, including weight;

11.1.6 Typical cross-sectional assembly drawing and list of materials;

11.1.7 Motor outline drawing.

11.2 *Submittal Documents*—Proposal documents shall consist of the following:

11.2.1 Outline dimension drawing with estimated, calculated or actual weight and center of gravity

11.2.2 Typical cross-sectional drawing and list of materials.

11.2.3 Performance curve which plots differential pressure, efficiency, and brake horsepower as a function of capacity

11.2.4 List of recommended spare parts.

## 12. Packaging and Preservation

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



12.1.1 *Preservation*—Items susceptible to deterioration or damage from environmental elements shall be preserved. Non-coated ferrous surfaces shall be preserved.

12.1.2 *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.

12.1.3 *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.

### 13. Keywords

13.1 lube oil pump; marine pump; sealless 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. Referenced Documents

#### S1.1 *ASTM Standard:*

D2519 Standard Test Method for Bond Strength of Electrical Insulating Varnishes by the Helical Coil Test

#### S1.2 *Underwriters Laboratories:*

984 Hermetic Refrigerant Motor-Compressors

#### S1.3 *Military Standards:*

Mil-STD-167-1 Mechanical Vibrations of Shipboard Equipment (Type I-Environmental and Type II-Internally Excited

MIL-STD-740 Airborne and Structure borne Noise Measurements and Acceptance Criteria of Shipboard Equipment

MIL-S-901 Shock Tests, H.I. (High Impact Shipboard Machinery, Equipment and Systems, Requirements, for

MIL-DTL-2212 Contactors and Controllers, Electric Motor AC or DC and Associated Switching Devices

MIL-M-17060 Motors, 60-Hertz, Alternating Current, Integral Horsepower, Shipboard Use

MIL-PRF-32168 Variable Speed Drive System for Induction and Synchronous Machines

NAVSEA Technical Publication T9074-AS-GIB-010/271 Requirements for Nondestructive Testing Methods

### S2. Applicability

S2.1 This CLP is part of the US Navy ships' lube oil system and must meet all system requirements for cleanliness, pressure and temperature.

### S3. Ordering Data

S3.1 *Requirements*—All CLPs in accordance with this Supplement shall have **Fig. S1.1** completed by the purchasing activity.

### S4. Design Requirements

S4.1 Motor shall be Service A in accordance with MIL-M-17060 and the following:

S4.1.1 A motor master drawing per MIL-M-17060 shall be provided.

S4.1.2 The motor shall have a means of visually verifying unit direction of rotation for each speed.

S4.1.3 The method of connecting terminal leads shall ensure that no external strains shall be transmitted to the motor internal wiring.

S4.1.5 The CLP may not meet the efficiency requirements of MIL-M-17060. Any specific efficiency requirements and testing for such requirements shall be detailed in the ordering document.

S4.1.6 Motor insulation shall undergo the following testing to prove the compatibility of the insulation system with oil. Test results shall be noted on the motor master plan. These tests only have to be performed once for each insulation design.

S4.1.6.1 Perform an Electrical Insulation Varnish Bond Strength test in accordance with ASTM D 2519. Twelve specimens shall be tested; six specimens in oil and six specimens in air. Specimens shall be tested at 150°C. The reduction in bond strength between the oil specimens and air specimens shall not exceed 50 percent

S4.1.6.2 Perform a compatibility test in accordance with paragraph 41 of UL 984. The test shall be modified to include oil only. A test plan shall be submitted to US Navy for approval prior to start of testing.

S4.1.7 The CLPs shall have non-overloading power characteristics, and the driver-rated horsepower shall at least equal the maximum power requirements of the pump at the maximum rated speed without allowances for a service factor.

S4.1.8 If required by **Fig. S1.1**, motor thermal protection shall be in accordance with MIL-M-17060 and the following:

S4.1.8.1 Bearing temperature sensors, thermistor or otherwise, are not required.

S4.1.8.2 All winding sensor leads shall be bought into the terminal box and shall be coiled and restrained to prevent lead damage.

S4.1.8.3 Sensor leads shall be marked. The marking shall be visible in the terminal box. Sensors located in the same winding phase group shall have a common identification.

S4.1.8.4 Thermal protection systems shall meet EMI requirements of MIL-STD-461 after installation in the motor.

S4.1.8.5 Sensors shall be installed so that at least one phase group with sensors is located in an expected or possible hot spot.

S4.1.8.6 If a sensor monitor is required, only one monitor shall be used per motor. The monitor shall be mounted on the motor near the terminal box. The monitor shall provide an output to a visual or audible alarm or ship control system when

## US NAVY SUPPLEMENT ORDERING DATA

PUMP TYPE:

Pump Classification (Para 4.1):

Mounting Type:      Horizontal      Vertical

Pumping Fluid:

Fluid Temperature (Min/Max) (°F):

Viscosity at Minimum Temp:

Viscosity at Maximum Temp:

Operating Conditions (Rotational):    Single Speed    Two-Speed    Variable Speed

Capacity at Rated Discharge Pressure (GPM):

Rated Discharge Pressure (PSIG):

Minimum Suction Pressure (PSIG, PSIA or Inches of Hg as applicable):

Special Efficiency Requirements (Para S4.1.5)

Thermal Protection (Para S4.1.8):

TEST

SPECIFICATION

PARA

<input type="checkbox"/> Motor Test	<input type="checkbox"/> Witness	S5
<input type="checkbox"/> Shock Test	<input type="checkbox"/> Witness	S6.1
<input type="checkbox"/> Vibration Test	<input type="checkbox"/> Witness	S6.2
<input type="checkbox"/> Performance Test	<input type="checkbox"/> Witness	S7.1.1
<input type="checkbox"/> Endurance Test	<input type="checkbox"/> Witness	S7.1.2
<input type="checkbox"/> Inclined Operation Test	<input type="checkbox"/> Witness	S7.1.3
<input type="checkbox"/> Hot Insulation Resistance Test	<input type="checkbox"/> Witness	S7.1.4
<input type="checkbox"/> Production Test	<input type="checkbox"/> Witness	S7.2
<input type="checkbox"/> Hydrostatic Pressure Test	<input type="checkbox"/> Witness	S7.2.1
<input type="checkbox"/> Assembled CLP Pressure Test	<input type="checkbox"/> Witness	S7.2.2
<input type="checkbox"/> Mechanical Soundness and Capacity Test	<input type="checkbox"/> Witness	S7.2.3
<input type="checkbox"/> Noise Test	<input type="checkbox"/> Witness	S7.2.4

CONNECTIONS:

TYPE (O-RING, ETC)

- Drain/Vent
- Inlet Pressure Gage
- Discharge Pressure Gage

MOTOR:

Volts/Phase/Hertz                      Type                      Encl

COMMENTS: (volume/weight requirements, special storage instructions, etc.):

FIG. S1.1 US Navy Supplement Ordering Data