INCH-POUND
MIL-P-18472G(SH)
24 APRIL 1989
SUPERSEDING
MIL-P-18472F(SHIPS)
15 December 1972
(See 6.9)

MILITARY SPECIFICATION

PUMPS, CENTRIFUGAL, CONDENSATE, FEED BOOSTER, WASTE HEAT BOILER, AND DISTILLING PLANT

This specification is approved for use by 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 centrifugal pumps for condensate, boiler feed booster, waste heat boiler, and distilling plant services on board Naval ships. Distilling plant pumps covered herein are distillate, brine overboard and drain service.

1.2 Classification. The pumps shall be of the following classes as specified (see 6.2).

Class D-1 - Auxiliary condensate and distilling plant pumps - more than 18-inch submergence,
Class D-2 - Main and auxiliary condensate pumps - 18-inch or less submergence.
Class E - Main and auxiliary feed booster pumps.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

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 5523, 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.

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-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-Silicone Alloy Castings.
QQ-S-763	- Steel Bars, Wire, Shapes, and Forgings, Corrosion Resisting.
TT-P-645	- Primer, Paint, Zinc Chromate, Alkyd Type.

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).
MIL-S-1222	- Studs, Bolts, Hex Cap Screws, Socket Head Cap Screws and Nuts.
MIL-C-2212	- Controllers, Electric Motor A.C. or D.C., and Associated Switching Devices.
MIL-P-15024	- Plates, Tags and Bands for Identification of Equipment.
MIL-P-15024/5	- Plates, Identification.
MIL-E-15090	- Enamel, Equipment, Light-Gray (Formula No. 111).
DOD-P-15328	- Primer (Wash), Pretreatment (Formula No, 117 for Metals) (Metric).
MS16142	- Boss, Gasket Seal, Straight Thread Tube Fitting, Standard Dimensions for.
MIL-T-16420	- Tube, Copper-Nickel Alloy, Seamless and Welded, (Copper Alloy Nos. 715 and 706).
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-P-17881	- Pumps, Centrifugal, Boiler Feed, (Multi-Stage),
MIL-B-17931	- Bearings, Ball, Annular, for Quiet Operation,
MS18229	- Plug for “O” Ring Gasket.
MIL-G-18916	- Governors, Steam Driven Pump, Pressure Regulating, Naval Shipboard.

MILITARY (Continued)

MIL-C-20159 - Copper-Nickel Alloy Castings (UNS No. C96200 and C96400).
MIL-P-22302 - Pumps, Centrifugal, Boiler Feed, Single Stage.
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-L-24131 - Lubricant, Colloidal Graphite in Isopropanol.
DOD-G-24508 - Grease, High Performance, Multi-Purpose (Metric).

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 - Requirements for Nondestructive Testing Methods.
MIL-STD-278 - Welding and Casting Standard.
MIL-STD-438 - Schedule of Piping, Valves, Fittings, and Associated Piping Components for Submarine Service.
MIL-STD-740-1 - Airborne Sound Measurements and Acceptance Criteria of Shipboard Equipment.
MIL-STD-740-2 - Structureborne Vibratory Acceleration 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-1371 - Inspection Procedure for Use of Anaerobic Thread Locking Compounds with Studs.
MIL-STD-1472 - Human Engineering Design Criteria for Military Systems, Equipment and Facilities.

(Unless otherwise indicated, copies of federal and military specifications and standards are available-from the Naval Publications and Forms Center (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.1.2 Government drawings and publications. The following Government drawings and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

DRAWINGS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

NAVSHIPS B-153 - Packing and Gaskets, Application of.
NAVSHIPS B-214 - Root Connections for Attaching Pipe.
NAVSEA 810-1385850 - Piping, Pressure Instrument for All Services.

PUBLICATIONS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)
NAVSEA 0900-LP-001-7000 - Fabrication and Inspection of Brazed Piping Systems.

(Application for copies should be addressed to the Naval Publications and Forms Center (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
A 27 - Standard Specification for Steel Castings, Carbon, for General Application. (DoD adopted)
A 36 - Standard Specification for Structural Steel. (DoD adopted)
A 276 - Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes. (DoD adopted)
A 285 - Standard Specification for Pressure Vessel Plates, Carbon Steel, Low- and Intermediate-Tensile Strength. (DoD adopted)
A 487 - Standard Specification for Steel Castings Suitable for Pressure Service.
A 515 - Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate and Higher-Temperature Service, (DoD adopted)
A 569 - Standard Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Scrip Commercial Quality. (DoD adopted) -
A 743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Nickel-Base, Corrosion Resistant, for General Application. (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 164 - Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire. (DoD adopted)
B 369 - Standard Specification for Copper-Nickel Alloy Castings. (DoD adopted)
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.)

HYDRAULILC INSTITUTE
Test Code of Standards - Centrifugal Pump Section.

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

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)
AMS 5398 - Steel Castings, Sand and Centrifugal, Corrosion Resistant.

(Application for copies should be addressed to the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.)

(Non-Government standards and other publications are normally available from the organizations that prepare or 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 document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.5) in accordance with 4.3.

3.2 General characteristics. The pumps shall conform to the space and weight requirements as specified (see 6.2). The pump unit shall perform under the list, pitch, roll and trim conditions specified (see 6.2). Pumps shall operate continuously at any point over the entire flow range and the design conditions as specified (see 6.2).

3.2.1 Maintenance. The equipment specified herein will be operated, maintained, and repaired on board Navy ships (see 6.3). Human engineering aspects, in accordance with MIL-STD-1472, 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. Positioning and alignment of parts 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:

(a) Lifting lugs.
(b) Casing assembly guide pins.
(c) Alignment and positioning dowels,
(d) Jacking screws,
(e) Ease of access to couplings.
(f) Remakeable 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, and so forth (except for submarine service.)
(j) Guards for rotating and moving components.
(k) Warning plates to prevent casualties to equipment and personnel.
(l) 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.

3.2.1.1 Service life. Each pump shall have a service life of 30 years of which 40 percent shall be actual operation. There shall be no limit on the number of starts during the life of the pump. 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) shall have a life of 40,000 actual operating hours. The requirement set forth above shall not be construed or interpreted as a warranty requirement, nor otherwise affect the manufacturer's warranty.

3.2.2 Shock and vibration. Pumps and drivers, all appurtenances, and controls shall pass a shock test in accordance with MIL-S-901, grade A, as specified in 4.6.3.2.

3.2.2.1 Shock mount. Unless otherwise specified (see 6.2), 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.

3.2.2.2 Mounting bolts. 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 not 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 Vibration. 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 meet the requirements of MIL-STD-167-1, type I and II when specified (see 4.6.3.4 and 6.2).

3.2.4 Alignment. The construction of all pumps shall be such that alignment 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. Alignment between separate components of a unit shall be maintained by means of keyways, rabbet or tongue and groove joints, or fitted bolts, as approved by NAVSEA. In no case shall a piece of equipment be rigidly supported from more than one plane.

3.2.5 Noise. The construction 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 4.6.1.4 and 6.2).

3.2.6 Mounting. Pump units shall be horizontally or vertically mounted, as specified (see 6.2).

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

3.2.6.1.1 Bedplates. Bedplates shall be cast steel or structural steel fabricated by welding and rigid to permit handling, shipment, and installation of the units on board ship, to minimize misalignment of the assembled units; and such that normal distortion, weaving or vibration of the supporting structures on board ships cannot cause misalignment between the pumps and driving units. Bearing and seating surfaces of bedplates shall have finish machined surfaces.

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

3.2.6.2 Vertical. 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.

3.2.6.2.1 Sideplates. In the event special bulkhead mounting is required, sideplates shall be furnished subject to all conditions specified for bedplates (see 3.2.6.1.1 and 3.2.6.1.2).

3.2.6.2.2 Assemblies. When motor driven pumps of the close-coupled type are specified, bedplates will not be required, except as otherwise specified (see 6.2). 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 counteracting any unbalanced hydraulic or mechanical thrust in either direction and the fact that rolling, pitching, listing and trim, and the athwartships, fore 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). The contractor shall calculate the resulting static and dynamic loads on the bearings (see 6.3).

3.2.7.1 Bearing types and mounting. Bearings shall be rolling contact bearings (see 3.2.7.2) or, for radial bearings only, water-lubricated bearings (see 3.2.7.3), or thrust bearings (see 3.2.7.4).

3.2.7.1.1 Locations. Rolling contact bearings shall be located in housings separate from and outside the pumped fluid boundary. Flingers. baffles and non-rubbing seals shall protect the bearing from entry of water and prevent lubricant loss. In vertical pumps, rolling contact bearings shall be located above the stuffing box or shaft seal. In rigidly coupled and close-coupled pumps, rolling contact bearings shall be located in the driver only.

3.2.7.1.2 Brackets. Bearing brackets for pumps shall be integral with the casing, securely bolted to the casing on a machined shoulder, or held in alignment with the casing by at least two heavy dowels and securely bolted thereto, The use of bolts alone for securing brackets is prohibited. The bearing housing shall be secured to the bracket on machined seats such that bearing alignment is ensured.

3.2.7.2 Rolling contact bearings. Rolling contact bearings shall be ball bearings, unless use of roller bearings is recommended by the contractor and approved by the design review agency. If approved, roller bearings shall be in accordance with FF-B-185 or FF-B-187. Ball bearings shall be in accordance with FF-B-171. Ball bearings shall be type 111, class 1 (open) or class 2 (single shield) bearings, or duplex pair type 134 angular contact bearings, in accordance with the applicable bearing specifications. If noise requirements are specified (see 3.2.6), rolling contact bearings shall comply with MIL-B-17931.

3.2.7.2.1 Fatigue life. Rolling contact bearings shall have a minimum L-10 fatigue life of 10,000 hours calculated in accordance with FF-B-171, FF-B-185 or FF-B-187, as applicable.

3.2.7.2.2 Lubrication. Rolling contact bearings shall be grease-lubricated, except bearings in turbine drivers may be oil-lubricated in accordance with MIL-T-17523. Oil-lubricated bearings shall be provided means to ensure adequate lubrication immediately when the shaft starts to turn, regardless of the length of time the pump unit is idle. Grease-lubricated rolling contact bearings shall not have a DN value greater than 200,000 (where D = bearing bore diameter in millimeters; N = revolutions per minute).

3.2.7.2.3 Operating temperature . Rolling contact bearing operating temperature (measured on the bearing outer ring) shall not exceed 194 degrees Fahrenheit (°F) at any operating condition up to the specified maximum ambient and pumped fluid temperatures. A straight hole with plug shall be provided in each rolling contact bearing housing to permit insertion of a thermocouple probe to contact the bearing outer ring circumference. Externally supplied cooling liquid or externally induced forced draft shall not be required to meet the above conditions.

3.2.7.2.4 Relubrication. Rolling contact bearings shall be relubricated without bearing removal, and shall not require frequent relubrication if the pump is not operated over an extended period of time. Bearing lubrication and drain connections shall be located so as to force new grease into the bearing and direct old displaced grease out the drain. The bearing relubrication procedure shall not cause bearing failure due to overgreasing, and shall be accomplished with the pump unit secured.

3.2.7.3 Water-lubricated bearings. Water-lubricated bearings shall be lubricated by the pumped fluid, and shall operate without metal-to-metal contact at all pump operating conditions. Unless otherwise approved by the design review agency, water-lubricated bearings shall be hydrodynamic and shall operate under full-fluid film lubrication for all operating conditions, except boundary lubrication will be permitted during pump start-up and shutdown. Where the requirement for full-fluid film lubrication cannot be met, a hydrostatic bearing may be recommended by the contractor for design review agency approval.

3.2.7.3.1 Construction. Water-lubricated bearings shall be of the fixed or self-aligning, one-piece sleeve (bushing) type. Bearing bushing and journal surfaces shall be finished to 32 roughness height rating (RHR) or better. Bearings shall not have lubrication grooves, except a circumferential groove is permitted if needed for lubricant feed.

3.2.7.3.2 Restrictions. Water-lubricated bearings shall not be used in single stage pumps or in pumps with single volute casings.

3.2.7.3.3 Pump casings. Where water-lubricated bearings are used, the pump casing shall be of the double volute type, diffuser type, concentric type or modified concentric design to minimize radial bearing load. 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.

3.2.7.4 Thrust bearings. A thrust bearing shall be installed in each unit for counteracting the forces resulting from the conditions stated in 3.2.7. The bearings shall be of the combined radial and thrust rolling contact type in accordance with 3.2.7.2.

3.2.7.4.1 Rigidly coupled units. For rigidly coupled units, the thrust bearing for the unit shall be in the driver and shall comply with 3.2.7.4.

3.2.7.4.2 Flexibly coupled units. For vertical flexibly-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 conform to all the requirements stated herein.

3.2.8 Lubricants. The only permitted lubricants shall be water or the pumped fluid, grease in accordance with DOD-G-24508, lubricating oil in accordance with MIL-L-17331 (Military symbol 2190 TEP), graphite in isopropanol in accordance with MIL-L-24131 (Military symbol CGI), and (for turbine drivers only) as otherwise permitted by MIL-T-17523.

3.2.8.1 Thread lubricant. Thread lubricant for pump fasteners both inside and outside the pumped fluid boundary shall be graphite in isopropanol in accordance with MIL-L-24131 (Military symbol CGI). This lubricant, or water, shall be used where an assembly lubricant is required for other pump internal parts.

3.2.9 Packing and gaskets. Packing and gaskets shall be in accordance with Drawing B-153. 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. O-rings and spiral wound gaskets shall be completely enclosed to prevent gasket pieces entering the fluid system.

3.2.10 Threaded fasteners. Threaded parts, such as bolts, studs, and tap-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 class 3 fit with locking resin in accordance with MIL-S-22473, type AV. The nut end shall be class 3 fit. The recommendations of the locking resin manufacturer regarding the use of a primer shall be adhered to. Inspection procedures shall be in accordance with DOD-STD-1371.

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

3.2.11.1 Pressure gauges. 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. Silver brazing is prohibited for casing joints and attachments. Where silver brazed joints are permitted, such joints shall be in accordance with NAVSEA 0900-LP-001-7000.

3.2.13 Turbines. Turbines for driving pumps shall be in accordance with MIL-T-17523 and as specified (see 6.2).

3.2.14 Motors. Motors for driving pumps shall be of the type and characteristics specified (see 6.2), and shall conform to service A requirements in accordance with MIL-M-17413 for direct current (de) motors and to MIL-M-17060 for alternating current (at) motors. For surface ship applications, motors shall be totally enclosed fan cooled. For submarines only, complete motor specification shall be as specified (see 6.2).

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

3.2.14.2 Horsepower. The horsepower rating of each motor shall be equal to or greater than 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 horsepower sizes as specified in the applicable motor specification (see 3.2.14). 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 horsepower size.

3.2.14.3 Insulation. Motor insulation shall be in accordance with MIL-E-917 and shall be class B or F as specified (see 6.2). The stator windings of the ac motors and the field coils and the armatures of the dc motors shall be insulated and varnish treated to provide a sealed insulation system in accordance with the procedures of MIL-M-17060. Regardless of class of insulation specified, motor temperature rise at rated full motor load shall not exceed 158°F in 122°F ambient.

3.2.14.4 Bearings. Motor bearings shall conform to 3.2.7.2.

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).

3.2.16 Painting. Paint shall not be applied to internal surfaces, rotating parts, surfaces close to running fits, mating surfaces for connections and fittings, mounting surfaces, identification plates, and instruments. Painting is not required for external surfaces on non-ferrous metal or corrosion-resisting ferrous metal alloys containing more than 17 percent chromium and 7 percent nickel. Other external surfaces of ferrous metal 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.

3.2.17 Identification plates. 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. They shall be secured to equipment with corrosion-resistant metallic screws or rivets. The plates shall contain data as follows:

(a) Manufacturer's name.
(b) Manufacturer's model or type and size.
(c) Semite application.
(d) Manufacturer's serial number.
(e) Salient design characteristics:
    (1) Capacity in gallons per minute.
    (2) Total head in pounds per square inch (lb/in^2).
    (3) Speed of shaft in revolutions per minute (r/min).
    (4) Brake horsepower.
    (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 Service Management Area (DCASMA) stamp.
(i) NAVSEA technical manual number.
(j) Certification data drawing number.

3.2.17.1 Other plates. Each driving unit and each accessory unit shall have an identification plate in accordance with the applicable equipment specification.

3.2.18 Piping valves and threaded items. 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 (see 6.2). Pump flanges, except for welded connections, shall have a face circular lay finish as specified in MIL-STD-438 for submarines and MIL-STD-777 for surface ships.

3.2.18.1 Threads and fittings. Tapered pipe threads are prohibited, except for 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.

3.2.18.2 Plugs and closures. Where thread connections are used, straight threads with O-rings are required for thread plugs and thread closures in pressure boundary of pumps.

3.2.19 Locking devices. Threaded fasteners and threaded machine elements internal to the fluid boundary shall be secured by locking devices. Locking devices shall be subject to approval by the design review agency.

3.2.19.1 Setscrews. Use of radially-oriented setscrews inside the fluid boundary is prohibited. Where no other means of locking is practicable, radially-oriented setscrews may be used outside the fluid boundary provided the setscrew can be inspected without disassembly. Where setscrews are used, all of the following requirements shall be met:

(a) At least two-setscrews shall lock the part.
(b) Setscrews shall be self-locking, nylon insert type.
(c) Setscrews shall be dog-point and shall be bottomed into and positively engage the locking part.
(d) Setscrews shall be secured by staking the locked part at two places 180 degrees apart.

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

3.2.21 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.

3.2,22 Type of driver. The type of driver shall be as specified (see 6.2).

3.3 Detail requirements.

3.3.1 Configurations. Pumps shall be horizontal or vertical, flexible-coupled or close-coupled (see 6.3) as specified (see 6.2).

3.3.1.1 All classes.

3.3.1.1.1 Stages. Pumps having a total head of 50 lb/in^2 or less may be single or multi-stage, Pumps having total head over 50 lb/in^2 may have two or more stages.

3.3.1.1.2 Impellers. Vertical pumps shall be provided with single top inlet or double suction first stage impellers located at the bottom of the pump so as to have maximum possible submergence and facilitate venting of the eye of the impeller during operation. Vertical bottom suction impellers with vents may be used provided prior approval for the specific application is obtained from the design review agency.

3.3.1.1.3 Axial unbalance. Axial hydraulic unbalance due to the use of single inlet impellers shall not exceed 150 pounds unless fully justified in the design data and calculations.

3.3.1.2 Class D-1 pumps.

3.3,1.2.1 Auxiliary condensate service. Class D-1 pumps for auxiliary condensate service may be horizontal or vertical. Horizontal single stage pumps may be either flexible-coupled or close-coupled. Vertical pumps shall be flexible-coupled.

3.3.1.2.2 Other services. Class D-1 pumps for all other services shall be vertical, single stage and close-coupled when the total head of the pump is 50 lb/in^2 or less. Multi-stage pumps may be vertical or horizontal and flexible-coupled unless otherwise approved by the design review agency.

3.3.1.2.3 Distilling plant pumps. Distilling plant pumps which are attached to and furnished with the distilling unit may be either vertical or horizontal.

3.3.1.3 Class D-2 pumps. Class D-2 pumps shall be vertical and flexible-coupled, except condensate pumps for submarine applications may be close-coupled or rigid-coupled subject to approval of the design review agency.

3.3.1.4 Class E pumps. Class E pumps shall be vertical and flexible-coupled.

3.3.2 Performance characteristics. The operating characteristics of the pumps shall be as specified (see 6.2).

3.3.2.1 Class D-1 and D-2 pumps.

3.3.2.1.1 Continuous operation. Class D-1 and D-2 pumps shall be capable of continuous operation over the entire range of specified fluid temperatures (see 6.2) with suction head equal to the saturation pressure of the fluid plus the specified submergence (see 6.2). Except for submarine applications, class D-1 and D-2 pumps shall operate continuously under submergence control.

3.3.2.1.2 High capacity. Class D-1 and D-2 pumps of 40 gallons per minute or more capacity shall have a constantly rising head-capacity characteristic curve such that at constant rated speed, the total head at shutoff is at least 15 percent in excess of the total head at rated capacity.

3.3.2.1.3 Low capacity. Class D-1 and D-2 pumps of less than 40 gallons per minute capacity shall have a constantly rising head-capacity characteristic tune at constant rated speed. For pumps having capacities in the range of 20 to 40 gallons per minute, the total head at shutoff shall be at least 5 percent in excess of the total head at rated capacity.

3.3.2.2 Class E pumps.

3.3.2.2.1 Capacity. Class E pumps shall have a constantly rising head-capacity characteristic tune such that the total head at shutoff is at least 10 percent above total head at rated capacity. At constant rated speed, class E pumps shall develop 120 percent rated capacity at a total head of not less than 80 percent of the rated total head.

3.3.2.2.2 Series operation. Class E pumps shall operate in series with pumps in accordance with MIL-P-17881 or MIL-P-22302 and shall operate in parallel without surging under all conditions of operation from shutoff to full capacity.

3.3.3 Casings.

3.3.3.1 Horizontal pumps. The casings of all horizontal pumps, except close-coupled pumps, shall be split horizontally at the centerline to permit ready removal of the rotors and replacement of bearings and glands.

3.3.3.2 Vertical pumps. The casings of all vertical pumps, except close-coupled or barrel type pumps, shall be split vertically in such a manner as to allow removal of the rotor without disturbing the pump on its foundation, the piping thereto, or the driving unit.

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

3.3.3.4 Assembly alignment. Fitted bolts or dowel pins shall ensure maintenance of alignment 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.

3.3.3.5 Forcing bolts. Forcing bolts shall be provided for breaking joints.

3.3.3.6 Drains and vents. Casings of horizontal and vertical 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 seine as the drain. The casings of all close-coupled and barrel type pumps shall permit ready replacement of wearing parts. Horizontal pumps shall be fitted with vent connections on the discharge casings of each stage. Pumps taking suction from vacuum shall be fitted with suction casing vent connections , except pumps for vapor compression distilling units which shall be self-venting.

3.3.3.7 Wearing rings. Pumps, except brine pumps with semi-open impellers, shall be fitted with removable casing wearing rings. Diaphragms (interstage pieces) in multi-stage pumps shall be fitted with bushings. For axially split casings, the wearing rings shall be held by a double tongue and groove in the fixed half casing, and a single tongue and groove in the removable half casing.

3.3.3.8 Gaskets. Pump casing joints shall be made up using compressed sheet gaskets. For close-coupled and barrel type pumps, O-rings may be used to make up casing joints. Gasket compression and tolerances shall not affect bearing, bushing or wearing ring fits to an extent that will adversely affect reliability and performance.

3.3.4 Suction and discharge connections. Unless otherwise specified (see 6.2), 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.

3.3.4.1 Split case pumps. Suction and discharge connections of split case pumps shall be on the fixed half of casing, except on close-coupled pumps. In special cases, suction and discharge connections may be on the top or removable half of casing subject to specific approval by the design review agency.

3.3.5 Impellers. Impellers shall be of the closed type, except brine pumps of 25 gallons per minute or less shall have semi-open impellers. Outside surfaces shall be smooth finished. Impellers shall be keyed on the shaft and securely held against axial movement by locked nuts or other means approved by the design review agency.

3.3.5.1 Wearing rings. 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 accom-modate undersize casing wearing rings to restore design running clearance.

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

3.3.5.3 Diametral clearance. Diametral clearance shall be as specified in table I.

TABLE I. Diametral clearance.

Rated capacity (gal/min)	Diametral clearance, minimum (inch)
249 and below	0.012
250 to 499	0.016
500 to 749	0.020
750 and above	0.024

3.3.6 Shafts.

3.3.6.1 Threading. 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 Tachometers. 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 Sleeves. Shafts shall be fitted with shaft sleeves in way of all wearing surfaces, such as stuffing boxes, bushings, and water lubricated bearings. An O-ring seal shall be installed between the shaft and stuffing box (including mechanical seal) shaft sleeve.

3.3.6.4 Flingers. 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 Close-coupled pumps. Shafts of close-coupled pumps shall be of one-piece construction.

3.3.7 Rotating assembly. 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. 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 configured so that balancing may readily be performed by overhaul activity personnel.

3.3.7.1 Operating speed. The pump construction shall be such and calculations shall be made to demonstrate that the maximum operating speed of the pump is not greater than 70 percent of the first critical speed.

3.3.7.2 Rotor assembly. Barrel-type pumps shall be so constructed that the assembled pump rotor exclusive of the coupling, plus non-rotating parts which can only be installed by removing some rotating parts, can be removed, replaced and stored as a complete assembly. This assembly shall be able to pass through a hatch of the specified diameter (see 6.2).

3.3.8 Stuffing boxes and mechanical shaft seals. Mechanical shaft seals may be used for waste heat boiler feed and waste heat boiler circulating pumps. A separate source of clean cooling water shall be provided to the mechanical seal for both services. The contractor shall be responsible to the design review agent or installing activity of the cooling requirements.

3.3.8.1 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.

3.3.8.2 Seal materials. Each seal installed shall be provided with a solid gland plate that houses two or more rings of packing for use in the event of a mechanical seal failure. The gland 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 ensure that 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.

3.3.8.3 Seal materials. Metal seal internal parts for waste heat boiler pumps shall be constructed of nickel-copper or highly alloyed corrosion-resisting steel in accordance with ASTM A 744, grade CN-7M or CN-7MS. Metal seal internal parts for fresh water service pumps shall be constructed of type 304 or 316 corrosion-resisting steel or nickel-copper alloy or highly alloyed corrosion-resisting steel in accordance with ASTM A 744, grade CN-7M or CN-7MS. The mechanical shaft seal shall have a solid tungsten carbide or silicon carbide against carbon sealing surface.

3.3.8.4 Cyclone separator construction. Cyclone separators shall be constructed of nickel-copper alloy. Fittings for abrasive separators and pump casings shall be of the 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.

3.3.8.5 Glands. 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 stub 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.

3.3.8.6 Leakage. Pumps shall be configured so that gland leakage, whether from mechanical seal or 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 shutdown, the collection area shall collect and drain all gland leakage, up to the greater of either 1 quart per minute or three times the minimum allowable leakage rate recommended by the contractor and approved by the design review agency for operation with emergency packing.

3.3.9 Stuffing boxes and packing (for pumps without mechanical seals). Stuffing boxes shall be of adequate depth to reduce leakage to a minimum under all operating conditions. A minimum of five rings of packing is required for each stuffing box. Stuffing boxes shall be fitted with throat bushings. The stuffing boxes shall be fitted with water seal connections and lantern rings located between inner and outer sets of packing. Special care shall be taken to ensure that compression of the inner packing will not allow the lantern rings to move to cut off or restrict the sealing water supply.

3.3.9.1 Leakage. The pumps shall be configured so that all gland leakage is collected without wetting the pump foundation, bearing housings, or driving units. The collection areas 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 pumps running or shutdown, the collection area shall collect and drain all gland leakage at a rate not less than 1 gallon per minute.

3.3.9.2 Packing gland and lantern rings. Packing gland and lantern rings shall be split in halves with the halves secured together in a manner to form a solid ring for setting up. Lantern rings of non-metallic materials and alternative design for securing may be used as approved by the design review agency.

3.3.9.3 Maintenance. Stuffing box glands shall be set up by nuts threaded on studs secured in the casings. Nuts shall be located to permit easy gland adjustment with pump operating. Space shall be provided between bearings and stuffing boxes to permit easy removal of packing, and examination and overhaul of bearings.

3.3.10 Coupling. For horizontal or vertical four-bearing units, an all-metal flexible coupling shall be installed between the pumps and driving units. Vertical units for submarine application may be rigidly coupled where prior approval of the design review agency has been obtained.

3.3.10.1 Flexible coupling. Flexible coupling for class D-2 and E pumps shall be grease-lubricated, double engagement dental couplings in accordance with type II, class 2 of MIL-C-23233. Flexible coupling pump hubs shall be keyed to the shafts and secured by locknuts. For pump shafts 1-1/2 inch diameter and larger, the hubs shall be fitted on a taper with keys parallel to the taper.

3.3.10.2 Rigid coupling. Rigid couplings shall have fitted bolts and the coupling flanges shall be marked at assembly to ensure proper reassembly after overhaul of the units.

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

3.3.11 Material. The materials of the pump shall conform to the materials specified in table II. 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 able to pass 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 II. Materials.

Application 1/ 2/ 7/	Material	Specification	ASTM publication
Casings, diffusors, 3/ interstage diaphragm and crossovers	Copper-nickel (70-30)	MIL-C-20159, type I	B 369, (UNS C96400)
Fresh water	Cast steel 12 percent chromium	MIL-S-16993, class 1	A 743, grade CA-15
Sea water (brine)	Copper-nickel (70-30)	MIL-C-20159, type I	B 369, (UNS C96400)
Casing bolts, studs nuts 4/	Nickel-copper alloy	QQ-N-281, class A or B	B 164, class A or B (UNS N04400 or UNS N04405)
Fresh water	Ni-Cu-Al alloy 5/	QQ-N-286	------
	Corrosion-resisting steel	MIL-S-1222, grade 304 or 316	------
Sea water (brine)	Nickel-copper alloy	QQ-N-281, class A or B	B 164, class A or B (UNS N04400 or UNS N04405)
	Ni-Cu-Al alloy	QQ-N-286	------
Impellers 8/	Stainless steel casting	17-4 PH cond H900	AMS 5398
Fresh water	Nickel-copper alloy	QQ-N-288, composition E	------
	Cast steel 12 percent chromium	MIL-S-16993, class 1	A 743, grade CA-15 A 487, grade CA-6NM
Impellers 8/			
Distilling plant sea water (brine)	Nickel-copper alloy	QQ-N-288, composition E	------

See footnotes at end of table.

TABLE II. Materials - Continued.

Application 1/ 2/ 7/	Material	Specification	ASTM publication
Casing rings and 8/ diaphragm bushings	Nickel-copper alloy	QQ-N-288, composition B or D	------
Fresh water	Bronze	QQ-C-390, alloy 910, 922 or 934	------
	Gun metal	QQ-C-390, alloy 90500 or 90300	B 584, alloy 1A or 1B (UNS C90500 or UNS C90300)
Casing wearing rings Sea water (brine)	Nickel-copper alloy	QQ-N-288, composition B or D	------
Shafts 11/	Nickel-copper alloy	QQ-N-281, class A or B	B 164, class A or B (UNS N04400 or UNS N04405)
Fresh water	Corrosion-resisting steel, 12 percent chromium	QQ-S-763, class 410 minimum hardness 302 Bhn	A 276, class 410 (UNS S41000)
	Ni-Cu-Al alloy 5/	QQ-N-286	------
Sea water (brine)	Ni-Cu-Al alloy 5/	QQ-N-286	------
	Nickel-copper alloy	QQ-N-281, class A or B	B 164, class A or B (UNS N04400 or UNS N04405)
Shaft sleeves			
Fresh water	Ni-Cu-Al alloy (minimum hardness 265 Bhn)	QQ-N-286	------
	Corrosion-resisting steel	QQ-S-763, class 410 minimum hardness 265 Bhn	A 276, class 410 (UNS S41000)

See footnotes at end of table.

TABLE II. Materials - Continued.

Application 1/ 2/ 7/	Material	Specification	ASTM publication
Sea water (brine)	Ni-Cu-Al alloy (minimum hardness 265 Bhn)	QQ-N-286	------
Bearing brackets and caps	Gun metal	QQ-C-390, alloy 90500 or 90300	B 584, alloy 1A or 1B (UNS C90500 or UNS C90300)
	Valve bronze	QQ-C-390, alloy 92200	B 584, alloy 2A or B 61 (UNS C92200)
	Copper-nickel (70-30)	MIL-C-20159, type I (UNS C96400)	B 369, (UNS C96400)
	Steel	-----	A 27, A 36, A 285, A 515 or A 569
Bearings, bushings water lubricated 6/	Bearing bronze	QQ-C-390, alloys 91000, 93200, 93400, 94100, or 94300	------
Journal sleeves	Ni-Cu-Al alloy (minimum hardness 265 Bhn)	QQ-N-286, class A (UNS N05500)	------
	Corrosion-resisting steel	QQ-S-763, class 410 maximum hardness 302 Bhn	A 276, class 410 (UNS S41000)
Lantern rings, glands and throat bushings	Copper-nickel (70-30)	MIL-C-20159, type I (UNS C96400)	B 369 (UNS C96400)
	Gun metal	QQ-C-390, alloy 90500 or 90300	B 584, alloy 1A or 1B (UNS C90500 or UNS 90300)
	Valve bronze	QQ-C-390, alloy 92200	B 584, alloy 2A or B 61 (UNS C92200)

See footnotes at end of table.

TABLE II. Materials - Continued.

Application 1/ 2/ 7/	Material	Specification	ASTM publication
Mounting brackets	Steel 9/	-----	A 27, A 36, A 285, A 515 or A 569
	Gun metal	QQ-C-390, alloy 90500 or 90300	B 584, alloy 1A or 1B (UNS C90500 or UNS C90300)
	Valve bronze	QQ-C-390, alloy 92200	B 584, alloy 2A or B 61 (UNS C92200)
	Copper-nickel (70-30)	MIL-C-20159, type I (UNS C96400)	B 369, (UNS C96400)
Shaft or impeller nuts			
Fresh water	Nickel-copper alloy	QQ-N-281, class A or B	B 164, class A or B (UNS N04400 or UNS N04405)
	Corrosion-resisting steel	QQ-S-763, class 410 maximum hardness 302 Bhn	A 276, class 410 (UNS S41000)
Sea water (brine)	Ni-Cu-Al alloy 5/	QQ-N-286	------
	Nickel-copper alloy	QQ-N-281, class A or B	B 164, class A or B (UNS N04400 or UNS N04405)
Cyclone separators 10/	Nickel-copper alloy	QQ-N-281 or QQ-N-288	------
Tubing	Copper-nickel alloy	MIL-T-16420 (70-30) class 700, alloy 715	------

See footnotes at top of next page.

1/ Accessory parts such as vent petcocks and drain plugs shall be of the material specified for the major part with a difference of 50 Bhn minimum if subject to galling or be of a more noble material.

2/ Detail drawings and lists of material shall reference the specification followed in each case, and shall include the class, type, or grade of material used in each case, as applicable.

3/ Post weld heat treatment shall be 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 contractor and the contracting agency.

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

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

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

7/ 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. These requirements are not applicable to heat treatment performed as the result of the weld repair.

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

9/ 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 provision is made for draining all pockets.

10/ 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: parts such as fittings, not readily available in 70-30 copper-nickel, may be made of nickel-copper alloy and parts that would be unacceptably galvanically attacked if made of 70-30 copper-nickel shall be made of nickel-copper alloy.

11/ For close-coupled type units the pump shaft material shall be specified to the motor manufacturer.

3.3.11.1 Recovered materials. Unless otherwise specified herein, all equipment, materials, 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 specified.

3.3.11.2 Prohibited materials. 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 (see 6.3).

3.3.12 Pump pressure regulating governors. Unless otherwise specified (see 6.2), one constant pressure regulating governor in accordance with MIL-G-18916 shall be furnished with each class E turbine-driven pump for main and auxiliary feed booster and waste heat boiler feed pumps. Steam pressure drop through pump pressure regulating governors shall be considered when rating turbine-driven pumps.

3.3.13 Interchangeability. In no case shall parts be physically interchangeable or reversible unless such parts are also interchangeable or reversible with regard to function, performance and strength.

3.4 Tools. Equipment shall be constructed to minimize need for special tools. 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 Workmanship. Workmanship shall be of the very highest quality to ensure that the utmost reliability for the service intended is achieved and all requirements of the specification are met.

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 (examinations and tests) 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 this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All Items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies

submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements; however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

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. Inspection shall be performed at a laboratory satisfactory to NAVSEA on each class for which first article approval is desired. Either horizontal or vertical units may be submitted. Several first article tests on one pump design may be conducted concurrently if practicable. The inspection shall fully establish that the product has the reliability and performance capability specified herein. First article inspection shall include all sizes of each class and both horizontal and vertical units. The following tests shall be performed:

(a) Performance evaluation tests specified in 4.6.2 through 4.6.2.3 and the examination specified in 4.5.
(b) Design evaluation tests as specified in 4.6.3 through 4.6.3.4.

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 4.6.3.4 (see 6.3).

4.5 Examination. Pumps shall be examined in accordance with a completed part 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 conformance to 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) Alignment. The equipment and its subassemblies shall be examined to ensure that the alignment 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 presentation 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.

4.6 Tests. The contracting activity and Government representatives shall have the right to examine the facilities at the contractor's plant 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. 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 the 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 Shop tests. Shop tests shall be performed on each pump being supplied (and subcomponents of each pump if applicable). Each shop test shall be fully documented by a prescribed test procedure and a written record of the performance and findings of each test. The following shop tests shall be performed on each pump:

(a) Hydrostatic pressure test (see 4.6.1.1).
(b) Over-speed test (see 4.6.1.2).
(c) Mechanical soundness and capacity test (see 4.6.1.3).
(d) Noise test (to be performed only when specified (see 6.2 and 4.6.1.4)).

4.6.1.1 Hydrostatic pressure test. Each pump casing shall be tested hydrostatically to a pressure one and one-half times the maximum discharge pressure or total head, whichever is greater 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.

4.6.1.1.1 Acceptance criteria. The pump shall exhibit no leakage through the pressure boundary,

4.6.1.2 Over-speed test. Each pump driven by a variable speed driver that can overspeed shall be operated continuously for 30 minutes at a speed 25 percent above maximum design operating speed. The pump need not be under load except as necessary to prevent damage or injury. Continuous shaft and rigid coupled pumps shall be tested with the driver. Units separately driven through flexible

couplings and geared units may be tested by separate pump, gear unit and driver overspeed tests. The dynamic balance shall be checked by the use of a vibration indicator of a type whereby vibrations of an amplitude of 0.001 inch may be readily observed on a scale.

4.6.1.2.1 Acceptance criteria. Neither the pump nor the driver shall exhibit abnormal noises or roughness of operation. Vibration shall not exceed the MIL-STD-167-1, type II vibration limits for this equipment.

4.6.1.3 Mechanical soundness and capacity tests. This shop test shall be conducted and recorded 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 record for each pump shall identify the pump and driver by manufacturer's serial number; it shall indicate the diameter of the pump impellers being tested in the pump; it shall include a description (by legend and sketch) of the test stand arrangement including an identifying list of test instruments used and the date when last calibrated; and it shall include the data sheets of all recorded data and sample calculations of data conversion to specified conditions. Test data used for plotting the head-capacity curve shall be corrected to the specified operating conditions. The test shall be performed in three phases, as follows:

(a) Operate the pump and its driver, if motor driven, continuously at maximum rated speed and capacity, with the pumped fluid at the specified operating temperature (see 6.2) until bearing temperatures (not including water-lubricated bearings) stabilize as manifested by at least three consecutive equal bearing temperature indications taken at intervals of not less than 15 minutes. Variations in temperature of the liquid pumped will be permitted provided the liquid is at saturated conditions for class D-1 and D-2 pumps and within plus or minus 20°F for class E pumps. The pump operation shall be fully monitored throughout this test for proper functioning of packings and seals and bearing lubrication, and for smooth running, The amount of packing leakage shall be measured at regular internals and recorded.

Acceptance criteria: 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 in any bearing and shall not exceed 180°F with inlet cooling water to the oil cooler at 85°F. There shall be no abnormal leakage of water or oil. For grease lubricated bearings the maximum outer race bearing temperature shall not exceed 194°F.

(b) Operate the pump at the maximum rated speed with the pumped fluid at the specified maximum normal temperature from recirculation flow to as close to free delivery as practicable. 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. Test shall include data for an NPSH curve.

Acceptance criteria: The pump shall deliver the rated capacity and head. The head-capacity tune at maximum rated speed shall meet the specified requirements. The total head at all capacities on the curve other than rated capacity shall not deviate by more than plus 5 percent or minus 2 percent of rated heads under 500 feet, plus 3 percent or minus 1 percent of rated heads over 500 feet from the corresponding head on the head-capacity tune at maximum rated speed established in the performance test specified in 4.6.2.1. NPSH shall be less than that if specified (see 6.2).

(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.

4.6.1.4 Noise test. When required (see 6.2), noise tests shall be conducted in accordance with MIL-STD-740-1 and MIL-STD-740-2. The noise test stand details, instrumentation, and testing technique shall be submitted by the supplier to the contracting activity for approval prior to test commencement. 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 (see 6.2).

4.6.2 Performance evaluation tests. One pump of each class, design and size on each contract or order shall successfully undergo the performance evaluation test to establish the complete pump performance map and to ascertain conformance to 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 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 4.6.2.1).
(b) Special tests (see 4.6.2.2).
(c) Packing and pump alignment procedure test (see 4.6.2.3).

4.6.2.1 Performance test. The performance test shall be conducted and recorded in accordance with the requirements for the shop test specified in 4.6.1.3, except that in addition to the head-capacity curve at maximum rate speed, a full performance map shall be established. The head-capacity tunes for pumps constructed to operate under submergence control (see 6.2) shall include complete submergence tunes for at least 7 suction pressures ranging from the lowest submergence for which stable pump operation can be obtained to the maximum submergence specified (see 6.2). Test data shall be converted to specified operating conditions for plotting of all performance tunes. The performance curves shall be determined at maximum and minimum operating speed for variable speed pumps and at each operating speed for multispeed pumps. 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.

Acceptance criteria: The acceptance criteria specified in 4.6.1.3(a) shall be met. The performance map shall exhibit the specified pump performance characteristics.

4.6.2.2 Special tests. The following special tests shall be performed:

(a) The pump shall be operated at least 1 hour at recirculation flow with maximum specified inlet water temperature.

Acceptance criteria: The temperature rise shall not cause the pump to cavitate or give evidence of incipient seizure. The unit shall operate smoothly without surging throughout the test. There shall be no unusual noises.

(b) The pump shall be operated at least 1 hour at rated capacity with maximum specified inlet temperature and the specified net positive suction head.

Acceptance criteria: The pump operation shall not exhibit any indications of a cavitation condition. The unit shall operate smoothly throughout the test,

4.6.2.3 Packing and alignment procedure test (for pumps without mechanical seals). The pump shall be packed and aligned precisely. The packing shall then be run in and the pump operated at maximum rated speed with the fluid pumped at maximum operating temperature. The dynamic balance shall be checked by the use of a vibration indicator (see 4.6.1.2).

4.6.2.3.1 Acceptance criteria. The packing leakage at the end of the run-in period shall not exceed the limits recommended by the pump manufacturer. The vibrations shall not exceed the limits specified in 4.6.1.2.

4.6.3 Design evaluation tests. One pump of each class, 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 contractor can demonstrate to the satisfaction of the design review agency that the pump to be offered has been proven in previous Navy shipboard service under conditions equally as strenuous as those specified in 4.6.3.1 through 4.6.3.1.6. The proposed design evaluation test procedures shall be submitted to the contracting agency for approval prior to performing the tests. The design evaluation tests shall consist of the following:

(a) Endurance test (see 4.6.3.1).
(b) Shock test (see 4.6.3.2).
(c) Inclined operation test (see 4.6.3.3).
(d) Vibration test (if specified in 6.2) (see 4.6.3.4).

4.6.3.1 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. The endurance test for distilling plant pumps on ships which do not have steam propulsion plants shall be of a period of not less than 100 hours of actual running time with a minimum of 25 starts. Other requirements in 4.6.3.1.1 through 4 6.3.1.6 are applicable except that acceptance criteria shall be based on 100 hours of operation.

4.6.3.1.1 Prior to commencement of the endurance test and immediately after completion of the endurance test, the pump shall be disassembled to the extent necessary and the critical dimensions and running clearance, or parts subject to wear, erosion and derangement, measured, calculated and recorded. Components such as pump impellers and casing 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 shall be determined and recorded.

4.6.3.1.2 During the initial and final hours of the endurance test run, capacity and noise test in accordance with 4.6.1,4 and 4.6.2.1 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 housing of the pump and driver at equal speeds during the initial and final capacity test to determine the changes in mechanical operation.

4.6.3.1.3 The endurance test shall not be continuous but shall be interrupted by at least three rest periods of approximately 8 hours each. The number of starts specified in 4.6.3.1 at full line voltage shall be performed during the course of the test. During an early part of the endurance test the pump shall be operated continuously for 24 hours at a capacity as near free delivery as possible at maximum rated speed, and normal specified temperature, submergence and suction conditions. During the latter part of the endurance test the pump shall be operated as near shutoff as possible for 12 hours continuously. The remainder of the endurance test shall be run at maximum speed and within plus 20°F, minus O°F of maximum specified liquid temperature for one half of the remaining time and at the maximum rated speed and within plus O°F, minus 20°F of the minimum specified liquid temperature the other half of the remaining time. The pump shall be operated at one-third, two-thirds, and rated capacity in approximately equal time intervals with the liquid at the maximum specified liquid temperature for one half of each portion and at the minimum specified liquid temperature for the other half of each portion. Flow control shall be achieved in a manner which simulates system operation, that is, submergence control or throttling of discharge, as specified (see 6.2). Operation shall be at minimum specified net positive suction head or submergence, or maximum suction lift or vacuum as applicable (see 6.2) for all operating temperatures.

4.6.3.1.4 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 examined at least twice per day of operation. For each periodic examination, in addition to all measured data, the record shall indicate the following:

(a) The pump packing or seal leakage rate and the percentage of gland leakage collected and drained by collection areas.
(b) The conditions of the bearings.
(c) Provisions for collection and draining gland leakage shall be 100 percent effective.
(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.

4.6.3.1.5 Endurance test acceptance criteria:

(a) The 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 tune before the 500 hour test.
(b) The unit performance and operation after 500 hours of operation shall be unchanged and normal and meet all specification requirements.
(c) The 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 to 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) The pump packing shall have performed as specified. The leakage rate shall not exceed that recommended by the supplier throughout the test.
(f) Running clearances shall be normal.
(g) Components subject to attack from corrosion, erosion, cavitation, and so forth, 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.

4.6.3.1.6 Post endurance test procedure. 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 shop tests specified in 4.6.1.1, 4.6.1.3(a) and 4.6.1.4 if applicable. The shop test documentation shall indicate that the unit was

subjected to the endurance test and subsequently restored and shop tested and that It shall be certified as fully conforming to the specification for unrestricted service.

4.6.3.2 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 and the specific shock test requirements specified herein.

4.6.3.2.1 Before and after the 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 shall be inspected by one of the applicable nondestructive test procedures, other than radiography, specified in MIL-STD-271.

4.6.3.2.2 Before and after the shock test, shop tests in accordance with 4.6.1.3 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.

4.6.3.2.3 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. 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 pump rotation. The pump shall be in operation during the first and third blow in each orientation on the medium weight shock machine. 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 minimum speed and pressure required to ensure lubrication of bearings and wearing parts. Other pumps shall be operated at the lowest rated speed.

4.6.3.2.4 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 vibration and proper functioning of controls. Turbine driven pumps may be air driven.

4.6.3.2.5 Shock test acceptance criteria:

(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 q aximum 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 shall be maintained.
(f) There shall be no significant change in the head-capacity tune.

4.6.3.2.6 Post-shock test procedure. The shock test unit, if it is to be supplied under a contract or order and if approved by the contracting activity 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 shop tests specified in 4.6.1.1, 4.6.1.3(a), and 4.6.1.4 if applicable. The shop test documentation shall indicate the unit was subjected to the shock test and subsequently restored, shop tested and inspected.

4.6.3.2.7 Unless otherwise specified (see 6.2), 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 subject to approval of the design review agency. Prime movers are subject to shock tests in accordance with the applicable equipment specifications .

4.6.3.3 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). 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 pump shall meet all specified performance requirements without damage while operating in the inclined position.

4.6.3.4 Vibration test. When specified (see 6.2), 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 and as specified (see 6.2). 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).

4.6.3.4.1 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.

4.7 Inspection of packaging. 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 acquisition. For the extent of applicability of the packaging requirements of referenced documents listed in section 2, see 6.7.)

5.1 Preservation, packing and marking. Pump units and accessories shall be preserved level A or C, and packed level A, B, or C (see 6.3) as specified (see 6.2).

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. Pumps covered by this specification are intended for condensate, boiler feed booster, waste heat boiler, and distilling plant services on board Naval ships.

6.2 Acquisition requirements. Acquisition documents must specify the following:

(a) Title, number, and date of this specification.
(b) Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
(c) When first article is required (see 3.1).
(d) Class required (see 1.2).
(e) General design required (see 3.2).

(1) Space and weight requirements (see 3.2).
(2) List, pitch, roll, trim, and other ship attitude conditions (see 3.2, 3.2.7, and 4.6.3.3).
(3) Environmental vibration frequencies (see 4.6.3.4).
(4) Airborne, structureborne, and fluidborne noise requirements (see 3.2.4 and 4.6.1.4).
(5) Ambient temperature, normal, maximum, and minimum.

(f) Performance-characteristics (see 3.2 and 3.3.2).

(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 (see 3.3.2.1.1 and 4.6.1.3).
(6) Suction head available, normal, maximum, and minimum and flow control method (see 3.3.2.1.1, 4.6.1.3, 4.6.2.1 and 4.6.3.1.3).
(7) Casing design and test pressures.
(8) Special performance requirements, if any (for example, maximum shutoff head).

(g) Whether shock mounts are to be used (see 3.2.2.1).
(h) Vibration test requirements (see 3.2.3, 4.6.3(d), and 4.6.3.4).
(i) Noise test, if required, and noise level limits (see 3.2.5, 4.6.1(d), and 4.6.1.4).
(j) Horizontal or vertical mounting (see 3.2.6).
(k) Bedplates for close-coupled pumps (see 3.2.6.2.2).
(l) Type of pressure regulating governor (see 3.2.11).
(m) Gauge connections (see 3.2.11).
(n) Ordering data for driver (see applicable specification; MIL-T-17523 for turbines (see 3.2.13); MIL-M-17413 or MIL-M-17060 for motors (see 3.2.14); whether motors are for submarine service.
(o) Class of motor insulation (see 3.2.14.3).
(p) Ordering data for electrical controllers, if required (see MIL-C-2212 and 3.2.15).
(q) Additional requirements for valves, flanges, fittings, and bolting for pipe connections (see 3.2.18).
(r) Type of driver (see 3.2.22).
(s) Coupling (see 3.3.1).
(t) If suction and discharge connection requirements are other than specified (see 3.3.4).
(u) Diameter of hatch through which pump must pass (see 3.3.7.2).
(v) If pressure regulating governor is required (see 3.3.12).
(w) If pump is to be shock tested without driver (see 4.6.3.2.7).
(x) Level of presentation, packing, and marking (see 5.1).
(y) Designation of manufacturer (pump or driver) responsible to the purchaser for compatibility of pump and driver and operation of the assembled units.

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DIDs) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/ provided and that the DIDs are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DoD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

Reference Paragraph	DID Number	DID Title	Suggested Tailoring
3.2.1	UDI-E-23216	Report, variation transmittal/referral letter	-----
3.2.1	DI-M-22404	Technical repair standard	-----
3.3.1	DI-E-7031	Drawings, engineering, and associated lists	Level 2 or 3
3.2.7	UDI-E-23253	Diagrams, calculation and stress	-----
3.3.11.2	DI-E-2121	Certificate of compliance	-----

Reference Paragraph	DID Number	DID Title	Suggested Tailoring
4.4	UDI-T-23732	Procedures, test	-----
4.4	DI-T-2072	Reports, test	-----
5.1	DI-PACK-80120	Preservation and packing data	-----

The above DIDs were those cleared as of the date of this specification. The current issue of DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL) , must be researched to ensure that only current, cleared DIDs are cited on the DD Form 1423.

6.4 Technical manuals. The requirement for technical manuals should be considered when this specification is applied on a contract. If technical manuals are required, military specifications and standards that have been cleared and listed in DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL) must be listed on a separate Contract Data Requirements List (DD Form 1423), which is included as an exhibit to the contract. The technical manuals must be acquired under separate contract line item in the contract.

6.5 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerors whether the items should be a first article sample, a first production item, a sample selected from the first _ productions items, a standard production item from the contractor's current inventory (see 3.1), and the number of items co be tested as specified in 4.3. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection 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. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

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

6.6.1 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,

6.7 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.

6.8 Subject term (key word) listing.

Auxiliary pump
Condensate
Main pump

6.9 Changes from previous issue. Marginal notations 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-N249)

INDEX

INDEX -

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-P-18472G(SH)	PUMPS, CENTRIFUGAL, CONDENSATE, FEED BOOSTER, WASTE HEAT B

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 Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)

DD FORM 82 MAR 1426

PREVIOUS EDITION IS OBSOLETE

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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