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18 February 1986
SUPERSEDING
MIL-P-17639E(SH)
23 March 1979
(See 6.8)

MILITARY SPECIFICATION

PUMPS, CENTRIFUGAL, MISCELLANEOUS SERVICE, NAVAL SHIPBOARD USE

This specification is approved for use within the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the requirements applicable to the design and construction of centrifugal pumps.

1.2 Classification. Pumps shall be of the following classes, as specified (see 6.2.1):

Class C-1 - Pumps with overhung impellers with all bearings on driver side of impeller (other than Navy standard close-coupled).
Class C-2 - Pumps with impellers between bearings.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 4320

AMSC N/A

SPECIFICATIONS

FEDERAL

FF-B-171	– Bearings, Ball, Annular (General Purpose).
FF-B-185	– Bearings, Roller, Cylindrical; and Bearings, Roller , Self-Aligning .
FF-B-187	– Bearing, Roller, Tapered.
QQ-C-390	- Copper Alloy Castings (Including Cast Bar),
QQ-C-465	- Copper-Aluminum Alloys (Aluminum Bronze) (Copper Alloy Numbers 606, 614, 630, 632M, and 642); Rod, Flat Products with Finished Edges (Flat Wire, Strip, and Bar), Shapes, and Forgings.
QQ-N-281	- Nickel-Copper Alloy Bar, Rod, Plate, Sheet, Strip, Wire, Forgings, and Structural and Special Shaped Sections.
QQ-N-286	- Nickel-Copper-Aluminum Alloy, Wrought (UNS N05500).
QQ-N-288	- Nickel-Copper Alloy and Nickel–Copper-Silicon Alloy Castings.
QQ-S-763	– Steel Bars, Wire, Shapes, and Forgings, Corrosion-Resisting.
QQ-T-390	- Tin Alloy Ingots and Castings and Lead Alloy Ingots and Castings (Antifriction Metal) for Bearing Applications.
TT-P-645	- Primer, Paint, Zinc Chromate, Alkyd Type.
GGG-E-950	– Extractor, Stuffing Box and Pump Packing (and Tamper); and Extractor, Lantern Gland.
GGG-P-781	– Puller, Mechanical Puller Attachment, Mechanical, and Puller Set, Mechanical.

MILITARY

MIL-S-901	- Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-E-917	– Electric Power Equipment, Basic Requirements (Naval Shipboard Use).
DOD-D-1000	– Drawings, Engineering and Associated Lists.
MIL-S-1222	- Studs, Bolts, Hex Cap Screws, and Nuts.
MIL-C-2212	– Controllers, Electric Motor A.C. or D.C., and Associated Switching Devices.
MIL-S-8660	– Silicone Compound, Nato Code Number S-736.
MIL-P-15024	– Plates, Tags and Bands for Identification of Equipment.
MIL-P-15024/5	- Plates, Identification.
MIL-M-15071	- Manuals, Technical: Equipments and Systems Content Requirements for.
MIL-S-15083	- Steel Castings.
MIL-E-15090	- Enamel, Equipment, Light-Gray (Formula No. 111).
MIL-P-15137	- Provisioning Technical Documentation for Repair Parts for Electrical and Mechanical Equipment (Naval Shipboard Use).
DOD-P-15328	- Primer (Wash), Pretreatment (Formula No. 117 for Metals). (Metric)

MILITARY (Continued)

MIL-C-15726		Copper-Nickel Alloy, Rod, Flat Products (Flat Wire, Strip, Sheet, Bar, and Plate) and Forgings.
MIL-T-16420		Tube, Copper-Nickel Alloy, Seamless and Welded (Copper Alloy Numbers 715 and 706).
MIL-P-16789		Packaging of Pumps, Including Prime Movers and Associated Repair Parts.
MIL-S-16993		Steel Castings (12-Percent Chromium).
MIL-M-17060		Motors, 60-Hertz, Alternating Current, Integral-Horsepower, Shipboard Use.
MIL-L-17331		Lubricating Oil, Steam Turbine and Gear, Moderate Service.
MIL-M-17413		Motors, Direct Current, Integral H.P., Naval Shipboard.
MIL-T-17523		Turbine, Steam, Auxiliary (and Reduction Gear) Mechanical Drive.
MIL-B-17931		Bearings, Ball, Annular, for Quiet Operation.
MIL-G-18916		Governors, Steam Driven Pump, Pressure Regulating, Naval Shipboard.
MIL-C-20159		Copper-Nickel Alloy Castings (UNS No. C96200 and C96400).
MIL-E-21562		Electrodes and Rods - Welding, Bare, Nickel Alloy.
MIL-E-22200		Electrodes, Welding, Covered; General Specification for.
MIL-E-22200/3	-	Electrodes, Welding, Covered: Nickel Base Alloy; and Cobalt Base Alloy.
MIL-S-22473	-	Sealing, Locking, and Retaining Compounds: (Single-Component).
MIL-C-23233	-	Couplings for Propulsion Units, Auxiliary Turbines and Line Shafts Naval Shipboard.
MIL-N-24106	-	Nickel-Copper Alloy Bars, Rods, and Forgings.
MIL-P-24377	-	Packing Material, Asbestos, Braided, Impregnated with PTFE (Polytetrafluoroethylene) , Surface Lubricated.
DOD-G-24508	-	Grease, High Performance, Multi-Purpose. (Metric)
MIL-I-45208	-	Inspection System Requirements.

STANDARDS

FEDERAL

FED-STD-H28	-	Screw-Thread Standards for Federal Services.
FED-STD-H28/2	-	Screw-Thread Standards for Federal Services Section 2 Unified Inch Screw Threads - UN and UNR Thread Forms.

MILITARY

MIL-STD-167-1	-	Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited).
MIL-STD-271	-	Nondestructive Testing Requirements for Metals.
MIL-STD-278	-	Fabrication Welding and Inspection; and Casting Inspection and Repair for Machinery, Piping and Pressure Vessels in Ships of the United States Navy.

MILITARY (Continued)

MIL-STD-438	- Schedule of Piping, Valves, Fittings and Associated Piping Components for Submarine Service.
MIL-STD-740	- Airborne and Structureborne Noise Measurements and Acceptance Criteria of Shipboard Equipment.
MIL-STD-777	- Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships .
DOD-STD-2147	- Technical Repair Standards (TRS); Hull, Mechanical and Electrical (HM&E), Preparation of. (Metric)
MS16142	- Boss, Gasket Seal Straight Thread Tube Fitting, Standard Dimensions for.
MS18229	– plug for “O” Ring Gasket.

2.1.2 Other Government drawings and publications. The following other Government drawings and publications form a part of this specification to the extent specified herein. Unless otherwise specified, the issues shall be those in effect on the date of the solicitation.

DRAWINGS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

B-153	– Packings and Gaskets, Standard Application of.
B-214	- Root Connections for Attaching Piping.
810-1385850	- Piping, Installation, Pressure for All Services.

PUBLICATIONS

NAvAL SEA SYSTEMS COMMAND (NAVSEA)

0900-LP-001-7000	- Fabrication and Inspection of Brazed Piping Systems.
0900-LP-003-8000	- Metals, Surface Inspection Acceptance Standards.
0941-LP-041-3010	- Submarine Safety Design Review Procedures Manual.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

AMERICAN SOCIETY FOR TESTNG AND MATERIALS (ASTM)

A 487 - Standard Specification for Steel Castings Suitable for Pressure Service.
A 582 - Standard Specification for Free-Machining Stainless and Heat-Resisting Steel Bars, Hot-Rolled or Cold-Finished. (DoD adopted)
A 744 - Standard Specification for Castings, Iron-Chromium-Nickel, Nickel-Base, Corrosion Resistant, for Severe Service. (DoD adopted)
B 61 - Standard Specification for Steam or Valve Bronze Castings. (DoD adopted)
B 148 - Standard Specification for Aluminum-Bronze Sand Castings.
B 164 - Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire. (DoD adopted)
B 367 - Standard Specification for Titanium and Titanium Alloy Castings.
B 369 - Standard Specification for Copper-Nickel Alloy Castings. (DoD adopted)
B 443 - Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625) Plate, Sheet, and Strip.
B 446 - Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625) ‘Rod and Bar.
B 584 - Standard Specification for Copper Alloy Sand Castings for General Applications. (DoD adopted)

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

HYDRAULIC INSTITUTE

Test Code of Standards - Centrifugal Pump Section.

(Application for copies should be addressed to Hydraulic Institute, 712 Lakewood Center N., 14600 Detroit Avenue, Cleveland, OH 44107.)

(Nongovernment standards and other publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified in the contract or purchase order, a sample shall be subjected to first article inspection (see 4.3 and 6.3). On board repair parts and stocked spare parts ordered for pumps built to this specification shall be subject to the same tests as the original equipment.

3.2 General design. The design and construction of pumps shall comply with the space and weight requirements as specified (see 6.2.1). The pump unit shall perform under the list, pitch, roll and trim conditions as specified (see 6.2.1). Pumps shall operate continuously at any point over the entire flow range and the design conditions as specified (see 6.2.1).

3.2.1 Reliability. The requirements of this specification are imposed exclusively to obtain equipment of utmost reliability for the service intended. The assurance of maximum reliability shall be the paramount controlling principle in the design, fabrication, assembly, and testing of this equipment. Users of, and contractors to, this specification are urged to communicate to NAVSEA any findings related to the requirements or lack of requirements of this specification whereby improvement of equipment reliability can be achieved. On board repair parts and stocked spare parts ordered for pumps built to this specification shall be subject to the same tests as the original equipment.

3.2.2 The equipment specified herein will be operated, maintained, and repaired on board Navy ships. Attention is directed to the high equipment density of shipboard machinery spaces, to the fact that maintenance and repair will be made underway in heavy seas, that equipment will operate unattended, and that maintenance personnel may not be seasoned mechanics. The requirements for maximum reliability directly relate to those shipboard environmental and service conditions, and they shall be fully considered in the pump design. The aspects of “human engineering” shall also be fully explored and considered in the equipment design to minimize the possibility of failure through improper operation and maintenance, and to preclude personnel safety hazards. In no case shall parts be physically interchangeable or reversible unless such parts are also interchangeable functionally and from considerations of strength.

3.2.2.1 The equipment shall have maximum repair accessibility for ease of examination of wearing parts and for simplicity of disassembly and proper reassembly. Positioning and alinement of parts in assembly shall employ positive means such as shoulder, tongue and groove or other locating techniques whereby correct reassembly is repeatedly assured. In consonance with the concept of ease of maintenance and where not already specified, the pump designer shall consider all of the following features for incorporation in the design and technical documentation wherever such incorporation will significantly contribute to ease of maintenance without compromising performance reliability:

(a) Lifting lugs.
(b) Casing assembly guide pins.
(c) Alinement and positioning dowels.
(d) Jacking screws.
(e) Ease of access to couplings.
(f) Re-makeable piping connections.

(g) Piping out of way of maintenance access.
(h) Ease of packing, mechanical seal, bearing, and wearing ring replacement.
(i) Split casing, bearing housings, etc., (except for submarine service).
(j) Guards for rotating and moving components.
(k) Warning plates to prevent casualties to equipment and personnel.
(1) Provisions for connecting instruments for performance evaluation.
(m) Attached instruments for monitoring performance.
(n) Visibility and access to attached instruments.
(o) Thoroughness of operating instructions.
(p) Thoroughness of preventive maintenance instructions.
(q) Explicit assembly and disassembly instructions.
(r) Exploded views of critical assemblies.
(s) Adequate system diagrams.

3.2.2.2 Each pump shall have a service life of 30 years of which 40 percer shall be actual operation. There shall be no limit on the number of starts during the life of the pump. It shall be assumed that during the life of the pump, parts subject to unavoidable wear and deterioration (with the exception of packing and seals) will be replaced at intervals no shorter than 3 years. The parts subject to wear, deterioration, and normally requiring replacement at 3-year intervals during the service life of the pump (with the exception of packing and seals) shall have a life of 10,000 actual operating hours, and they shall be identified in appropriate drawings and manuals. The requirement set forth above shall not be construed or interpreted as a warranty requirement, nor shall it otherwise affect the manufacturer's warranty.

3.2.2.3 In the design of sea-connected pumps for submarine application, full consideration shall be given to the cyclic nature of the pressure loading. The design shall be in accordance with NAVSEA 0941-LP-041-3010. Justification of design to the command or agency concerned shall be made by experimental stress analysis (see 4.6.7.5).

3.2.3 Shock and vibration.

3.2.3.1 Pumps and drivers, all appurtenances, and controls shall pass a shock test in accordance with MIL-S-901, grade A, as specified in 4.6.7.2.

3.2.3.2 Unless otherwise specified (see 6.2.1), shock mounts (resilient mounts for shock attenuation) shall not be used. When noise attenuation mounts are specified, the pump shall pass the specified shock test on the noise attenuation mounts.

332.3.3 Bolts designed to be stressed in shear shall be installed in holes with a minimum of clearance. Hole diameters shall be not more than 1/32 inch larger than the bolts for sizes up to and including 3/4-inch, and no more than 1/16 inch larger than bolts of greater than 3/4-inch size, Mounting bolts for fastening the equipment shall conform to grade 2 or better of MIL-S-1222.

3.2.3.4 Pumps shall not be damaged or caused to malfunction by either the environmental vibrations or by internally excited vibrations. Units furnished under this specification shall be tested to meet the requirements of MIL-STD-167-1, type I and IX (see 4.6.7.4).

3.2.4 Alinement.

3.2.4.1 The design of all pumps shall be such that alinement will not be disturbed or undue stresses set up in any part by normal vibration or contraction and expansion of piping attached thereto in service.

3.2.4.2 Alinement between separate components of a unit shall be maintained by means of keyways, rabbeted or tongue and groove joints, fitted bolts, or other means. Parts manufactured to the same drawings shall be interchangeable.

3.2.4.3 In no case shall a piece of equipment be rigidly supported from more than one plane.

3.2.5 Noise. The design, construction ", and workmanship of the equipment shall be such that noise levels during operation at the design conditions will meet the airborne noise and structureborne vibration noise requirements as specified (see 6.2.1 and 4.6.4).

3.2.6 Mounting.

3.2.6.1 Class C-1 pump units shall be horizontally or vertically mounted, as specified (see 6.2.1).

3.2.6.2 Class C-2 pump units shall be horizontally mounted.

3.2.6.3 Each horizontal flexible coupled pump and separable driving unit, complete with all appurtenances, shall be mounted on a common bedplate.

3.2.6.4 Bedplates shall be sufficiently rigid to permit handling, shipment, and installation of the units on board ship, to minimize misalinement of the assembled units; and such that normal distortion, weaving or vibration of the supporting structures on board ships cannot cause misalinement between the pumps and driving units.

3.2.6.5 Bearing and seating surfaces of bedplates shall be finish machined.

3.2.6.6 Each component part of an assembled flexible coupled unit supported directly by a bedplate shall be doweled thereto to facilitate reassembly and maintenance of alinement, except that final doweling of the driver shall be performed by the installing activity after final installation. The manufacturer shall furnish a warning plate indicating the above.

3.2.6.7 Vertical pumps shall be base mounted or center of gravity mounted. The base and support bracket shall have provisions for bolting to a foundation. Pumps which are resiliently mounted shall be supported as close to the center of gravity as practical.

3.2.6.8 Bedplates shall be of cast steel or structural steel fabricated by welding.

3.2.6.9 In the event special bulkhead mounting is required, sideplates shall be furnished subject to all conditions specified for bedplates (see 3.2.6.3 through 3.2.6.5 and 3.2.6.7).

3.2.6.10 When motor driven pumps of the close-coupled type are specified, bedplates will not be required, except as otherwise specified (see 6.2.1). Each pump shall be provided with a support for bolting to the foundation to augment the support from the motor frame,

3.2.7 Bearings. Bearings shall be installed in each pump unit for counter acting (a) any unbalanced hydraulic or mechanical thrust in either direction and (b) the fact that rolling, pitching, listing and trim, and the athwartships, for and aft, and the vertical distance from the pump to the ship's rolling and pitching center may introduce loads even though the unit is in hydraulic balance (see 6.2.1). The contractor shall calculate the resulting static and dynamic loads on the bearings and certify that the bearings are suitable for this loadin (see 6.2.2).

3.2.7.1 Radial bearings.

3.2.7.1.1 Radial bearings may be of the hydrodynamic or rolling contact type. If specifically approved by the design review agency (see 6.4) hydro-static bearings may be used.

3.2.7.1.2 Except as otherwise approved by the design review agency, rolling contact bearings shall be of the ball type in accordance with FF-B-171. Roller bearings may be recommended if use of ball bearings is impractical. If approved, roller bearings shall be in accordance with FF-B-185 or FF-B-187. Rolling contact bearings shall be selected to result in a minimum B-10 life of 10,000 hours calculated in accordance with FF-B-171, FF-B-185, or FF-B-187.

3.2.7.1.3 Rolling contact bearings specifically selected for quiet opera-tion in accordance with MIL-B-17931 shall be used for pumps for submarine appli-cation and for surface ships where required to meet special noise requirements.

3.2.7.1.4 Hydrodynamic radial bearings may be of the fixed or self-alining type and shall operate under full-fluid film lubrication for all operating condi-tions, except boundary lubrication will be permitted during pump start-up and shut-down. Where the requirement for full-fluid film operation cannot be met, a hydrostatic bearing may be recommended by the contractor for design review agency approval. The hydrostatic bearing shall operate without metal-to-metal contact over the entire range of the pump characteristic curve.

3.2.7.1.5 Water lubricated hydrodynamic radial bearings shall not be provided with lubrication grooves unless specifically recommended by the contractor and approved by the design review agency. If a hydrodynamic bearing design having axial grooves is recommended by the contractor, positive proof of the direction of radial loading shall be established. The orientation of the bearing shall be such that the effective bearing arc will not be reduced to less than 120 degrees at any operating condition of the pump. Orientation of the bearing shall be maintained by positive means. The effective arc is defined herein as the continuous load-carrying surface which is symmetrical with respect to the load vector. Release for manufacture shall be subject to verification of the applied load direction, by experimental data, and derived from tests of the manufacturer’s own similar designs. Where the method or experimental data are considered inconclusive by the design review agency, the recommendation for a grooved bearing design will be disapproved.

3.2.7.1.6 The hydrodynamic and hydrostatic bearing surface and the journal shall be finished to 32 roughness height rating (RHR) or better.

3.2.7. 1.7 Water lubricated hydrodynamic or hydrostatic bearings may be of the one piece sleeve type. Pumps utilizing water-lubricated bearings shall use one or more of the following means to minimize radial loading on the shaft:

(a) Double volute casing.
(b) Concentric casing.
(c) Diffusers.
(d) Modified concentric casing.

For modified concentric casings, the casing shall be circular over at least 270 degrees of the arc beginning at the cut water and proceeding in the direction of impeller rotation toward the discharge nozzle. For both concentric and modified concentric casings, the ratio of the casing diameter at the cut water to the impeller diameter shall be 1.3 or greater.

3.2.7.2 Thrust bearings.

3.2.7.2.1 Thrust bearing shall be installed in each flexible coupled unit for counteracting the forces resulting from the conditions stated in 3.2.7.

3.2.7.2.1.1 Thrust bearings shall be of the combined radial and thrust rolling contact type in accordance with 3.2.7.1.2.

3.2.7.2.2 For rigidly coupled units, the thrust bearing for the unit shall be in the driver and shall comply with 3.2.7.2.1.1. For rigidly coupled units where the driver is a turbine rated 500 horsepower (hp) or over, the thrust bearing shall be as specified in MIL-T-17523. Thrust bearings of the rolling contact type shall be type 111, 120 or 134 in accordance with FF-B-171.

3.2.7.2.3 When pivoted segmental type thrust bearings are used, the design shall permit renewal or refitting of shoes without removal of shafts.

3.2.7.2.4 For vertical flexible-coupled pumps, thrust bearings shall be installed at the top, external of the pump, between the coupling and stuffing box. For rigidly-coupled pumps, the thrust bearing shall be located in the driver and shall comply with all requirements stated herein.

3.2.7.3 Installation.

3.2.7.3.1 Ball or roller bearings, when used, shall be installed in housings separate from and independent of the stuffing boxes and with adequate protection from gland leakage. In vertical flexible coupled pumps, rolling contact bearings, where used, shall be installed external to the pump between the coupling and gland seal. Means shall be provided to prevent escape of lubricant around the shaft. All baffles, wipers, and related parts shall be readily renewable.

3.2.7.3.2 Bearing brackets for class C-2 pumps shall be either cast integral with the casing, securely bolted to the casing on a machined shoulder, or held in alinement with the casing by at least two heavy dowels and securely bolted thereto. The use of bolts alone for securing brackets is prohibited.

3.2.7 .3.3 Bearing housings shall be cast integral with the bracket or secured thereto in such a manner as to insure alinement. Bearing housing to bracket seats shall be machined such that precision of bearing alinement is insured.

3.2.7.3.4 Bearing lubrication and drain connections shall be located so as to provide a path which will force new grease into the bearing and direct old displaced grease out of the drain. Bearing relubrication shall be performed with the unit secured.

3.2.7.3.5 Hydrodynamic radial bearing shells for oil lubricated bearings of class C-2 pumps shall be split along the axis and so arranged as to permit renewal or refitting without removal of the pump rotor from the casing. They shall be fitted in their housing seat under a light-crush fit and shall have locking-lips or dowels to prevent circumferential rotation. If they do not have a crush-fit? they shall be bolted to prevent actual motion. Shells and their seatings shall be finish machined.

3.2.8 Lubrication.

3.2.8.1 The lubrication of rolling contact bearings shall be in accordance with FF-B-171, FF-B-185, or FF-B-187, as applicable.

3.2.8.1.1 Rolling contact bearing lubrication method shall prevent bearing failure resulting from over-greasing. Bearing relubrication procedures shall be accomplished with the unit secured.

3.2.8.2 Rolling contact bearings having a DN value in excess of 200,000 shall be oil lubricated unless the contractor can demonstrate to the satisfaction of the design review agency that the specific grease lubricated bearing application has been proven in previous Navy shipboard service. Grease lubrication is preferred where DN is less than 200,000.

Where:

D = Diameter of bearing bore in millimeters.
N = Revolutions per minute (r/rein).

3.2.8.3 Where forced feed lubrication is provided for turbine-driven pumps, the lubricating system shall be in accordance with the requirements of the applicable turbine specification (see 3.2.13).

3.2.8.4 Grease lubricants shall be in accordance with DOD-G-24508. Oil lubricants shall be in-accordance with MIL-L-17331, military symbol 2190-TEP. The design shall be such that any qualified grease under DOD-G-24508 or oil under MIL-L-17331, military symbol 2190-TEP, can be used interchangeably with any other qualified product to the same specification. Bearings shall be capable of being relubricated without removing the bearings, and shall not require frequent lubrication if the pump is not operated over an extended period of time. Bearing relubrication procedures shall be accomplished with the unit secured.

3.2.8.5 Thrust bearing housings shall be so designed that the thrust bearing will be adequately lubricated immediately when the shaft starts to turn. This shall be accomplished by properly locating lubricant supply and drain fittings, and by adequate sealing of the bearing housings so that, regardless of the length of time the units are idle, an adequate supply of lubricant will remain in the bearing housings.

3.2.9 Packing and gaskets. Packing and gaskets shall be in accordance with Drawing B-153. Packing shall be of the polytetrafluoroethylene impregnated type in accordance with MIL-P-24377. Gasket compression and tolerances shall not affect bearing bushing or wearing ring fits to an extent that will adversely affect reliability and performance. Spiral wound gaskets shall be used only where use of a sheet gasket or O-ring is impracticable. Internal spiral wound gaskets shall be completely enclosed to prevent the gasket from unwinding and entering the fluid system.

3.2.10 Threaded fasteners. Threaded parts, such as bolts, studs, and nuts, shall conform to FED-STD-H28, FED-STD-H28/2, and MIL-S-1222. The use of tap-bolts or cap-screws is prohibited unless explicitly discussed and justified in a submittal to the design review agency and approved by the design review agency and where the use. of through bolts or studs is impractical. The setting end of the studs shall be a class 3 fit with anaerobic locking compounds in accordance with MIL-S-22473, type AV. The nut end shall be a class 3 fit. The recommendations of the anaerobic locking compound manufacturer regarding the use of a primer shall be adhered to (see 3.6.1.2.3.2). Studs installed using locking anaerobic compound shall be inspected with a procedure proposed by the pump manufacturer and approved by the design review agency. The inspection method shall be shown on the pump drawing.

3.2. 10.1 The length of minimum stud engagement shall be computed as specified in FED-STD-H28.

3.2.10.2 Unless otherwise specified (see 6.2.1), threaded fasteners of normally stocked lengths shall be used. Male threads on threaded fasteners, after being installed and tightened, shall protrude at least one thread beyond the top of the nut or plastic locking element. Excessive protrusion shall be avoided, particularly where necessary clearances, accessibility, and safety are important. Where practical, the number of threads protruding shall not exceed five; however, in no case shall thread protrusion exceed ten threads. Washers shall not be used for the sole purpose of lessening thread protrusion.

3.2.11 Piping root connections. Root connections for attaching pipes shall be in accordance with Drawing B-214.

3.2. 11.1 Pumps shall be fitted with flanged connections conforming to Drawing B-214 for suction and discharge pressure gauges or MS connections in accordance with MS16142, as specified (see 6.2.1).

3.2.11.2 Pressure gauges when provided with the units shall be mounted in accordance with Drawing 810-1385850. Gauges shall be positioned for accessibility of reading and maintenance. Gauges shall be secured on the parent equipment in such a manner as to prevent. vibration, breakage, and disconnection.

3.2.12 Welding and brazing. Welding shall be in accordance with MIL-STD-278. The use of silver brazed joints is prohibited for any joint which could be heated by future weld repair of the casing. Where silver joints are not prohibited, such joints shall be in accordance with NAVSEA 0900-LP-001-7000. The use of silver-brazed joints is prohibited in the fluid boundary for sea water pumps for submarine applications.

3.2.13 Turbines.

3.2.13.1 Turbines for driving pumps shall be in accordance with MIL-T-17523 and as specified (see 6.2.1).

3.2.14 Motors.

3.2.14.1 Unless otherwise specified (see 6.2.1), motors for driving pumps shall have sealed insulation, service A with the characteristics specified in the contract or order, and shall conform to MIL-M-17413 for direct current (de) motors and to MIL-M-17060 for alternating current (at) motors. For surface ships applications, the motors shall be totally enclosed fan cooled. For submarines , see 6.2.1 for complete motor specification.

3.2. 14.2 Motor rotors for use on dual turbine and motor-driven pumps shall be designed and tested for a speed of 25 percent in excess of rated turbine speed.

3.2.14.3 The horsepower (hp) rating of each motor shall be equivalent to at least the maximum brake horsepower (bhp) of the driven pump under any condition from shut-off to free delivery. Head capacity and bhp curve shall demonstrate that motor is non-overloading at any point. The actual motor rating shall be in accordance with the Navy standard motor ratings as indicated in the applicable motor specification (see 3.2.14.1). If the maximum bhp of the pump is less than 2, and if there is a possibility of an unpredictable high frictional load due to improper adjustment of the gland or to some other cause, then the maximum bhp shall be multiplied by a safety factor of 1.5 minus $\frac{\text{(max. bhp)}}{4}$ before selecting the next larger Navy standard rating.

3.2.14.4 Motor insulation shall be in accordance with MIL-E-917 and shall be class B or F as specified (see 6.2.1). Regardless of class of insulation used , motor temperature rise at rated full motor load shall not exceed 70 degrees Celsius (“C) in 50°C ambient as specified for class B insulation in MIL-M-17060.

3.2.15 Controllers. Motor controllers shall be in accordance with MIL-C-2212 for ac and dc and shall have the characteristics as specified (see 6.2.1).

3.2.16 Painting. External unmachined surfaces of ungalvanized ferrous metal parts shall be thoroughly cleaned and coated with one coat of pretreatment conforming to DOD-P-15328, and one coat of zinc chromate primer conforming to TT-P-645 followed by a finish coat of light gray equipment enamel conforming to MIL-E-15090.

3.2.16.1 Painting of external surfaces of nonferrous parts of pumps will not be required.

3.2.17 Identification plates.

3.2. 17.1 Identification plates shall be furnished on each pump and shall be type A or B in accordance with MIL-P-15024 and MIL-P-15024/5, except that identification plates of plastic or aluminum shall not be used.

3.2.17.2 Identification plates shall be secured to equipment with corrosion-resistant metallic screws or rivets.

3.2.17.3 Pump identification plates shall contain data as follows:

(a) Manufacturer's name.
(b) Manufacturer's model or type and size.
(c) Service application.
(d) Manufacturer's serial number.
(e) Salient design characteristics:
    (1) Capacity in gallons per minute (gal/min).
    (2) Total head in pounds per square inch (lb/in^2),
    (3) Speed of shaft in r/rein.
    (4) Brake hp.
    (5) Test pressure (omit for submarine seawater pump).
    (6) Special data vital to the unit:
        a. Suction pressure (omit for submarine seawater pump).
        b. Submergence (omit for submarine seawater pump).
        c. Impeller diameter.
(f) Contract number and item number for multiple unit orders.
(g) National stock number.
(h) Section for Defense Contract Administration Services Management Area (DCASMA) stamp.
(i) NAVSEA technical manual number.
(j) Certification data drawing number.

Identification plates for submarine seawater pumps shall not contain items (e)(5), (e)(6)a, and (e)(6)b.

3.2. 17.4 Each driving unit and each accessory unit shall have an identification plate in accordance with the applicable equipment specification.

3.2.18 Pump pressure regulating governors.

3.2.18.1 Unless otherwise specified in the contract or order (see 6.2.1), one constant pressure regulating governor shall be furnished with each class C-2 turbine-driven pump for fire, or fire and flushing service. Pressure regulating governor shall be in accordance with MIL-G-18916 and of the type and characteristics as specified (see 6.2.1).

3.2. 18.2 Steam pressure drop through pump pressure regulating governors should be considered when rating turbine-driven pumps.

3.2.19 Piping, valves, and threaded items.

3.2.19.1 Valves, flanges, fittings, and bolting for pipe connections shall conform to MIL-STD-438 for submarines and MIL-STD-777 for surface ships and as specified in the contract or order (see 6.2.1). All pump flanges except for welded connections shall have a face circular lay finish as detailed in the applicable general note of MIL-STD-438 for submarines and MIL-STD-777 for surface ships.

3.2.19.2 Tapered pipe threads are acceptable for use in grease fittings located on nonmoving parts. Fittings not covered by MIL-STD-438 and MIL-STD-777 for application when ship connections are not involved shall be submitted for review by the design review agency.

3.2.19.3 Threaded plugs, threaded connections, and threaded closures are prohibited in the pressure boundary of submarine sea water pumps.

3.2.20 Locking devices. Internal threaded fasteners and threaded machine elements shall be secured by locking devices where continuous operation under the condition of shock, vibration, and temperature specified herein depend on maintaining tight connections of parts. All setscrews internal to the pressure boundary of the pump, and all setscrews on internal and external rotating portions of the pump shall be secured by locking devices. Locking devices shall be subject to approval by the design review agency.

3.2.21 Reverse rotation. Motor driven pumps shall withstand reverse rotation for a period of 1 minute at all speeds up to design speed without damage.

3.2.22 Provision for handling. Eyebolts, lugs, holes, and other means shall be provided to permit attachment of lifting gear for lifting the assembled pump, driver, and attached accessories as a complete unit. Means shall be provided for the handling of parts and components weighing 150 pounds and over which cannot be handled manually during unit overhauls and preventive maintenance inspections.

3.2.23 Self-priming pumps. Pump units which are required to be self-priming shall be of a type approved by NAVSEA.

3.2.24 Type of driver. The type of driver shall be as specified (see 6.2.1).

3.3 Detail requirements.

3.3.1 Unless otherwise specified (see 6.2.1), horizontal pumps shall be flexible coupled, and vertical pumps shall be rigid coupled.

3.3.1.1 Class C-1 pumps.

3.3.1.1.1 The design shall be of the single stage, single suction, volute type.

3.3.1 .1.2 Pumps shall have constantly rising head capacity characteristic curves. Pumps with rated capacities of 50 gal/rein or more shall have head capacity characteristic curves such that total head at shutoff is not less than 10 percent above total head at rated capacity.

3.3.1 .1.3 Casing wearing rings shall be fitted in all pumps. For submarine sea water pumps, casing wearing rings shall be located and shaped in such a manner that leakage through wearing ring clearances shall not be allowed to impinge directly on the casing.

3.3.1.1.4 Casing wearing rings shall be secured by means of both axially oriented setscrews, which are equally spaced, and interference fit.

3.3. 1.1.5 Pump casing joints shall be made up using compressed asbestos sheet gaskets. 0-rings may be used to seal casing joints in sea water pumps for submarines and other applications when approved by the design review agency.

3.3.1.2 Class C-2 pumps.

3.3.1.2.1 Pumps shall be capable of parallel operation and shall have constantly rising head capacity characteristic curves. Each pump with a total head gauge pressure of 100 lb/in^2 or more shall have a characteristic curve such that at constant rated speed the total head at shut-off will be not less than 10 percent nor more than 20 percent above total head at rated capacity.

3.3. 1.2.2 The preferred design shall be of the single stage suction volute type. Two stages may be used if necessary to provide an acceptable hydraulic design.

3.3. 1.2.3 Casing wearing rings shall be fitted in all pumps. For pumps with axially split casings, casing wearing rings shall be fitted to the lower-half casing by a double tongue and groove and in the upper-half casing by a single tongue and groove. A single tongue and groove may be used in the upper and lower-half casing provided the radius of the tongue and groove in the lower-half casing is greater than in the upper-half casing to prevent rotation of the casing wearing ring. For submarine sea water pumps, casing wearing rings shall be located and shaped in such a manner that leakage through wearing ring clearances shall not be allowed to impinge directly on the casing.

3.3.1.2.4 Each class C-2 pump with a total head gauge pressure of 100 lb/in^2 or higher shall have a synthetic rubber seal between the casing wearing ring and casing. The seal may be an O–ring or flat face type.

3.3.1 .2.5 Pump casing joints shall be made up using compressed asbestos sheet gaskets. O-rings may be used to seal casing joints in sea water pumps for submarines and other applications when approved by the design review agency.

3.3.2 Performance characteristics.

3.3.2.1 The performance characteristics of the pump shall be as specified (see 6.2.1).

3.3.2.2 Pump suction conditions shall be as specified (see 6.2.1).

303.3 casings.

3.3.3.1 Casings of class C-2 flexible-coupled pumps shall be divided into two parts to permit ready removal of the rotors and replacement of bearings and glands.

3.3.3.2 Casings of close-coupled and rigid-coupled pumps shall be designed to permit ready replacement of wearing parts.

3.3.3.3 Casing thickness shall include an allowance for corrosion and the possibility of core shift. The minimum casing thickness shall be 1/2 inch excluding class C-1 pumps with a rated total head of 115 feet or less. For submarine sea water pumps, areas subject to fluid velocity in excess of 15 feet per second at rated flow shall be readily renewable or shall be protected by replaceable erosion shields.

3.3.3.4 Casings shall be sufficiently rugged to withstand without fracture or appreciable distortion the strains to which they may be subjected. The nozzle loadings to which the pump will be subjected will be calculated by the shipbuilder and forwarded to the pump contractor by the contracting activity (see 6.2.1). Under the combined effect of the nozzle loads and design pressure, no parts of the casing or other pump parts shall exceed yield strength and no rotating clearances shall make contact.

3.3.3.5 Clearance shall be provided around bolt heads and nuts to permit the use of ordinary tools. Ordinary tools are tools which are listed in the Federal Supply Catalog (copies of this catalog may be consulted in the office of the DCASMA).

3.3.3.6 Fitted bolts or dowel pins shall be provided to insure maintenance of alinement in assembly. Dowel pins shall be corrosion-resistant, shall have a threaded end and nut design, and shall be secured against coming adrift under shock loading.

3.3.3.7 Forcing bolts shall be provided for breaking joints.

3.3.3.8 Casings of horizontal and vertical pumps other than submarine sea water pumps shall be fitted with drain and vent connections. Drain connections shall be in accordance with MS16142 and MS18229 and shall permit complete drainage of the pump without disassembly of the pump. For vertical, bottom suction pumps, the pump suction may serve as the drain. Threaded drain connections are prohibited in the pressure boundary of submarine seawater pumps.

3.3.3.9 Gasket compression and tolerances shall not affect bearing, bushing, and wearing ring fits to an extent that will adversely affect reliability and performance.

3.3.3.10 For all pumps, the casings shall be fitted with removable casing wearing rings. The casing wearing rings shall be located and shaped in such a manner that leakage through wearing ring clearances shall not be allowed to impinge directly on the casing.

3.3.3. 10.1 Spare casing wearing rings (see table 11) shall be machined undersize by at least 0.050 inch on the diameter in order to permit finish machining during overhaul installation to mate with machined-down used impellers.

3.3.3.11 Pump casing joints shall be made up using compressed asbestos sheet gaskets, O-rings may be used to seal casing joints in the sea water pumps for submarines. O-rings and gaskets are prohibited from being in contact with highly-alloyed corrosion-resistant steel parts.

3.3.3.12 Venting. Pump casing shall be self-venting or be provided with casing vents. Those portions of the casings which might trap air, but are not vented , when the pump is secured, shall be. rapidly cleared of air by flow during pump operation. Special attention shall be paid to the vent location so that the seal lubrication requirements of 3.3.8.5 are met during pump start-up and operation.

3.3.3.13 For pumps with suction and discharge connections which are prepared for welding to the system piping, the vent connections shall be located on parts of the pump which do not need to be removed for repair or maintenance and shall be configured for welding the system venting piping directly to the pump. If, in order to perform its intended function, the vent connection must be located on a removable part of the pump, then the vent connection shall be flanged for mating with flanges.

3.3.3.14 The bottom of drip pockets shall be tapped for drain connections.

3.3.4 Suction and discharge connections.

3.3.4.1 Unless otherwise specified (see 6.2.1), suction and discharge connections shall be flanged for mating with flanges in accordance with MIL-STD-777 or MIL-STD-438 for the applicable system.

3*3.4.2 Suction and discharge connection of split case pumps shall be on the fixed half of casing except on close-coupled pumps.

3.3.5 Impellers.

3.3.5.1 Unless otherwise specified in the contract or order (see 6.2.1), impellers shall be of the closed type. Outside surfaces of impellers shall be smooth finished.

3.3.5.2 Impellers shall be keyed on the shaft and securely held against lateral movement by locked nuts or other means approved by the design review agency.

3.3.5.3 Impellers shall not be furnished with wearing rings. Impeller hub wearing surfaces shall have material thickness to permit reducing the diameter of the impeller hubs by as much as 0.050 inch to accommodate undersize casing wearing rings to restore design running clearance.

3.3.5.4 Each impeller shall be dynamically balanced in accordance with MIL-STD-167-1.

3.3.5.5 For seawater pumps, O-rings and gaskets are prohibited from being in contact with highly-alloyed corrosion resistant steel parts.

3.3.6 Shafts.

3.3.6.1 Shaft threading, except threading for rolling contact bearing locknuts, shall be counter to the direction of rotation. Shaft threading for rolling contact bearing locknuts may be clockwise or counterclockwise.

3.3.6.2 The shaft (pump or driver), except those driven by ac motors, shall be provided with means to permit the ready and direct use of portable tachometers. When this is impracticable, provision shall be made for the use of a portable tachometer on the shaft of the driver.

3.3.6.3 Shafts shall be fitted with shaft sleeves in way of all wearing surfaces, such as stuffing boxes, bushings, and water lubricated bearings. O-rings shall be installed between the shaft sleeve and shaft.

3.3.6.4 Shaft flingers shall be provided adjacent to the gland for all pumps. The flinger shall be so located that leakage which might occur between the gland shaft sleeve and the shaft, as well as from the gland, is not allowed to reach pump or motor ball bearings. For rigid coupled units, the coupling may serve as the pump flinger provided the coupling is constructed of corrosion-resistant material.

3.3.6.5 Shafts of class C-1 close-coupled pumps shall be of one-piece construction.

3.3.6.6 Shafts of class C-2 pumps, except those driven by ac motors, shall be provided with means to permit the ready use of portable tachometers.

3.3.7 Rotating assembly.

3.3.7.1 Rotors shall be dynamically balanced with all rotating parts connected thereto; for common shaft assemblies, or those using rigid coupling, this requires dynamic balance with the rotating element of the driving unit in place. However, rotating parts may be balanced individually provided that, when assembled, the imbalance shall not exceed the limits specified in MIL-STD-167-1.

3.3.7.2 Where balancing is required as a maintenance procedure to maintain proper vibration or noise performance of the pump and driver unit in service, the pump shall be designed such that balancing may readily be performed by overhaul activity personnel.

3.3.7.3 The pump design shall be such and calculations shall be made to demonstrate that the maximum operating speed of the pump will not be greater than 70 percent of the first critical speed.

3.3.7.4 Impellers, shafts, and other parts of the rotating assembly shall not contain radially oriented setscrews, except setscrews solely used as balancing weights in the balancing ring design required by 3.3.7.5 are acceptable.

3.3.7.5 A balance ring shall be located in the coupling area between the lower motor bearing and the pump stuffing box, allowing sufficient clearance for packing gland adjustment. The balancing ring shall include the features and ounce-inch capacity specified in MIL-E-917 for submarine rotating equipment balance rings.

3.3.8 Stuffing boxes and mechanical shaft seals.

3.3.8.1 Mechanical seals. All pumps shall be provided with mechanical shaft seals. Magnetic type seals shall not be used.

3.3.8.2 Surface ship sea water pumps with total head of 30 lb/in^2 or more shall also be fitted with cyclone separators. Submarine sea water pumps regardless of pressure shall be furnished with cyclone separators. A cyclone separator is required for each stuffing box. The separator shall be integrally mounted on the pump (preferably by means of a bracket on the casing parting flange) and shall be connected to the suction and discharge piping by means of tubing and fittings.

3.3.8.3 Each seal installed on surface ships shall be provided with a solid gland plate designed to house two or more rings of packing for use in the event of a mechanical seal failure. The stuffing box of all pumps installed in submarine service shall be designed to house a minimum of four rings of packing for use in the event of mechanical seal failure. The packing shall. be in accordance with MIL-P-24377. The gland design shall be such that the packing can be installed without removing the mechanical shaft seal. The gland shall also be provided with a flush connection to insure positive liquid pressure is supplied to the seal faces under all operating conditions and that there is adequate circulation of the liquid at the seal faces to minimize deposits of foreign matter in the seal parts.

3.3.8.4 Metal seal internal parts for sea water service pumps (except fire pumps) shall be constructed of nickel-copper alloy in accordance with QQ-N-281 or Ni-Cr-No-Cb alloy in accordance with ASTM B 446, or B 443. For sea water pumps where the mechanical seal is in close proximity to the impeller, the mechanical seal internal parts shall be made of Ni-Cr-Mo-Cb alloy in accordance with ASTM B 446, or B 443. Fire pump mechanical seal body and internals, except springs, shall be made of titanium in accordance with ASTM B 367. Metal seal internal parts for fresh water service pumps shall be constructed of 304 or 316 corrosion resisting steel or nickel–copper alloy in accordance with QQ-N-281 or highly alloyed corrosion resisting steel in accordance with ASTM A 744, grade CN-7M or CN-7MS or Ni-Cr-Mo-Cb alloy in accordance with ASTM B 446 or B 443. Mechanical seal springs for all pumps shall be made from Ni-Cr-Mo-Cb alloy in accordance with ASTM B 446 or B 443. The mechanical shaft seal for both fresh and sea water service shall have a solid tungsten carbide or silicon carbide against carbon sealing surface.

3.3.8.5 On sea water pumps only, the mechanical seal O-ring and other elastomers shall not be mounted or come in contact with the impeller.

3.3.8.6 Cyclone separators shall be constructed of nickel-copper alloy in accordance with QQ-N-281. Fittings for abrasive separators and pump casings shall be straight thread type adapter with O–ring seals and shall be constructed of nickel-copper alloy. Tubing shall be copper-nickel (70-30) in accordance with MIL-T-16420. Multiple springs for sea water service pumps shall be constructed of Ni-Cr-Mo-Cb alloy in accordance with ASTM B 446 or B 443.

3.3.8.7 Stuffing box glands shall be set up by nuts threaded on studs secured in the casings. The emergency packing gland shall be set up by nuts threaded on studs. Space shall be provided between bearing and stuffing boxes to permit easy examination of mechanical seals and bearings. Mechanical shaft

seals shall be positioned on the shaft by means of stud or step sleeves on close coupled pumps and step sleeves on flexible coupled pumps. Mechanical shaft seals shall not be positioned by use of set screws. Pump certification data shall contain certification by the seal manufacturer that there will be adequate circulation of liquid and adequate lubrication at the seal faces when the seal is installed as shown on the sectional assembly drawing.

3.3.8.8 Stuffing boxes of class C-2 pumps shall be cast integral with the casing.

3.3.8.9 Pumps for submarine application shall be provided with pressure breakdown device. The pressure breakdown device shall be located in way of a shaft sleeve and not in way of the impeller. The device shall limit the leakage to 5 gal/rein in the event of failure of the mechanical seal, under conditions of maximum suction pressure specified.

3.3.8.9.1 Pumps shall be configured so that normal gland leakage, whether from mechanical seal or when operating under emergency packing, shall be collected and piped to waste. The collection area shall be tapped for drain connections so that the leakage can be drained away from the pump casing foundation, bearing housings, or driving units. With the pump running or shut down, the collection area shall collect and drain all gland leakage, up to the greater of either (a) 1 quart per minute or, (b) three times the minimum allowable leakage rate recommended by the contractor and approved by the design review agency for normal operation under packing.

3.3.9 Coupling.

3.3.9.1 For horizontal or vertical four-bearing units, an all-metal flexible coupling shall be installed between the pumps and driving units. Flexible couplings for pumps for gasoline service or other explosive liquids shall be non-sparking as specified (see 6.2.1). Flexible couplings shall be in accordance with type II, class 2 of MIL-C-23233.

3.3.9.2 Flexible coupling pump hubs shall be keyed to the shafts and secured by lock nuts. For pump shafts 1-1/2 inches in diameter and larger, the hubs shall be fitted on a taper with keys parallel to the taper.

3.3.9.3 Rigid couplings shall have fitted bolts and the coupling flanges shall be marked at assembly to insure proper reassembly after overhaul of the unit.

3.3.9.4 Horizontal flexibly coupled units with bedplates shall have coupling guards provided. Guards shall permit ready access to the coupling for lubrication and examination.

3.3.10 Material. The materials of the pump shall conform to the materials specified in table I. However, this specification is not intended to be restrictive provided proposed alternative materials will give equal or better service than the material specified. Proposed alternative materials shall be subject to approval by the design review agency. Components of the pump for which the specific materials are not specified shall be materials best suited for the intended service. Materials which can be sensitized and are subjected to heat treatment in the sensitization range during fabrication shall be capable of

passing the intergranular corrosion tests of the base material specifications. particular attention shall be given to avoiding sensitization of materials during hard facing, stress-relieving, or repair welding. Use of cadmium-plated parts and fasteners, including washers, is prohibited.

TABLE I. Materials.

Application 1/2/11/12/	Material	Specification	ASTM publication
Casings and diffusers, salt water service Surface ships	Copper-nickel (70-30)	MIL-C-20159, UNS C96400	B 369, UNS C96400
Submarines	Wrought copper-nickel (70-30)	MIL-C-15726 (hot forged) 19/	-------
	Copper-nickel (70-30) permitted only for diffusers not contributing to pressure boundary strength	MIL-C-20159, UNS C96400	B 369, UNS C96400
Casings and diffusers, fire pump service 18/ (surface ships)	Titanium	-------	B 367, grade C-2
Casings and diffusers (fresh water service) 6/,14/	Copper-nickel (70-30)	MIL-C-20159, UNS C96400	B 369, UNS C96400
	12 percent chrome cast steel	MIL-S-16993	A 487, CA-6NM or CA-15
	Highly-alloyed corrosion resisting steel 3/	-------	A 744, CN-7M or CN-7MS
Casing bolts 4/,5/,7/, salt water service	Nickel-copper alloy	QQ-N-281, class A	B 164, class A
	Ni-Cu-Al alloy	QQ-N-286	-------
Impellers 6/,14/,15/, salt water service	Highly-alloyed corrosion-resisting steel	-------	A 744, CN-7M or CN-7MS
Impellers 6/, 8/, 9/, fresh water service	Nickel-copper alloy	QQ-N-288, composition E	-------
	12 percent chrome cast steel	MIL-S-16993	A 487, CA-6NM or CA-15
	Highly-alloyed corrosion-resisting steel	-------	A 744, CN-7M or CN-7MS
Casing wearing rings, 14/, 15/, salt water service	Ni-Cu-Mo-Cb alloy	-------	B 446, UNS N06625
	Nickel-copper alloy	QQ-N-288, composition B or D	-------

See footnotes at end of table.

TABLE I. Materials. - Continued

Application 1/2/11/12/	Material	Specification	ASTM publication
Casing wearing rings, fresh water service 14/, 15/	12 percent chrome corrosion-resisting steel	QQ-S-763, class 410	A 276, type 410
		-------	A 582, type 416
	Nickel-copper alloy	QQ-N-288, composition B or D	-------
	Gun metal	QQ-C-390, alloy C90300	B 584, alloy 903 or 905
	Bearing bronze	QQ-C-390	-------
		QQ-T-390, alloy 910 or 934	-------
	Valve bronze	QQ-C-390, alloy C92200	B 584, alloy 922 or B 61
Shaft 7/ salt water service	Nickel-copper alloy, rolled	QQ-N-281, class A	B 164, class A or B
	Ni-Cu-Al alloy	QQ-N-286	-------
Shaft 7/ fresh water service	Ni-Cu-Al alloy	QQ-N-286	-------
	Nickel-copper alloy rolled	QQ-N-281, class A	B 164, class A or B
	12 percent chrome corrosion-resisting steel	QQ-S-763, class 410	A 276, type 410
Shaft sleeves 7/, 8/ 9/, 14/ salt water service	Ni-Cu-Al alloy, minimum hardness 250 Bhn	QQ-N-286	-------
	Ni-Cu-Mo-Cb alloy	-------	B 446, UNS N06625
Shaft sleeves 7/, 9/ fresh water service	Ni-Cu-Al alloy, minimum hardness 250 Bhn	QQ-N-286	-------
	12 percent chrome corrosion-resisting steel	QQ-S-763, class 410	A 276, type 410
Bearing brackets and caps, sea water service	Gun metal	QQ-C-390, alloy C90300	B 584, alloy 903 or 905
	Valve bronze	QQ-C-390, alloy C92200	B 584, alloy 922 or B 61
	Copper-nickel (70-30)	MIL-C-20159, C96400	-------
	Aluminum-bronze alloy	QQ-C-390, alloy C95300	B 148, alloy 953
	Highly-alloyed corrosion-resisting steel	-------	A 744, grade CN-7M or CN-7MS

See footnotes at end of table.

TABLE I. Materials. - Continued

Application 1/2/11/12/	Material	Specification	ASTM publication
Bearing shells for oil lubricated sleeve bearing	Gun metal, lined with anti-friction metal	Bearing shell QQ-C-390, alloy C39000	B 584, alloy 903
		Liner QQ-C-390, alloy C91000 or C93400 and QQ-T-390	-------
Bearing, internal water lubricated 10/	Bearing bronze	QQ-C-390, alloy C91000, C93200, C93400 or C94300 and QQ-T-390	-------
Journal sleeves	Ni-Cu-Al alloy, min. hardness 265 Bhn	QQ-N-286	-------
Glands and throat 14/ bushing, sea water pumps	Copper-nickel (70-30)	MIL-C-20159, C96400 or C96200	-------
	Nickel-copper alloy	QQ-N-288	-------
	Highly-alloyed corrosion-resisting steel	-------	A 744, grade CN-7M or CN-7MS
Mounting brackets for close coupled pumps	Gun metal	QQ-C-390, alloy C90300	B 584, alloy 903 or 905
	Valve bronze	QQ-C-390, alloy C92200	B 584, alloy 922 or B 61
	Copper-nickel (70-30)	MIL-C-20159, type C96400 or C96200	-------
	Cast steel 16/	MIL-S-15083	-------
	Structural steel 16/	-------	-------
Casing bolts 4/,5/, 7/ fresh water service	Nickel-copper alloy	QQ-N-281	B 164, class A or B
	Ni-Cu-Al alloy	QQ-N-286	-------
Bearing brackets and caps, fresh water service	Gun metal	QQ-C-390, alloy C90300	B 584, alloy 903 or 905
	Valve bronze	QQ-C-390, alloy C92200	B 584, alloy 922 or B 61
	Copper-nickel alloy	MIL-C-20159, C96400 or C96200	-------
	Nickel-copper alloy	QQ-N-288	-------
	Highly-alloyed corrosion-resisting steel	-------	A 744, grade CN-7M or CN-7MS
	Steel	-------	A 487, CA-6NM or CA-15

See footnotes at end of table.

TABLE I. Materials. - Continued

Application 1/2/11/12/	Material	Specification	ASTM publication
Glands and throat bushings, fresh water service	Gun metal	QQ-C-390, alloy C90300	B 584, alloy 903 or 905
	Valve bronze	QQ-C-390, alloy C92200	B 584, alloy 922 or B 61
	Nickel-copper alloy	QQ-N-288	-------
	Copper-nickel alloy	MIL-C-20159, C96400 or C96200	-------
	Highly-alloyed corrosion-resisting steel	-------	A 744, grade CN-7M or CN-7MS
	Steel	-------	A 487, CA-6NM or CA-15
Studs, bolts, nuts and washers 4/, 5/, 7/ fresh water service	Nickel-copper alloy	QQ-N-281	B 164, class A or B
	Ni-Cu-Al alloy	QQ-N-286	-------
Shaft or impeller nuts impeller washers, and impeller keys 7/ fresh water service	Nickel-copper alloy	QQ-N-281	B 164, class A or B
	Ni-Cu-Al alloy	QQ-N-286	-------
	Steel, corrosion-resisting	MIL-S-1222, grade 304 or 316	-------
Studs, bolts, nuts, washers and petcocks, sea water service 4/, 5/, 7/, 17/	Nickel-copper alloy 5/	QQ-N-281	B 164, class A or B
	Ni-Cu-Al alloy	QQ-N-286	-------
Shaft or impeller nuts impeller washers, and impeller keys 7/ sea water service	Nickel-copper alloy	QQ-N-281	B 164, class A or B
	Ni-Cu-Al alloy	QQ-N-286	-------
Bedplates	Cast steel	MIL-S-15083	-------
	Structural steel	-------	-------
Cyclone separators 13/	Nickel-copper alloy	QQ-N-281 or 288	-------
Tubing	Copper-nickel alloy	MIL-T-16420 (70-30) class 700	-------

See footnotes at end of table.

TABLE I. Materials. - Continued

Application 1/2/11/12/	Material	Specification	ASTM publication
Fittings 17/ silver brazing O-ring face seal type	Nickel-copper alloy	QQ-N-281, class A	B 164, class A or B
	Copper-nickel alloy (70-30)	MIL-C-15726 (70-30)	-------
Mechanical seal springs for sea water service	Ni-Cr-Mo-Cb alloy	-------	B 446, UNS N06625

1/ Subassembly parts which are used in a major pump part listed in table I and which perform the same or similar functions as the major part (for example, casing drain plug) shall be of a material specified for the major part,

2/ Detail drawings and lists of q aterial shall reference the specification followed in each case (preferably in the order specified in 3.6.2.1) and shall include the class, type, or grade of material used in each case, as applicable. ASTM materials shall not be used for submarine submergence boundary parts.

3/ Post weld heat treatment is required for repairs to areas in which excavation depth of 20 percent of wall thickness, or 1 inch, whichever is smaller is realized, or when total cavity area exceeds 2 square inches. Post weld heat treatment is not required for other repairs except by agreement between the manufacturer and the purchaser.

4/ The design of bolts, studs, and nuts shall be in accordance with MIL-S-1222, in addition to the material specification specified in table I. Nickel-copper-aluminum alloy bar stock used for threaded fasteners shall be as specified in MIL-S-1222.

5/ Nickel-copper alloy shall not be used for both male and female threaded members in the same assembly. If bolts and studs in accordance with QQ-N-281, class A, are used, they shall be hot finished for submarine sea water application. Any nickel-copper bolts and studs made of cold drawn, stress-relieved material for use in submarine pump parts shall be in accordance with MIL-N-24106, class C in lieu of QQ-N-281.

6/ A certificate of compliance with ASTM A 744 shall be provided. In addition, certification of the chemical test results for each heat of material and the specific heat treatment (including temperature and holding time) to which each casting was subjected shall be provided. The time between removing the stainless steel part from the furnace and quenching shall be minimized. This certification shall list both chemical test result values and the corresponding acceptance criteria value specified in ASTM A 744. Repair welding shall be accompanied by post-weld heat treatment in accordance with ASTM A 744 (see 6.2.2).

7/ All nickel-copper-aluminum alloy parts shall be annealed prior to age-hardening except parts for which a hardness greater than 265 Bhn is required.

8/ For submarine sea water pumps, sleeves which are a seat for O-rings where movement occurs, e.g., under mechanical seals which are spring loaded, shall be nickel-copper alloy that is weld clad with Ni-Cr-Mo-Cb alloy. The area to be weld clad shall be minimized. Cladding shall extend a minimum of 3/16 inch deep in the final machined condition. Deposit shall

be made by a minimum of two passes. The filler weld material shall be as follows: Covered electrode in accordance with MIL-E-22200/3 (MIL-1N12), or bare wire in accordance with MIL-E-21562 (MIL-EN625). Machining into the first (lower) layer for the final surface shall not be permitted. The final machined surface of the cladding shall be PT inspected. The acceptance standard shall be class I of NAVSEA 0900-LP-003-8000. The surrounding areas shall be inspected in accordance with MIL-STD-278.

9/ Sleeves that are subject to wear or that establish a critical clearance (that is, less than 40 roils radial clearance) shall be made of nickel-copper-aluminum alloy and shall meet the 265 Bhn specified in the table. Sleeves for which footnote 8 requires weld cladding shall be made of nickel-copper alloy. Other sleeves shall be made of either: (a) nickel-copper-aluminum alloy meeting the annealing requirement of footnote 7 rather than the above hardness requirement or, (b) nickel-copper alloy.

10/ Special high lead bronze or other suitable bearing materials may be used subject to review by the design agency. Bearing metal, alloy B-10, is an acceptable alternative material.

11/ When the mechanical properties of the material used in the fabrication of a part are altered by metal working processes or heat treatment, sample material from each lot of material, as defined in the material specification, shall be subjected to tensile tests in the final heat treated condition for the part. As a minimum, tensile tests shall determine ultimate strength, yield strength, percent reduction in area, percent elongation and hardness. The tensile tests shall be conducted on test samples machined from the heat treated material or from a piece of parent stock which had been heat treated in the same batch in the lot processed at the same time. The tensile test requirements and acceptance criteria for mechanical properties shall be included on the part drawing. Acceptance criteria for the mechanical properties shall be in accordance with the material specification or as approved by the design review agency. In no case shall ductility of less than 10 percent elongation in 2 inches be allowed.

12/ Where nickel-aluminum-bronze is used, it shall be in accordance with alloy 632M of QQ-C-465 and its amendment.

13/ Cyclone separator parts exposed to water velocities greater than 15 feet per second shall be made of nickel-copper alloy. Other cyclone separator parts shall be 70-30 copper-nickel except: (a) parts such as fittings, not readily available in 70-30 copper-nickel, may be made of nickel-copper alloy and (b) parts that would be unacceptably galvanically attacked if made of 70-30 copper-nickel shall be made of nickel-copper alloy.

14/ These materials shall be furnished for all pumps furnished with corrosion-resisting steel (ASTM A 744, grade CN-7M or CN-7MS) casings:

Casing, impeller, and throat bushing	Highly-alloyed corrosion resisting steel	ASTM A 744, grade CN-7M or CN-7MS
Casing wearing ring	Ni-Cr-Mo-Cb alloy	ASTM B 446, UNS N06625
Shaft sleeves	Ni-Cr-Mo-Cb alloy	ASTM B 446, UNS N06625

15/ A wearing ring and its opposing surface shall be of dissimilar material or shall have a difference in hardness of at least 50 Bhn.

16/ For vertical close-coupled pumps, where the entire weight Of the assembled unit is supported by the mounting bracket, steel may be used for the material of the bracket provided it does not form a part of the pump casing and adequate provision is made for draining all pockets.

17/ Mechanical flareless (bite), compression or flared type fittings are not permitted.
18/ These materials shall be furnished for fire pumps for the parts indicated:

Casing and throat bushing	Titanium	ASTM B 367, grade C-2
Impeller	Titanium	ASTM B 367, grade C-5
Casing wearing ring	Titanium	ASTM B 367, grade C-2
Shaft sleeves	Titanium	ASTM B 367, grade C-5
Shaft	Ni-Cu-Mo-Cb alloy	ASTM B 446, UNS N06625
Studs	Titanium	ASTM B 367, grade C-5
Stud nuts	Titanium	ASTM B 367, grade C-2
Impeller nut and washer	Titanium	ASTM B 367, grade C-2

19/ Yield strength at 0.5 percent extension under 18,000 lb/in^2 minimum, 48,000 lb/in^2 maximum.

3.3.10.1 Recovered materials. Unless otherwise specified herein, all equipment, material, and articles incorporated in the products covered by this specification shall be new and may be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term “recovered materials” means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification unless otherwise specifically specified.

3.3.11 Pump pressure regulating governors.

3.3.11.1 Unless otherwise specified (see 6.2.1), one constant pressure regulating governor in accordance with MIL-G18916 shall be furnished with each class C-2 turbine-driven pump for fire, or fire and flushing service.

3.3.11.2 Steam pressure drop through pump pressure regulating governors should be considered when rating turbine-driven pumps.

3.3.12 Part interchangeability. All parts for pumps manufactured to the same drawings shall be interchangeable.

3.4 Tools. Tools which are available in the Federal Supply Catalog, such as common wrenches and standard pullers and extractors, will not be required. Standard complete or limited sets of pullers or extractors or pares of puller sets in accordance with GGG-P-781 or GGG-E-950 shall be identified as to type and use in notes on the outline or sectional assembly drawings. Special tools shall be detailed and included in the list of material. Special tools required for the maintenance and repair of the pump units shall be furnished. The number of sets of special tools of the pump units shall be as specified (see 6.2.1). Special wrenches shall be of forged steel with hardened jaws. Special tools are defined as those tools not listed in the Federal Supply Catalog (copies of the catalog may be consulted in the office of the DCASMA).

3.5 Technical data. The contractor shall prepare the following technical data in accordance with the data ordering documents included in the contract or order (see 6.2.2) and as specified in 3.6 through 3.10.2.

3.6 Drawings. Unless otherwise specified (see 6.2.1), the contractor shall prepare drawings and technical manuals in accordance with the data ordering document included in the contract or order (see 6.2.2) and the unique features specified in 3.6.1 through 3.6.4 shall be included.

3.6.1 Drawing content.

3.6.1.1 General requirements.

3.6.1.1.1 "Manufacturer's use only*' notes. Information intended for manufacturer's use only shall be–so designated. Conversely, on a commercial drawing with wide usage it is permissible to designate portions thereon, "For Navy use only.'*

3.6.1.1.2 Dimensional tolerance. Unless otherwise indicated by note, legend, or key all tolerances shown on a drawing shall be complied with during both manufacture and maintenance repair.

3.6.1.2 Design drawings. Design drawings shall consist of the drawings described in 3.6.1.2,1 through 3.6.1.2.4.

3.6.1.2.1 Sectional assembly drawings. Sectional assembly drawings shall include a sectional assembly with references to the list of material for identification of individual parts. All running clearances shall be shown and shall be dimensioned and labeled as diametral clearances. (Diametral clearance equals the difference between the diameters of mating parts.) This may necessitate some side or partial view in order to show parts not otherwise shown in the main section view. Tightening torques with tolerances and thread lubrication requirements for threaded fasteners shall be shown on the assembly drawing.

3.6.1 .2.2 List of material. The list of material shall include every part required in the pump assembly, including those parts not required to be detailed. The list of material shall include an indication of each part required by this specification to be furnished as an on board repair part (this is not a repair parts list). The list of material shall include the manufacturer's drawing number and service part number for all parts for which detail drawings are required (see 3.6.1.2.3) as well as quantity required, material type, and material specification for all parts. Parts shall be named to indicate the function they serve. Parts for which detail drawings are not required shall be identified as to dimensions. The list of material may be shown on the sectional assembly drawing.

3.6.1.2.3 Detail drawings. Detail drawings shall be furnished of all parts and sub-assemblies necessary for evaluation of the equipment, and of all parts necessary for maintenance and overhaul of the pumps. Details of these parts shall be so complete as to permit emergency manufacture by a Naval shipyard without assistance from the original manufacturer. Details of pump casing shall be furnished. However, for all cast parts that carry substantial loads under shock, the detail drawings shall specify minimum cross-sectional areas (whichever is more appropriate). Sub-assemblies whose parts cannot be acquired or serviced individually, shall be shown as a single part and so indicated. Multi-detail drawings are preferred, but monodetail drawings may be used.

3.6.1 .2.3.1 Impeller machining and inspection drawing. Detail drawings shall explicitly require that each impeller, including spare and replacement impellers, be dynamically balanced to less than the maximum ounce-inch residual imbalance allowed by MIL-STD-167-1 (type II) for the impeller's weight and rotational speed. For submarine pumps, the impeller detail drawing shall: (a) show the dimensions and shape of the discharge vane tip, including any under-filing or over-filing details, (b) specify sufficient dimensions and tolerance, to be recommended and justified by the manufacturer, to prevent significant impeller–to-impeller variation in required net positive suction head due to manufacturing variations including casting variations. Significant variation is defined as that which would be large enough to cause a spare or replacement impeller to not pass the net positive suction head test of 4.6.3(b) if such impeller were to be tested and (c) explicitly require that each impeller, including spare and replacement impellers, be inspected and comply with the above dimensions and tolerances.

3.6.1 .2.3.2 Drawings showing the application of studs requiring the use of a locking resin shall have a notation requiring: (a) manufacturer's recommendation regarding the use of primer, (b) manufacturer's recommended primer, and (c) the minimum and maximum waiting times associated with the use of the primer and resin. The. notation shall require strict adherence to these requirements.

3.6. 1.2.3.3 Drawings that include springs, such as for some mechanical seals and labyrinth seals, shall:

(a) State the number of coils, the coil diameter, the wire diameter, the material, the free length, the solid length, the nominal working length, the working length force and the plus and minus tolerance on that force.
(b) Include a requirement that quality control testing be done on production springs to ensure the springs return to their original length after being fully compressed and to ensure the force at working length is within tolerance. The drawing shall identify the sampling plan and the acceptance criteria.

3.6.1 .2.4 Outline drawings and certification data.

3.6.1 .2.4.1 Outline drawings and certification data shall be in the form of supplemental drawings to all sectional assemblies and detail. Separate outline drawings, drawing lists, and certification data shall be furnished under each contract or order unless the complete equipments covered by the outline drawing and the referenced drawings are in fact identical in all respects.

3.6.1 .2.4.2 The outline drawings in addition to the certification data required by DOD-D-1000 shall contain the following:

(a) Dimensional outline assembly drawing of the pump with its prime mover, bedplate and attached auxiliaries.
(b) Complete performance data of pump, prime mover, and attached auxiliaries, if applicable.
(c) Complete equipment performance curves, based on actual tests (the original submission may show design performance curves vice test curves). The serial number of the unit whose test results are shown shall be written on the curve, unless the

curve is predicted, in which case "predicted" shall be written The actual test data shall be that of the first performance tested unit which 4.6.3 requires be used as the head repeatability acceptance criteria basis for fellow units.

(d) Weights of major sub-assemblies over 50 pounds, e.g., rotor, upper half-casing, impeller and the weight of the complete unit including driver, dry and in operating condition.

(e) Shipbuilder's connections showing size, type and dimensions of flanges.

(f) Center of gravity of the pump component and of the complete assembly.

(g) Radii of gyration of complete assembly about each of the three principal axes.

(h) Identification of system in which installed.

(i) Critical speed.

(j) Maximum thrust loads.

(k) Endurance tests, high-impact shock tests and nondestructive tes (if performed) and the design review agency letters approving these reports or extension of any tests.

(l) Overall dimensions of the complete unit including locating of a fittings and connections, the space required for removal and replacement of parts for maintenance, and mounting information

(m) The certification by the mechanical seal manufacturer required 3.3.8.7.

(n) The following dimensions, which are related to interchangeabili of pumps and drivers as a unit. The drawing shall include a tolerance for each of these dimensions. Each dimension shall also be shown with the same value and tolerance on the detail drawing for the part:

(1) For support feet or other support connections between the ship and the pump and driver unit: The X, Y, and Z dimen sions, or three dimensions in another suitable coordinate system, locating the feet and any bolt holes in the feet.

(2) For all piping connections: The X, Y, and Z dimensions, o three dimensions in another suitable coordinate system, locating the point of intersection between the axis of the connection and the face of connection, such as a flange fa The dimensions shall be referenced to the same surfaces to which the support feet are referenced, either directly or via other tolerance dimensions.

(3) For all flanged piping connections:

a. The diameter of the bolt circle and the concentricity o that circle relative to the axis of the connection.

b. The angular location of each bolt hole with respect to some reference line shown on the drawing, Even if the angle to the reference line is O to 90 degrees, that number shall be stated with a tolerance. It is acceptable to locate only one bolt hole relative to th reference line and to state the remaining holes are equally spaced as long as a tolerance is specified on the equalness of the spacing.

c. In lieu of a. and b. above, an X-Y coordinate system may be used to locate the bolt holes.
d. The diameter of the bolt holes.
e. The tolerance on perpendicularity between the flange face and the axis of the connection.
f. The inner diameter of the suction and discharge nozzle at the flange face and the concentricity of that diameter relative to the axis of the connection.

3.6.1 .2.5 On board repair parts list. A list of on board repair parts shall accompany the outline drawings. This list shall be prepared on provisioning list forms in accordance with MIL-P-15137. This list shall be furnished whether or not the parts are required in the pump contract or order, This list shall not be modified to indicate parts or quantities of parts furnished under supplementary or separate contracts or orders. The list is intended as a record of recommendations of the manufacturer and purchaser at the time of equipment drawing approval. The list of on board repair parts actually purchased shall be prepared as required by MIL-P-15137 (see 6.5.2).

3.6. 1.2.6 Review. Design drawings shall be submitted to the design review agency for approval (see 6.2.1).

3.6.1.3 Basic design drawings. Basic design drawings covering pumps under this specification are intended for submittal to the design review agency prior to and independent of invitations for bids. As such these are different from design drawings as described in 3.6.1.2. Each drawing may be a range of sizes of pumps so long as they are of the same basic design.

3.6.1 .3.1 Contents of basic design drawings. These drawings shall consist of small scale (not necessarily to scale) plan and elevation views showing overall dimensions. If the plans cover a family of pump sizes all of the same design, the dimensions may be tabulated. The range of capacities, pressure and speeds shall be shown. The main part of this drawing shall be an undimensioned sectional assembly with complete list of material which shall include every part required in the pump assembly. If materials of some parts may change with various pump characteristics or with differing fluids to be pumped, a table shall be included to show these variations. Alternate subassembly arrangements of different parts may be included as desired.

3.6.1 .3.2 Detail drawings of individual parts are not required in connection with basic design drawings, but may be included if desired by the manufacturer for clarification, or to obtain advance approval of the design review agency.

3.6.1.4 On one of the delivered design drawings described in 3.6.1.2, the mechanical seal contractor shall identify and certify the following:

(a) Whether or not there is an adhesive or other setting compound factory-installed on the elastomer bellows or O-ring that seals between the mechanical seal and the impeller hub or shaft sleeve.
(b) The description of any such adhesive or setting compound.

(c) Any time limit associated with that compound when installed on a mechanical seal in stowage and any time limit between initial wetting of that compound and the final positioning of the mechanical seal in the pump.

(d) The type and amount of lubricant, if any, to be used to facilitate axial positioning of the mechanical seal in the pump during seal installation. The lubricant shall be silicone compound in accordance with MIL-S-8660, and all elastomers , O-rings, or seals shall be compatible with the silicone compound. The drawing shall require the manufacturer to use that lubricant during pump assembly.

3.6.2 Material identification.

3.6.2.1 Preferred material reference. Where materials of identical or equal quality can be identified by more than one specification or standard, the drawings need reference only one such specification or standard. In selecting the specification or standard to be referenced the following is the order of preference:

(a) Federal specification or standard.
(b) Military specification or standard.
(c) Industry and technical society specification or standard.
(d) Manufacturer’s specification or standard.

3.6.2.2 Material substitutions. Where materials other than covered by (a), (b), and (c) of 3.6.2.1 are referenced and approved by the design review agency, the drawings shall show the complete chemical and physical properties of the approved material. In addition, the drawings shall identify the material in terms of the nearest Federal or Military specification, in order to enable Naval repair facilities to make emergency repairs as necessary from Navy material stocks.

3.6.3 Drawing identification. Prime contractors who purchase items from subcontractors shall use the subcontractor’s drawing number as the single reference identification in all cases where the parts delineated thereon are produced by the subcontractor. The prime contractor shall not add his drawing number to the drawing except as an unofficial reference outside the drawing border or margin.

3.6.3.1 Prime contractors who purchase semi-finished parts from subcontractors for final production, test or selection phases in their own shops, have the option of using as the single drawing identification either their own title block and drawing number or the title block and drawing number of the subcontractor, but not both.

3.6.4 Drawings of drivers and associated equipment shall be in accordance with the specifications covering those equipments.

3.7 Technical manuals.

3.7.1 Unless otherwise specified in the contract or order (see 6.2.1), technical manuals shall be prepared in accordance with type I of MIL-M-15071. The modifications and clarifications specified in 3.7.2 through 3.7.5 shall apply. A separate manual shall be furnished for each different pump unit except in special cases when manuals covering more than one pump may be approved. Preliminary manuals shall be submitted to the design review agency for approval and shall include all proposed sections complete. Unless otherwise specified in the contract or order (see 6.2.1), manuals shall include pump, driver, controls and all appurtenances and all applicable drawings. Performance curves for final manuals may be furnished as insert pages after delivery of hardware.

3.7.2 Manuals covering pumps driven by turbines or engines shall include drawings and full operation and maintenance instructions covering the turbines, engines, governors and any other applicable accessories.

3.7.3 Manuals covering pumps driven by conventional electric motors with conventional controllers need not include operation and maintenance instructions covering the motors and controllers. They shall, however, include master drawings and certification data covering the motors and controllers. Complete operation and maintenance instructions covering electrical equipment shall be included when specifically required (see 6.2.1).

3.7.4 Each manual shall include not less than the following illustrations covering the pump and driver:

(a) Sectional assembly drawing.
(b) Outline drawing.
(c) Complete list of material corresponding to the sectional assembly drawing.
(d) Certification data.
(e) A minimum of two photographs of the complete unit, pump and driver, taken 180 degrees apart on a horizontal plane. Where several sizes of identical design units are being supplied, photographs of one design unit only need be supplied.

3.7.5 The alinement procedure instructions in the manual shall describe in complete detail the means by which the required alinement clearance at sleeve bearings and wearing rings is to be established. The manual shall prescribe the maximum permissible eccentricities which can be tolerated in the aforementioned areas with the pump in the assembled condition. Exceptions to any part of the aforementioned requirements in any specific area may be had only by providing for design review agency approval a written technical justification for the said exception. The manual shall specify the maximum allowable clearance for wearing rings and sleeve bearings before replacement of the parts. In addition, the manuals shall contain:

(a) Lubrication schedule including lubricant and procedure.
(b) A statement directing the user of the technical manual to see the Centrifugal Pump Chapter of the Naval Ships Technical Manual for the criteria for replacing mechanical seals due to leakage. The pump technical manual shall not redundantly specify the same or different criteria.
(c) Torque values and sequence required to maintain proper seal and alinement.
(d) In-field dynamic balancing instructions.
(e) The mechanical seal installation procedure including complete information regarding adhesive, the adhesive time limits and lubricant (see 3.6.1.4), and any additional guidance needed to avoid causing an excessive preload on the mechanical seal.

3.7.6 The quantity and distribution of manuals shall be as specified (see 6.2.1).

3.8 Design data and calculations. Design data and calculations and design records shall be submitted for approval of the design review agency for each pump class, design and size, Submittal shall be not later than submittal of design drawings for approval. It is intended that the design data and calculations shall be in sufficient detail to describe the design, physical appearance and internal assembly to permit release for manufacture. References listing the author, publication, volume or text for all assumptions made in the calculations and for all formulae or methods of computation not readily identifiable shall be cited.

3.8.1 Design performance curves. The following curves shall be provided:

(a) Head versus flow.
(b) Hydraulic efficiency versus flow.
(c) Net positive suction head required versus flow.
(d) Brake hp versus flow. This curve shall demonstrate that the motor is not overloaded under any condition of suction head, discharge head or free delivery possible within the pump application.

3.8.2 Design features. A discussion of the following design features shall be provided:

(a) Number of stages and reasons for selection.
(b) Method of shaft sealing.
(c) Type of coupling including previous service experience.
(d) Those areas in which system design conditions, as furnished by the design review agency, adversely affect pump reliability or result in abnormal design features.
(e) Steps required for disassembly and reassembly (including alinement) to perform routine maintenance.
(f) For sea water pumps the galvanic, wear, and galling compatibility of the materials used for parts in contact with the pumped fluid.

(g) Any other design features which the manufacturer considers of significant interest to describe the proposed unit.
(h) Whether the specified rated capacity and range of capacity (see 6.2.1) will result in shipboard operation at capacities that will cause pump internal recirculation (suction or discharge) sufficient to degrade pump life, performance, or reliability.

3.8.3 Part materials. The materials proposed for all parts shall be justified as follows, both for proposals that use the materials in table I and proposals that do not:

(a) For all threaded parts, galling compatibility between mating parts must be justified with technical substantiation.
(b) For all parts that form a close running clearance between rotating and stationary parts, the galling and wear compatibility between the mating parts must be justified with technical substantiation. A close running clearance is defined as one that will or might close during operation (including during inclined operation or shock or the combination of the two) and in any event every running clearance with less than 40 roils radial clearance.
(c) For all parts exposed to sea water, the part must be shown to be galvanically compatible with the material proposed for each nearby part. The justification must identify and take into account the relative area ratios of the galvanically coupled parts. To facilitate design review activity review, the justification shall include a copy of the sectional assembly drawing with each part colored in accordance with a color coding scheme picked by the manufacturer to permit visual distinction between parts of different materials.
(d) For parts that are both exposed to sea water and form a close running clearance, the justification for galling and wear as required in 3.8.3(b) and for galvanic acceptability as required in 3.8.3(c) must be based on successful actual experience in similar applications. The justification must state the basis for thinking the two applications similar and for thinking the past application successful. The justification must include a copy of the sectional assembly drawing for the past application showing the geometry and showing, by markup if necessary, the minimum and maximum clearance, the running speed, and the materials.
(e) If the material proposed for a given part is not one of the materials allowed in table I for that part (as defined by part function, even if the part name is different), then additionally justify with technical substantiation why the proposed material is more in the Navy's interest than the material specified in table I and why the latter material cannot be used.
(f) If the part is one for which table I does not specify a material, the proposed material must be justified with technical substantiation.

3.8.4 Calculations shall be submitted to cover the following:

(a) Shafting analysis of pump and driver assembly including calculation of critical speed. If calculations are done by a computer, the method of analysis shall be described and only the results shall be submitted with identification of corresponding pump parameters used in the calculations. The following shall form the basis of the critical speed calculation:

(1) The effects of all major changes in shaft cross section moment of inertia shall be included.
(2) No support for the shaft shall be assumed other than at the designated bearings.
(3) All masses in the rotating system, including the effect of entrained fluids, shall be lumped at discrete points along the shaft.
(4) No support for any shafting shall be assumed to be provided by additional shafting when two sections of shafting are separated by a flexible coupling, nor should any flexibility in bending or shear be assumed for a rigid coupling.
(5) For pumps which operate under variable speed conditions, the operating speed shall be construed to be the maximum operating speed.

(b) Loads imposed on the shaft and bearings. The calculations shall include the following:

(1) Axial and radial loads and load directions. Loading shall be calculated for the design point and also for the highest loaded conditions over the operating range (see 6.2.1). These loads shall include all operating loads together with those that might be induced by thermal expansion, by bearing preload, and by build-up of tolerances in the completed assembly and by ship roll, pitch, list, and trim. The radial loads at the impeller shall be calculated by the following:

$$P = \frac{KHD_2B_2}{2.31}$$

Where:

P = the radial load in pounds.
H = head in feet.
D_2 = impeller outside diameter, inches.
B_2 = impeller overall width including shroud, inches.
K = a constant which varies with capacity.

Unless data, supported by tests, justifies the selection of a lower value, K shall be in accordance with the following. Lower K values may be used only if specifically approved by the design review agency.

Casing type	At shutoff	At rated flow	At 140 percent rated flow
Single volute	0.00024Ns for Ns less than 1500 0.36 for Ns of 1500 or greater	0.10	0.36
Double volute	0.11	.05	.10
Concentric and modified concentric	.15	.15	.15
Varied diffuser in volute	.15	.07	.15
Vaned diffuser in concentric	.07	.03	.15

Where:
NS = specific speed at the best efficiency point.

(2) Effects of thrust reversal where conditions which might cause thrust reversal exist.
(3) Effects of roll, pitch, list and trim of the ship (including gyroscopic effects) shall be considered in the bearing design.
(4) Bearing clearance ratios, L/D ratio and characteristic numbers, lubricant flow, and temperature rise (water-lubricated bearings).
(5) Minimum film thickness required and calculated under maximum radial and axial load conditions over the range of specified pump operating conditions (water-lubricated bearings).

(c) Analysis of driver bearings for close-coupled or rigidly coupled units.

(d) Calculations of the worst case cumulative effect of dimensions and tolerances for parts and locations. These calculations shall demonstrate:

(1) There will no interferences between rotating and stationary parts as assembled.
(2) There will be no interference between rotating and stationary parts and hence no reduction in life of wearing parts, when these worst case cumulative effects are combined with operational, environmental, and thermal loading.

(e) Casing design (submarine sea water pumps only). In the design of submergence pressure boundaries in sea connected pumps for submarine application, full consideration shall be given to the cyclic nature of the submergence pressure, external nozzle loading, and liquid temperature. The design of the pressure containing parts shall be in accordance with the following:

(1) Attached system piping size and material shall be as specified (see 6.2.1).
(2) Pressure and temperature transients as specified (see 6.2.1).
(3) The average flow velocity in the casing shall be calculated in feet per second at rated flow. This velocity shall be shown for the narrowest and widest sections of the casing.

(f) Calculations demonstrating that the gland leak-off collection and drainage features meet the flow capacity requirement of 3.3.8.9.1.

(g) Calculations demonstrating that assemblies that use springs, such as some mechanical seals and labyrinth seals, shall function as intended given the tolerances on the spring and the tolerances of the parts that restrain the two ends of the spring. As a minimum, a tolerance stackup analysis shall be provided calculating the minimum and maximum valves for working length and the minimum and maximum spring force (see 3.6.1.2.3.3) at those lengths. The basis for believing the assembly will perform properly with those spring forces shall be stated.

(h) For all submarine sea water pumps, calculations demonstrating that the shaft pressure breakdown device meets the maximum flow requirements of 3.3.8.9 for worst case tolerances shall be provided. Also, a curve shall be provided, calculated in the same manner, showing how the flow rate increases as the critical clearances increase. This curve shall extend out to a flowrate of 100 gal/rein and shall be for Navy use during shop life.

3.9 Design record. A design record shall be submitted to the design review agency concerned in accordance with the data ordering document included in the contract or order (see 6.2.2). This record shall be completed except as noted in 3.9.2, and forwarded prior to unit delivery or at a time agreed to by the design review agency.

3.9.1 The design record shall contain the following:

(a) The design and calculations which were submitted for manufacturing release, except as modified to resolve comments at time of manufacturing release.

(b) Revised calculations in those areas of design where the original calculations must be modified as a result of an approved design change.

(c) Approved design evaluation test reports, including resolution of comments, the approval action and any special testing which may be performed to verify new design features.

3.9.2 Changes in pump design approved subsequent to issue of the design record when required, or approved deviations in the design evaluation test unit from the design described in the design record, shall be submitted as as addendum to the design record. The addendum shall include applicable revised drawings.

3.10 Technical repair standard. A technical repair standard (TRS) shall be provided upon initial introduction of a new equipment or introduction of an equipment that has an approved TRS if major or minor configuration changes have been approved that would effect the adequacy of the standard for use in new equipment repairs (see 6.2.2).

3.10.1 TRS technical content shall include sufficient technical details to enable a repair, maintenance, or overhaul activity to restore the equipment’s dimensions, clearances, and tolerances such that the equipment is capable of performing its function as originally specified and is capable of being logistically supported by the DoD logistics support system.

3.10.2 The TRS format and content shall conform to DOD-STD-2147 and shall be approved and validated in accordance with this standard.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Inspection system. The inspection system which the contractor is required to maintain, as provided in the Inspection clause of the contract or order, shall be in accordance with MIL-I-45208 (see 6.2.1). The completed parts examination (see 4.1.1.1) shall fulfill the completed articles inspection requirements of MIL-I-45208 (see 6.2.1).

4.1.1.1 The inspection system shall include a completed parts examination procedure whereby each functionally and dimensionally critical part and assembly, including the final product, is examined on completion in accordance with a completed parts examination check list accompanying each part or assembly (see 4.5).

4.1.1.2 A copy of the completed parts examination check list for the completed pump, identified by manufacturer's serial number, shall be furnished the contracting activity (see 6.2.2) in duplicate for each pump. On these copies the contractor's quality control manager shall certify that the inspection requirements specified herein have been fulfilled and that the unit is in accordance with the approved drawings and the applicable specifications.

4.1.2 Variations. No variations or deviations from approved design drawings in 3.6.1.2 shall be permitted.

4.1.3 Mercury prohibition. Pumps, drivers, and auxiliary parts furnished by the pump contractor shall be free of mercury contamination and free of functional mercury. During the manufacturing processes, checks, examinations and tests, the product being offered for acceptance shall not come in direct contact with mercury, any of its compounds, nor with any mercury containing device, such as gauges and thermometers. The manufacturer shall certify that the product, when shipped, is free from mercury contamination.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

(a) First article inspection (see 4.3).
(b) Quality conformance inspection (see 4.4).

4.3 First article inspection. First article inspection shall be performed at a laboratory satisfactory to NAVSEA on each class. Either horizontal or vertical units may be submitted. The several first article tests on one pump design may be conducted concurrently, if practicable. The test shall fully establish that the product has the reliability and performance capability specified herein. A first article test report shall be prepared in accordance with the data ordering document included in the contract or order (see 6.2.2). The following tests shall be performed:

(a) Performance evaluation tests specified in 4.6.6 through 4.6.6.3 and the examination specified in 4.5. Performance evaluation tests shall be conducted on one pump of each type, design and size on each contract or order (see 4.6.6).
(b) Design evaluation tests as specified in 4.6.7 through 4.6.7.6. Design evaluation tests shall be conducted on one pump of each type, design and size (see 4.6.7).

4.3.1 First article inspection shall include all sizes of each type and both horizontal and vertical units.

4.3.2 The contractor of a specific class pump shall submit design data and calculations, as specified in 3.8 to the design review agency for review and approval as a prerequisite to the performance of the first article tests specified herein. The design record, as specified in 3.9, shall be submitted upon completion of the first article tests.

4.4 Quality conformance inspection. Each pump (and subcomponents of each pump, if applicable) shall be examined as specified in 4.5 and tested as specified in 4.6.1 through 4.6.5. Quality conformance inspection shall be fully documented by a prescribed test procedure and a written record of the performance and findings of each test (see 6.2.2). A compilation of the documentation of all the quality conformance tests performed on each pump shall be furnished in duplicate (see 6.2.2).

4.5 Examination. Pumps shall be examined in accordance with a completed parts examination check list accompanying each part or assembly. The examination shall be performed by inspection personnel not engaged in the fabrication and assembly of the part. The check list for each part shall include accurate part identification and shall list the specific attributes which determine the part's acceptability. The check list shall be filled in during the time of examination. The check list shall be arranged in tabular form, calling forth separately the following examination assignments, each accompanied by the specific attributes of acceptability which shall be checked or measured, and the findings recorded:

(a) Dimensions. They shall be as indicated on the approved design drawing. Rotating parts shall be examined for balance and maximum permissible run-out as indicated on the drawings.
(b) Materials. Visual examination for compliance with approved design drawings. Any appearance of nonconformance shall be further verified by appropriate tests.
(c) Cleanliness. Examination for cleanliness shall apply equally to parts examination prior to assembly as well as subassemblies and the completed product.

(d) Missing parts. This examination applies primarily to the completed product prior to shipment.
(e) Assembly. During assembly, positioning tolerances and wear ring/impeller running clearances shall be verified.
(f) Alinement. The equipment and its subassemblies shall be examined to insure that the alinement is as specified.
(g) Adjustment. The adjustment of safety, control, and monitoring devices shall be verified and the settings recorded. Settings which should not be tampered with, once adjusted, shall be tagged with an appropriate precautionary warning.
(h) Preservation. The preservation used, the method of application, and recommended procedure for removal of preservative prior to placing the unit in service shall be stated on a supplemental sheet and attached to the check list.

4.5.1 A copy of the completed part examination check list for each completed pump, identified by manufacturer's serial number, shall be furnished (see 6.2.2). On these copies, the contractor's quality control manager shall certify that the inspection requirements specified herein have been fulfilled and that the unit is in accordance with the approved drawings and the applicable specifications.

4.6 Tests. The contracting activity and Government representatives shall have the right-to examine the facilities at the contractor's plants and at the contractor's subcontractor's plants, and to witness all tests specified herein. Failures, deficiencies , and discrepancies revealed during the performance of the specified tests and the corrective measures taken, shall be recorded and fully documented in the applicable test records and test reports (see 6.2.2). After correction of deficiencies, tests shall be repeated to the extent necessary to ascertain acceptability for the modified pump, Major failures indicative of the design deficiency (as distinguished from shop error or faulty workmanship) shall be reported to the design review agency before a correction is made. Except where specifically required herein to be tested with actual device, tests of turbine driven pumps may be conducted using a substitute driver provided the actual device separately passes the tests required by its specification.

4.6.1 Hydrostatic pressure test. All pressure boundary parts shall be tested hydrostatically to a pressure—one and one-half times the maximum discharge pressure at maximum submergence, but in no case less than 50 lb/in^2. The hydrostatic test pressure shall be maintained for at least 30 minutes or longer as necessary for examination of entire casing.

Acceptance criteria: The pump shall exhibit no leakage through the pressure boundary material or joints. The leaking rate through a mechanical seal shall not exceed 5 drops per minute.

4.6.2 Over-speed test. Each variable speed driver capable of overspeeding shall be over-speed tested in accordance with the specification applicable to the driver.

4.6.3 Mechanical soundness and capacity test. This test shall be conducted, recorded, and reported in accordance with the centrifugal pump Rating Standard and Test Code of the Hydraulic Institute, to the extent that these standards are applicable and are not in conflict with the requirements specified herein. The test report for each pump shall include the following as a minimum: (a) identification of the major pump components (pump, gear assembly, driver) by manufacturer's drawing number and serial number that were tested; (b) identification of the diameter of the impellers tested in the pump; (c) a dimensioned sketch of the test loop showing location of the pump, location of all instrumentation, distance (vertical and along the pipe axis) from the suction and discharge gauge taps to the pump suction and discharge flanges, vertical distance from the gauge(s) to the elevation datum to which they are calibrated, azimuthal location of the gauge taps on the pipe circumference, and location and orientation of any elbows in the pump suction piping; (d) the test loop water temperature during the test; (e) a list of the test instruments including date of last calibration, advertised accuracy, size (e.g., 0.25 lb/in^2) of the smallest graduation on the readout scale, range of the readout scale (e.g., 0-100 lb/in^2), and unit (e.g., lb/in^2) of measurement including the water temperature the gauges are calibrated for if a gauge is calibrated in feet of water rather than in lb/in^2; (f) the data sheets of all recorded data, with the unit of measurement identified for all data; (g) a sample calculation of each type of calculation converting the raw data to specified conditions and showing the conversion in sufficient detail to permit an independent reviewer to verify the calculations, including all temperature and density corrections; (h) a copy of the specific table of water properties used in the calculations and a reference to the source of that table; and (i) a plot of the measured head-capacity curve, corrected to the specified operating conditions following the method described in the sample calculations. The test shall be performed as follows:

(a) Operate the pump and its driver, if motor driven, continuously at the maximum rated speed and capacity, with the pumped fluid at ambient temperature until bearing temperatures (not including water-lubricated bearings) stabilize. Stabilization is defined as three consecutively recorded readings taken over intervals of at least 15 minutes that fall within 3 degrees Fahrenheit ("F) band when adjusted for ambient. The three consecutive readings shall not be constantly rising. The pump operation shall be monitored for proper functioning of safety devices, bearing lubrication, and for smooth running.

Acceptance criteria: Unit operation shall be without heating and shall be free of abnormal vibrations and noises. Oil temperature rise in force-feed lubricated bearings shall not exceed 50°F with inlet cooling water to the oil cooler at 85°F. Controls and attached instruments shall function as specified and are in calibration. There shall be no abnormal leakage of water or oil.

(b) Operate the pump at the maximum rated speed with the pumped fluid at maximum normal temperature from recirculation flow as close to free delivery as practicable and with the minimum specified suction pressure prevailing. The unit shall be operated at seven or more test points throughout the full operating range to establish accurately the head-capacity curve at maximum rated speed.

The unit shall be operated at each test point until the test values being measured stabilize. In addition to the above testing, determine the required net positive suction head at the maximum rated speed at maximum rated flow rate.

Acceptance criteria: The pump shall deliver the rated capacity and head. The head-capacity curve at maximum rated speed shall satisfy the specified requirements. The total head at all capacities from O to 120 percent of rated capacity on the curve shall not deviate by more than plus 5 percent or minus 2 percent of rated head under 500 feet from the head at the corresponding capacity on the head-capacity curve at maximum rated speed established in the performance of 4.6.6.1. If more than one performance test has been performed for a given pump design for use in a given ship class, then the head-capacity curve established in the first performance test is the one to which the preceding sentence refers. In no case shall the pump deliver less than the rated head at rated flow. The required net positive suction head shall not exceed the minimum net positive suction head available as specified in 6.2.1. Pumps originally qualified in accordance with earlier revisions of this specification shall continue to meet the head repeatability percentage requirements of the applicable earlier revision, not the above plus 5 percent or minus 2 percent requirement in order to maintain consistency with the original design of the shipboard piping system.

(c) Operate the electric motor-driven unit for a minimum of 1 minute in reverse rotation at maximum rated speed.

Acceptance criteria: The unit shall not be damaged by the reverse rotation test. Conformance to hydraulic and noise requirements shall be demonstrated subsequent to the reverse rotation test.

4.6.4 Noise tests. Airborne and structureborne noise tests when specified (see 6.2.1) shall be conducted and reported in accordance with MIL-STD-740. Noise test details, instrumentation, and testing techniques identified in MIL-STD-740 shall be submitted to the contracting activity prior to testing for approval. Noise tests shall be performed with the driver furnished with pump, and tests shall be conducted on all units. Airborne noise tests shall be conducted on the lead unit only on each contract or order.

Acceptance criteria: The unit shall meet the noise level limits specified in 6.2.1.

4.6.5 Non-destructive inspection and ultrasonic inspection. All non-destructive inspection, all welding, and all inspection of welds shall comply with MIL-STD-278 and MIL-STD-271.

4.6.6 Performance evaluation tests. One pump of each type, design, and size on each contract or order shall successfully undergo the performance evaluation tests to establish the complete pump performance map and to ascertain compliance with the specified performance requirements. Motor driven units shall be tested with the motor to be furnished with the pump. A substitute driver may be used for turbine driven pumps. When pumps of identical type, design, and size are being produced under two or more contracts within a 2-year period, only one series of performance evaluation tests shall be required for that production run. The following tests shall comprise the performance evaluation tests:

(a) Performance test (see 4.6.6.1).
(b) Mechanical shaft seal and pump alinement procedure test (see 4.6.6.2).

4.6.6.1 Performance test. The performance tests shall be conducted, recorded, and reported in accordance with the requirements of the test specified in 4.6.3, except that, in addition, a full performance map shall be established. The proposed test procedure for this test shall be submitted to the contracting activity for approval approximately at the time of drawing submittal. Test data shall be converted to specified operating conditions for plotting of all performance curves. The performance curves shall be determined at maximum and minimum operating speed for variable speed pumps and at each operating speed for multi-speed pumps. A full net positive suction head (NPSH) curve is required on lead production unit and on subsequent units the NTSH shall be determined at design rated capacity only. The following curves shall be established:

(a) Capacity versus total head.
(b) Capacity versus pump efficiency.
(c) Capacity versus brake horsepower.
(d) Capacity versus net positive suction head required.

Acceptance criteria: The acceptance criteria specified in 4.6.3(a) shall be met. The performance map shall exhibit the specified pump performance characteristics. The net positive suction head required shall not exceed the minimum suction head available specified in 6.2.1. Controls and safety devices shall function reliably as intended throughout the full operating ranges of capacity and speed.

4.6.6.2 Mechanical seal and alinement test. Mechanical seal and alinement test shall be as follows:

(a) The mechanical seal shall be installed and alined precisely in accordance with the procedures stated in the proposed pump technical manual. Packing shall not be installed during this test. The amount of force required to axially position the mechanical seal onto the impeller hub, the shaft sleeve or whatever it rests on in the assembled condition shall be measured and recorded. If the mechanical seal includes an adhesive or setting compound on the elastomer that seals between the mechanical seal and the impeller hub or shaft sleeve, and if there is a maximum allowed time between initial wetting of that compound and final positioning of the mechanical seal in the pump, then do not perform that final positioning until the maximum allowed time has elapsed.
(b) After installation, the mechanical seal shall be run in and the pump operated for at least 4 hours at maximum rated speed with the pumped fluid at maximum operating temperature and with pump suction pressure as high as feasible without requiring pump test loop modifications. The seal leak rate shall then be measured and recorded. Also, the dynamic balance shall be measured and recorded using a vibration indicator of the neon tube or similar

type capable of measuring vibrations of 0.001 inch or less. During subsequent pump disassembly, the final axial position of the mechanical seal shall be measured and recorded if the pump design permits.

Acceptance criteria: Mechanical seal leakage shall not exceed five drops per minute. The pump and drive shall exhibit no abnormal noises or roughness of operation. Vibration shall not exceed the limits specified in MIL-STD-167-1, type II, measured on the bearing caps. The mechanical seal shall have been positioned at the axial position recommended by the mechanical seal vendor to generate the proper amount of mechanical seal spring force. The mechanical seal vendor shall provide in writing his recommendation regarding the axial position in his concurrence that the. mechanical seal alinement test results demonstrated proper positioning of the seal. If it was not practicable to measure the axial position of the mechanical seal, then the seal vendor shall concur that the recorded force used to position the seal during assembly was acceptable and shall state the technical basis for considering that force acceptable. A COPY of these mechanical seal vendor documents shall be provided as part of the test report.

4.6.6.3 Packing and alinement test. The mechanical seal shall not be installed during this test. The pump shall be packed and alined precisely in accordance with the procedures stated in the proposed technical manual. The packing shall then be run in the pump and operated for at least 4 hours at a maximum rated speed with the pumped fluid at maximum operating temperature and with pump suction pressure as high as feasible without requiring pump test loop modifications . The time of day of each packing leakage measurement and of each packing adjustment shall be recorded. The dynamic balance shall be checked with a vibration indicator. After the tests, the packing and shaft sleeve shall be inspected and the results recorded. If the rated maximum operating temperature exceeds 200°F and the normal operating temperature is less than or equal to 200°F, the packing and alinement test shall be repeated satisfactorily with the pumped fluid at normal operating temperature.

Acceptance criteria: The stabilized packing leak rate, defined as that measured at least 30 minutes after the last packing adjustment, shall be within the limit recommended by the pump vendor. Vibration shall not exceed the limits specified in MIL-STD-167-1, type II, measured on the bearing caps. There shall be no smoking or scorching of packing and no scoring (vice polishing) of the shaft sleeve.

4.6.6.4 Test reports for the performance evaluation tests shall be compiled into a single document. The document shall identify the pump by manufacturer's serial numbers of pump and driver, the contract or order number under which the tests were performed, the ship or class of ships for which the pump is intended if known, and the letter and date of test procedure approval. The test compilation document shall be distributed as specified (see 6.2.2).

4.6.7 Design evaluation tests. One pump of each type, design, and size complete with the driver and all appurtenances and controls shall successfully undergo the design evaluation tests specified herein. Design changes which in the opinion of the design review agency may detrimentally affect the reliability of a previously tested and accepted pump design shall be cause to require new design evaluation tests in part or in full. It shall be at the discretion of the

design review agency to require new design evaluation tests when an accumulation of several design changes, each of itself apparently not significant to pump reliability, collectively considered render suspect the validity of any one or all of the previously performed design evaluation tests. An endurance test need not be performed provided that the vendor can demonstrate to the satisfaction of the design review agency concerned that the pump to be offered has been proven in previous Navy shipboard service under conditions equally as strenuous as those specified in the ordering data. The proposed design evaluation test procedures shall be submitted for approval to the contracting activity prior to performing the tests. The design evaluation tests shall consist of the following:

(a) Endurance test (see 4.6.7.1).
(b) Shock test (see 4.6.7.2).
(c) Inclined operation test (see 4.6.7.3).
(d) Vibration tests (if specified (see 6.2.1)) (see 4.6.7.4).
(e) Experimental stress analysis (see 4.6.7.5).

4.6.7.1 Endurance test. The pump shall be operated for a period of not less than 500 hours of actual running time with a minimum of 100 starts to ascertain reliability of performance and operation.

4.6.7.1.1 Prior to commencement of the endurance test and immediately after completion of the 500-hour operating run, the pump shall be disassembled to the extent necessary and the critical dimensions and running clearance of parts subject to wear, erosion and derangement, shall be measured, calculated and recorded. Components such as pump impellers and casings subject to erosion, corrosion, cavitation, and wear, the effects of which are not subject to routine measurement, shall be listed in the inspection record and after completion of the test the condition of each component determined and recorded.

4.6.7.1.2 During the initial and final hours of the endurance test run, noise and performance tests in accordance with 4.6.4 and 4.6.6.1 shall be performed to determine the changes in the pump's performance characteristics and noise signature. Vibration measurements shall be taken at the bearing caps or housings of the pump and driver at equal speeds during the initial and final capacity test to determine the changes in mechanical operation.

4.6.7.1.3 The endurance test shall not be continuous but shall be interrupted by at least three rest periods of a minimum of 8 hours each. A minimum of 100 starts at full line voltage shall be performed during the course of the test. The remainder of the endurance tests shall be run at maximum rated speed and within plus 20°F, minus 0°F of maximum specified liquid temperature. The pump shall be operated at one-third, two-thirds, and rated capacity in approximately equal time intervals. Operations at rated capacity shall be at minimum specified net positive suction head available, or maximum specified suction lift or vacuum, as applicable.

4.6.7.1,4 The pump shall be monitored during the endurance test to accurately record the conditions of operation, the capacity delivered, the total head developed, the speed at which operated, and the general performance observed. Data shall be collected and the pump inspected at least twice per day of operation. For each periodic inspection, in addition to all measured data, the record shall indicate the following:

(a) Seal leakage rate and the amount of gland leakage collected and drained by the collection area.
(b) The conditions of the bearings (by audible noise; by feel; and by bearing temperature via probe if the design includes provisions for a probe, otherwise via a surface pryometer on a normally exposed surface; no disassembly required).
(c) The airborne noise level (normal–abnormal).
(d) The vibration level (normal-abnormal).
(e) The smoothness of operation (normal-abnormal).
(f) All other abnormal findings.
(g) All adjustments made.
(h) Changes made in the conditions or method of operation.

4.6.7.1.5 Endurance test acceptance criteria. Endurance test acceptance criteria shall be as follows:

(a) Head-capacity curve at maximum rated speed after 500 hours of pump operation shall conform to the specification requirements and shall show no abnormal deviations from the curve before the 500-hour test.
(b) Unit performance and operation after 500 hours of operation shall be unchanged and normal and meet all specification requirements .
(c) Unit operation at the end of the endurance test shall be smooth and shall exhibit noise and vibration levels that are normal and in conformance with the specification.
(d) Lubrication shall have remained satisfactory throughout the test period. Bearing temperatures shall have remained normal and shall be consistent with their respective bearing clearances and oil and grease limitations.
(e) Leakage rate from a mechanical shaft seal shall not exceed five drops per minute.
(f) Running clearances shall be normal.
(g) Components subject to attack from corrosion, erosion, cavitation, etc. shall be in a condition commensurate with 500 hours of service.
(h) Wear rates for wearing parts, critical for proper operation, shall show a rate of wear for the test period that shall be consistent with the specified design life requirements.
(i) No failures shall have occurred throughout the 500-hour test.

4.6.7.1.6 Post endurance test procedures. The unit subjected to the 500-hour endurance test shall be restored to the as-new condition by replacement of all parts worn beyond the as-new design tolerances. The restored unit shall successfully pass the tests specified in 4.6.1, 4.6.3(a), and 4.6.4, if applicable. The quality conformance test documentation shall indicate that the unit was subjected to the endurance test and subsequently restored and tested, and that it shall be certified as fully conforming to the specification for unrestricted service.

4.6.7.2 Shock test. The pump shall undergo a shock test to ascertain that the pump has the necessary shock resistance. The shock test shall be performed in accordance with MIL-S-901, grade A, and the specific shock test requirements (see 6.2.1).

4.6.7 .2.1 Before and after shock test, the pump and driver and other components susceptible to internal derangement shall be disassembled to the extent necessary and the critical dimensions and running clearances measured, calculated, and recorded. During this disassembly, the critical components and assemblies subject to shock damage and derangement shall be identified and listed in the inspection record and after completion of the test. The condition of each component and assembly shall be determined and recorded. Shafts, impellers, and turbine rotors, motor rotors, and reduction gears shall be inspected by one of the applicable non-destructive test procedures, other than radiography, specified in MIL-STD-271.

4.6.7.2.2 Before and after the shock test, tests in accordance with 4.6.3 shall be performed to determine the changes in performance characteristics of the pump. Vibration measurements shall be taken at the bearing caps or housings of the pump and driver at equal speeds during the initial and final capacity test to determine the changes in mechanical operation.

4.6.7.2.3 The unit shall be mounted on the shock machine or barge essentially identical to the actual shipboard installation. The contracting activity will furnish the contractor a drawing of the shipboard mounting arrangement and foundation's stiffness. Horizontal pumps, when tested in the inclined position on the medium weight shock machine, shall be oriented so that the direction of shock is perpendicular to the axis of the pump rotation. The pump shall be in operation during the first, third, and fifth blows of the shock test on the floating barge. Variable speed pumps shall be operated at the minimum speed and pressure required to insure lubrication of bearings and wearing parts. Other pumps shall be operated at the lowest rated speed.

4.6.7.2.4 The pump shall be carefully observed during each shock blow and thoroughly examined visually after each blow. After each blow, the unit shall be operated at as close to maximum rated speed as possible and checked for abnormal noises and vibrations and proper functioning of controls. Turbine driven pumps may be air driven. Tightening of bolts during shock tests will not be permitted. If any bolt loosens during the test, the equipment manufacturer shall provide a corrective procedure which must be approved by the design review agency.

4.6.7 .2.5 Shock test acceptance criteria shall be as follows:

(a) There shall be no breakage of parts, including mounting bolts.
(b) There shall be no distortion or derangement of any part which would render the unit incapable of performing as specified.
(c) The amplitude of vibration after test at maximum rated speed shall be less than twice the amplitude measured at the same speed before the test.
(d) Adequate lubrication to all bearings shall be maintained.
(e) Critical dimensions and running clearances have been maintained.
(f) There shall be no significant change in the head-capacity curve.

4.6.7,2.6 Post shock test procedure. The shock tested unit, if it is to be supplied under a contract or order, shall be restored to the as-new condition by replacement of all parts damaged or distorted beyond the as-new design tolerances. Rolling contact bearings shall be replaced regardless of condition. The shock tested rolling contact bearings shall be destroyed. The restored unit shall successfully pass the tests specified in 4.6.1, 4.6.3(a), and 4.6.4, if applicable, Quality conformance test documentation shall certify that the unit was subjected to the shock test and subsequently restored, tested, and inspected in accordance with this specification. A completed parts examination check list shall be supplied (see 6 .2.2) and shall identify the parts which were replaced (such as the bearings) and shall certify that the unit fully conforms to the specifications for unrestricted service.

4.6.7 .2.7 Unless otherwise specified (see 6.2. 1), pump units shall be shock tested with drivers. Flexible coupled pumps shock tested with one driver will not be required to be shock tested again when supplied with a different driver of equal or less weight. Prime movers are subject to shock tests in accordance with applicable equipment specifications.

4.6.7.3 Inclined operation test. Vertical pumps shall be operated for not less than 30 minutes inclined at-an angle from the normal equal to the combination of the maximum permanent list and trim as specified (see 6.2.1). Horizontal pumps shall be tested in accordance with the inclined operation test specified for the driving unit. Operation in the inclined position shall be as close to rated speed and capacity as practicable. The performance point shall be indicated in the test report. The pump shall meet specified performance requirements (see 3 .2) without damage while operating in the inclined position.

4.6.7.4 Vibration test. When specified (see 6.2.1), one pump of a quantity of identical pumps-being supplied shall successfully undergo a vibration test in accordance with the requirements of MIL-STD-167-1, type I, and as supplemented in the contract or order. The vibration test need not be repeated on subsequent contracts or orders for pumps of identical design to those previously tested, provided the previous tests included the frequencies specified (see 6.2.1).

4.6.7 .4.1 The unit shall be mounted on typical shipboard foundations during the vibration test or the shipboard mounting arrangement shall be simulated in spring mass characteristics except where this mounting arrangement causes the largest test table capacity to be exceeded. Inability to vibration test the unit because of excessive weight or size shall not release the contractor from furnishing equipment which can withstand the specified vibration inputs. Vibration test acceptance criteria shall be in accordance with MIL-STD-167-1, type I.

4.6.7.5 Experimental stress analysis. For submarine sea-connected pumps subject to full submergence pressure, the structural adequacy of one pump casing of each design shall be verified by an experimental stress analysis.

4.6.7.6 Design evaluation test documentation. The test reports for the design evaluation tests shall be prepared in accordance with accepted engineering practice. The test arrangement and procedure, the test events, and test instruments used, the measured data, and the effects, results, and observations shall be accurate and complete and shall be presented in a professional manner and in a usable durable form to the design review agency for approval. The report shall include a definite statement regarding conformance to the acceptance criteria specified herein and suitability of the unit for its intended application. After approval, test reports shall be distributed as specified in 6.2.2.

4.7 Packaging inspection. Sample packages and packs and the inspection of the packaging, packing, and marking for shipment and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisitions. For the extent of applicability of the packaging requirements of referenced documents listed in section 2, see 6.6.)

5,1 Technical data. Unless otherwise specified (see 6.2.1), technical data depicting the preservation, packaging, and transportation of support data shall be prepared by the contractor and submitted to the contracting activity (see 6.2.2).

5.2 Preservation-packaging, packing and marking. Pump units and accessories shall be preserved-packaged level A or C, packed level A, B, or C as specified (see 6.2.1), and marked in accordance with MIL-P-16789.

6. NOTES

6.1 Intended use. Pumps covered by this specification are intended for miscellaneous services on board Naval ships.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

(a) Title, number, and date of this specification.
(b) Class required (see 1.2).
(c) General design required (see 3.2).
    (1) Space and weight requirements.
    (2) List, pitch, roll, trim, and other ship attitude conditions (see 3.2, 3.2.7, and 4.6.7.3).
    (3) Environmental vibration frequencies (see 3.2.3.4 and 4.6.7.4).
    (4) Airborne, structureborne, and fluidborne noise requirements (see 3.2.5 and 4.6.4).
    (5) Ambient temperature, normal, maximum, and minimum.
(d) Performance characteristics (see 3.2, 3.3.2.1, 3.3.2.2, 3.8.2, and 3.8.4).
    (1) Rated capacity and range of capacity.
    (2) Rated total head at rated capacity.

(3) Fluid to be pumped.
(4) Specific gravity of fluid.
(5) Temperature of fluid, normal, maximum, and minimum-
(6) Suction head available, normal, maximum, and minimum (see 4.6.3).
(7) Casing design and test pressures.
(8) Special performance requirements, if any (e.g., maximum shutoff head).

(e) Whether shock mounts are to be used (see 3.2.3.2).
(f) Horizontal or vertical mounting (see 3.2.6.1).
(g) Bedplates for close-coupled pumps (see 3.2.6.10).
(h) If threaded fastener lengths are to be other than specified (see 3.2.10.2).
(i) Gauge connections (see 3.2.11.1).
(j) Ordering data for driver (see MIL-M-17413 or MIL-M-17060 for motors ; MIL-T-17523 for turbines; for submarine motors list complete motor specifications) (see 3.2.13.1 and 3.2.14.1).
(k) Class of motor insulation (see 3.2.14.4).
(1) Ordering data for electrical controllers, if required (see MIL-C-2212) including variable speed controllers (see 3.2.15).
(m) Whether constant pressure regulating governor is required (see 3.2.18.1).
(n) Type and characteristic of pressure regulating governor required (see 3.2.18.1).
(o) Additional requirements for valves, flanges, fittings, and bolting for pipe connections (see 3.2.19.1).
(P) Type of driver (see 3.2.24).
(q) If coupling is other than specified (see 3.3.1).
(r) Casing nozzle loadings (see 3.3.3.4).
(s) If suction and discharge connection requirements are other than specified (see 3.3.4.1).
(t) If impellers are other than closed type (see 3.3.5.1).
(u) Non-sparking coupling, if required (see 3.3.9.1).
(v) If impeller material is other than specified (see table I).
(w) Type of pressure regulating governor (see 3.3.11.1).
(x) Number of sets of special tools (see 3.4).
(y) Drawings required (see 3.6 and 3.6.1.2.6).
(z) Manuals required and whether complete information for electrical equipment is required (see 3.7.1, 3.7.3 and 3.7.6).
(aa) Information required for stress analysis of submarine seawater pumps (see 3.8.4(e)).
(1) pressure and temperature transients.
(2) System piping size and material if rigidly attached.
(bb) Inspection system (see 4.1.1).
(cc) Mercury prohibition (see 4.1.3).
(old) Shock test requirements (see 4.6.7.2).
(ee) If pump is to be shock tested without driver (see 4.6.7.2.7).
(ff) Vibration test requirements (see 4.6.7.4).
(gg) Preservation and levels of packaging and packing (see 5.2).
(hh) When packaging technical data is not required (see 5.1).
(ii) Identification of contracting activity and design approval agency (see 6.4).

(jj) Ship type and fluid system in which units are to be installed.
(jj) Designation of manufacturer (pump or driver) responsible to the purchaser for compatibility of pump and driver and operation of the assembled units.

6.2.2 Data requirements. When this specification is used in an acquisition and data are required to be delivered, the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved Contract Data Requirements List (CDRL), incorporated into the contract. When the provisions of DoD FAR Supplement, Part 27, Sub-Part 27.410-6 (DD Form 1423) are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this specification is cited in the following paragraphs.

Paragraph no.	Data requirement title	Applicable DID no.	Option	Deliverable to
3.2.2.3, 3.2.7, 3.8, 3.9, and 4.6.7.5	Diagrams, calculations and stress	UDI-E-23253	----	1,2,3,4,5,6,7
Table I, footnote 6, 4.1.1.2, 4.1.3, 4.5.1, and 4.6.7.2.6	Certificate of compliance	DI-E-2121	----	1,2,3,4,5,6,7
3.6	Drawings, engineering and associated lists	DI-E-7031	Level 2 or 3 Design activity designation - Contractor Drawing No. - Contractor Delivery of hard copy - Contracting activity	1,2,3,4,5,6,7
3.10	Technical/maintenance overhaul and repair standards (TRSS)	UDI-L-26481	----	1,2,3,4,5,6,7,8
4.3	First article inspection report	DI-T-4902	----	1,2,3,4,5,6,7
4.4 and 4.6	Procedures, test	UDI-T-23732	----	1,2,3,4,5,6,7
4.4, 4.6.6.4, and 4.6.7.6	Reports, test	DI-T-2072	10.1.b	1 ,2,3,4,5,6,7

Paragraph no.	Data requirement title	Applicable DID no.	Option	Deliverable to
5.1	Preservation and packing data	DI-L-7135	----	1,2,3,4,5,6,7
6.5	Supplementary provisioning technical documentation	DI-V-7000	----	2,8
	Manufacturer's commercial manual (provisioning)	D1-V-7001	----	2,8
	Provisioning parts list	DI-V-7002	----	2,8
	Short form provisioning parts list	DI-V-7003	----	2,8
	Interim support items list	DI-v-7006	----	1,2,3,5 ,6,7,8

CODE No.	ACTIVITY
	Naval Sea Systems Command Washington, DC 20362
1	56Y21 (2 copies)
2	08L (Propulsion plant pumps in submarines and nuclear surface ships only)
3	Contracting Activity
4	Design Review Agency
5	Cognizant Supervisor of Shipbuilding
6	Shipbuilder
7	Defense Contracting Administration Services Management Area
8	Ships Parts Control Center Mechanicsburg, PA

NOTE : Numbers 3 and 6 may be the same activity and only one copy thus may be required.

(Data item descriptions related to this specification, and identified in section 6 will be approved and listed as such in DoD 5000.19L. , Vol. II, AMSDL. Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

6.2.2.1 The data requirements of 6.2.2 and any task in sections 3, 4. or 5 of this specification required to be performed to meet a data requirement may be waived by the contracting/acquisition activity upon certification by the offeror that identical data were submitted by the offeror and accepted by the Government under a previous contract for identical item acquired to this specification. This does not apply to specific data which may be required for each contract regardless of whether an identical item has been supplied previously (for example, test reports).

6.3 First article inspection. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection as to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.4 Definitions. As used herein, “contracting activity” refers to the activity purchasing the equipment covered by this specification. The contracting activity may be the Government or a shipbuilder. The *’design review agency” refers to the activity responsible for controlling the technical requirements for design and testing of the equipment. The design review agency is generally a Government command or agency such as NAVSEA or an authorized representative. Communication with the design review agency should be handled through the contracting activity.

6.5 Provisioning. Provisioning Technical Documentation (PTD), spare parts, and repair parts should be furnished as specified in the contract.

6.5.1 When ordering spare parts or repair parts for the equipment covered by this specification, the contract should state that such spare parts and repair parts should meet the same requirements and quality assurance provisions as the parts used in the manufacture of the equipment. Packaging for such parts should also be specified.

6.5.2 On board repair parts. The repair parts listed are shown for guidance only in preparing provisioning technical documentation.

TABLE II. On board repair parts.

Name of part	Quantity per set
Ball bearings Roller bearings Internal water lubricated bearings Coupling bushings, pins, springs, and other wearing parts Felt wiper rings or oil seals Packing, if special Mechanical seal Shaft sleeves	100 percent complete replacement for all installed units per ship.
Sleeve bearings Undersize casing wearing rings Casing liners Couplings, gear type Stuffing box throat bushings Impeller nuts	100 percent replacement for one pump per ship.

6.5.3 Each box containing on board repair parts should contain a list entitled "List of on board repair parts". The list should be in a format for use on outline drawings and in the technical manuals. It should be not less than nominal 8-1/2 by 11 inches in size.

6.5.3.1 The format of the list should include a heading and columns of data for the items listed. The heading should include titles and applicable entries as follows:

Reproduced from drawing number_____
Number of ships_____
Application_____
Contract number_____
Manufacturer_____
Quantities are for_____units per ship
The columns shall include:
Piece number_____
Name of part_____
Quantity_____
Drawing number_____
National stock number_____
Additional columns may be used as applicable.

6.5.3.2 The list should be so treated as to be resistant to oil, water, and fading.

6.5.4 The repair parts requirements for the drivers and accessories should be in accordance with the related equipment specification.

6.6 Sub-contracted material and parts. The packaging requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.7 Noise waiver. If a contractor cannot comply with the specified noise limits, he should notify NAVSEA and negotiate a waiver. If a waiver is granted the pump should be labeled with Hazardous Noise Labels in accordance with OPNAV Instruction 6260.2 and the cognizant NAVSEA code should be notified.

6.8 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Preparing activity:
Navy - SH
(Project 4320-N229)

INSTRUCTIONS: In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvements. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge *(DO NOT STAPLE)*, and mailed. In block 5, be as specific as possible about particular problem areas such as wording which required interpretation, was too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 6 any remarks not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

NOTE: This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document*(s)* or to amend contractual requirements.

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2 DOCUMENT TITLE
MIL-P-17639F(SH)	

3a. NAME OF SUBMITTING ORGANIZATION	4 TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*. _____

5 PROBLEM AREAS

a. Paragraph Number and Wording.

b. Recommended Wording.

c. Reason/Rationale for Recommendation

6 REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

DD FORM 82 MAR 1426

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