INCH-POUND

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MILITARY SPECIFICATION

PUMPS, CENTRIFUGAL, BOILER FEED, SINGLE STAGE, NAVAL SHIPBOARD USE

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 the requirements applicable to the design and construction of turbine driven horizontal, centrifugal, close-coupled, single-stage boiler feed pumps on board Naval ships.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (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 55Z3, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 4320

SPECIFICATIONS

FEDERAL

GGG-E-950	Extractor, Stuffing Box and Pump Packing (and Tamper); and Extractor, Lantern Gland
GGG-P-781	Puller, Mechanical Puller Attachment, Mechanical, and Puller Set, Mechanical
QQ-S-763	Steel Bars, Wire, Shapes, and Forgings, Corrosion Resisting
TT-P-28	Paint, Aluminum, Heat Resisting (1200 °F)
TT-P-645	Primer, Paint, Zinc-Molybdate, Alkyd Type

MILITARY

MIL-S-860	Steel Forgings for Steam Turbine Rotors
MIL-S-901	Shock Tests, HI (High-Impact) Shipboard Machinery, Equipment and Systems, Requirements for
MIL-E-917	Electric Power Equipment, Basic Requirements (Naval Shipboard Use)
MIL-C-1212	Contractors and Controllers, Electric Motor AC or DC, and Associated Switching Devices
MIL-S-1222	Studs, Bolts, Hex Cap Screws, Socket Head Cap Screws and Nuts
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)
MS 16142	Boss, Gasket Seal Straight Thread Tube Fitting, Standard Dimensions for
MIL-P-16789	Pumps (Including Prime Movers and Support Items); Packaging of

MIL-M-17059	Motors, 60-Cycle, Alternating Current, Fractional HP (Shipboard Use)
MIL-M-17060	Motor, 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 HP, Naval Shipboard
MIL-T-17523	Turbine, Steam, Auxiliary (and Reduction Gear) Mechanical Drive
MIL-M-17556	Motor, Direct-Current, Fractional HP (Shipboard Use)
MS 18229	Plug for "O" Ring Gasket
MIL-P-18472	Pumps, Centrifugal, Condensate, Feed Booster, Waste Heat Boiler and Distilling Plant
MIL-P-19131	Pumps, Rotary, Power Driven, Miscellaneous
MIL-S-22473	Sealing, Locking and Retaining Compounds (Single Component)
DOD-F-24669	Forgings and Forging Stock, Steel Bars, Billets and Blooms, General Specification for; (Metric)
MIL-C-24707	Castings, Ferrous, General Specification for
MIL-C-24707/1	Castings, Ferrous, for Machinery and Structural Applications
MIL-C-24707/3	Castings, Ferrous, Corrosion Resistant, Austenitic, Chromium-Nickel
MIL-C-24707/6	Castings, Ferrous, Chromium Steel, for Pressure – Containing Parts Suitable for High Temperature Service

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 Foams

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-740-1	Airborne Sound Measurements and Acceptance Criterion 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-1399 Section 301	Interface Standard for Shipboard Systems Section 301A Ship Motion and Attitude (Metric)

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, 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, Standard Application of
NAVSHIPS B-214	Root Connections for Attached Piping
810-1385850	Piping, Gage for All Services

(Copies of the drawings are available from the Commander, Portsmouth Naval Shipyard, Code 202.2, Portsmouth, NH 03801.)

PUBLICATIONS

NAVSEA

0900-LP-001-7000 Fabrication and Inspection of Brazed Piping Systems

(Copies of this publication are available from the Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

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 non-government 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 193	Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service; (DOD adopted)
A 194	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service; (DOD adopted)
A 276	Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes; (DOD adopted)
A 336	Standard Specification for Steel Forgings, Alloy, for Pressure and High-Temperature Parts; (DOD adopted)
A 743	Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application; (DOD adopted)

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

HYDRAULIC INSTITUTE

Test Code of Standards Centrifugal Pump Section

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

(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 6.4) in accordance with 4.3.

3.2 General design. The design and construction of pumps shall be in accordance with the space and weight requirements as specified (see 6.2 and 6.3). The pump unit shall perform under the list, pitch, roll, and trim conditions in accordance with MIL-STD-1399, section 301. Pumps shall operate continuously at any point over the entire flow range and design conditions as specified (see 6.2).

3.2.1 Reliability. The requirements of this specification are imposed exclusively to obtain equipment of utmost reliability for the service intended. The assurance of maximum reliability shall be the paramount controlling principle in the design, fabrication, assembly, and testing of this equipment. Users of and contractors to this specification are urged to communicate to NAVSEA any findings related to the requirements or lack of requirements of this specification whereby improvement of equipment reliability can be achieved.

3.2.2 Maintainability. The equipment specified herein shall be operated, maintained, and repaired on board Navy ships. Attention is directed to the high equipment density of shipboard machinery spaces, to the fact that maintenance and repair will be made underway in heavy seas, that equipment will operate unattended, and that maintenance personnel may not be seasoned mechanics. The requirements for maximum reliability directly relates to those shipboard environmental and service conditions, and those requirements shall be fully considered in the pump design. The aspects of "human engineering" shall also be fully explored and considered in the equipment design to minimize the possibility of failure through improper operation and maintenance and to preclude personnel safety hazards.

3.2.2.1 Maintenance. The equipment shall have maximum repair accessibility for ease of examination of wearing parts and for simplicity of disassembly and proper reassembly. Positioning and alignment of parts in assembly shall employ positive means such as shoulder, tongue, and groove, or other locating techniques whereby correct reassembly is repeatedly assured. In consonance with the concept of ease of maintenance and where not otherwise specified, the pump

designer shall consider all of the following features for incorporation in the design and technical documentation wherever such incorporation will significantly contribute to ease of maintenance without compromising performance reliability:

a. Lifting lugs
b. Casing assembly guide pins
c. Alignment and positioning dowels
d. Jacking screws
e. Re-makeable piping connections
f. Piping out of way of maintenance access
g. Ease of packing, bearing, and wearing ring replacement
h. Split casing, bearing housings, and so forth
i. Warning plates to prevent casualties to equipment and personnel
j. Provisions for connecting instruments for performance evaluation
k. Attached instruments for monitoring performance
l. Visibility and access to attached instruments
m. Thoroughness of operating instructions
n. Thoroughness of preventive maintenance instructions
o. Explicit assembly and disassembly instructions
p. Exploded views of critical assemblies
q. Adequate system diagrams.

3.2.2.2. 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. It shall be assumed that during the life of the pump, parts subject to unavoidable wear and deterioration (with the exception of packing and seals) will be replaced at intervals no shorter than 3 years. The parts subject to wear, deterioration, and normally requiring replacement at 3-year intervals during the service life of the pump (with the exception of packing and seals) shall have a life of 10,000 actual operating hours, and they shall be identified in appropriate drawings and manuals.

3.2.3 Shock and vibration.

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

3.2.3.2 Mounts. Shock mounts (resilient mounts for shock attenuation) shall not be used. When noise attenuation mounts are specified (see 6.2), the pump shall pass the specified shock test without attenuation mounts.

3.2.3.3 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 no more than 1/16 inch larger than bolts of greater than 3/4-inch size.

3.2.3.4 Vibration. Pumps shall not be damaged or caused to malfunction by either environmental vibrations or by internally excited vibrations. When specified (see 6.2), units furnished under this specification shall be tested in accordance with MIL-STD-167-1, types I and II.

3.2.4 Alignment.

3.2.4.1 Stress. The design 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.

3.2.4.2 Attachment. Alignment between separate components of a unit shall be maintained by means of keyways, rabbeted or tongue and groove joints, fitted bolts, or other means.

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

3.2.5 Noise. The design, construction, and workmanship of the equipment shall be such that noise levels during operation at the design conditions will meet the airborne noise and structureborne vibration noise requirements as specified (see 6.2 and 4.6.4).

3.2.6 Mounting.

3.2.6.1 Pump. Pump units shall be horizontally mounted.

3.2.6.2 Bedplate. Each pump unit, complete with all appurtenances, shall be mounted on a common bedplate.

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

3.2.6.4 Surfaces. Bearing and seating surfaces of bedplates shall be finish machined (see 3.2.7.3.1).

3.2.6.5 Oil reservoir. The reservoir for bearing lubricating oil shall be incorporated into the bedplate and shall be of the material specified in MIL-T-17523.

3.2.6.6 Fabrication. Bedplates shall be either cast or fabricated by welding.

3.2.6.7 Dowels. Each part of an assembled unit supported directly by a bedplate shall be doweled thereto to facilitate reassembly and maintenance of alignment.

3.2.7 Bearings. Suitable bearings shall be installed in each pump unit for counteracting (a) any unbalanced hydraulic or mechanical thrust in either direction and (b) 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 and determine that the bearings are suitable for this loading (see 6.3).

3.2.7.1 Radial sleeve bearings.

3.2.7.1.1 Type. Radial bearings shall be of the sleeve type.

3.2.7.1.2 Construction. A radial sleeve bearing shall consist of a housing, shell, and liner. The housing shall be of a split design consisting of a cap bolted to the base and shall contain the bearing shell and liner. The liner may be either cast in the shell or may be a removable insert.

3.2.7.1.3 Lubrication. Oil lubricated bearings shall be separate from and independent of the pump stuffing boxes and adequately protected from gland leakage. Means shall be provided to prevent the escape of oil around the shaft. Baffles and wipers shall be readily renewable.

3.2.7.2 Thrust bearings.

3.2.7.2.1 Type. Thrust bearings shall be of the pivoted segmental type.

3.2.7.2.2 Shoe replacement. The design of the pivoted segmental type bearing shall permit renewal or replacement of shoes without removal of the shaft.

3.2.7.2.3 Lubrication. The thrust bearing housings shall be designed so that the thrust bearing will be adequately lubricated immediately when the shaft starts to turn. This shall be accomplished by properly locating lubricant supply and drain pipes and adequately sealing the bearing housing so that regardless of the length of time the unit is idle, an adequate supply of lubricant will remain in the bearing housing.

3.2.7.3 Installation.

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

3.2.7.3.2 Housings. Bearing housings shall be cast integral with the bracket or secured thereto in such a manner as to ensure alignment. Bearing housing to bracket seats shall be machined so that precision of bearing alignment is assured.

3.2.7.3.3 Brackets. Each bearing housing shall be supported by a bracket that is cast integral with the turbine casing, securely bolted to the turbine casing on a machined shoulder, or held in alignment with the turbine casing by at least two heavy dowels and securely bolted thereto. The use of bolts alone for securing brackets is prohibited.

3.2.7.4 Water lubricated bearings. Water lubricated bearings will be considered when specifically requested by the pump manufacturer. The use and design of water lubricated bearings shall be subject to the approval of the design review activity.

3.2.8 Lubrication.

3.2.8.1 Force feed lubrication. A simple, positive, and self-contained forced feed lubrication system shall be provided on each turbine driven pump assembly in accordance with MIL-T-17523.

3.2.8.2 Oil pumps. If oil lubricated bearings are used, a motor driven auxiliary oil pump shall be provided, in addition to the direct connected pump and the hand operated pump, to be used for bearing lubrication during shutdown. The pump shall be in accordance with class 0-2 of MIL-P-19131 and the motor shall be in accordance with MIL-M-17059 or MIL-M-17060 for alternating current (ac) motors, or in accordance with MIL-M-17413 or MIL-M-17556 for direct current (dc) motors as specified (see 6.2). Each unit shall be connected with a pressure switch that will cut in automatically upon a reduction in oil pressure.

3.2.8.3 Lubricants. Oil lubricants shall be in accordance with MIL-L-17331, military symbol 2190-TEP. The design shall be such that any qualified oil in accordance with MIL-L-17331, military symbol 2190-TEP, can be used interchangeably with any other qualified product to the same specification.

3.2.8.4 The lubricating oil sump filing connection shall be provided with a breather cup of adequate size.

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. Internal spiral wound gaskets shall be completely enclosed to prevent the gasket from unwinding and entering the fluid system.

3.2.10 Threaded fasteners. Threaded parts, such as bolts, studs, and nuts, shall be in accordance with 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 activity and approved by the design review activity and where the use of through bolts or studs is impractical. The setting end of the studs shall be a class 3 fit with anaerobic locking compounds in accordance with MIL-S-22473, grade AV. The nut end shall be a class 3 fit. The recommendations of the anaerobic locking compound manufacturer regarding the use of a primer shall be adhered to (see appendix A, 30.1.2.3.2). Studs installed using anaerobic locking compound

shall be inspected with a procedure proposed by the pump manufacturer in accordance with DOD-STD-1371 and approved by the design review activity. The inspection method shall be shown on the pump drawing.

3.2.10.1 Stud engagement. The length of minimum stud engagement shall be computed in accordance with FED-STD-H28. Unless otherwise specified (see 6.2), threaded fasteners of normally stocked lengths shall be used. Male threads on threaded fasteners shall protrude at least one thread beyond the top of the nut or plastic locking element. Excessive protrusion shall be avoided, particularly where necessary clearances, accessibility, and safety are important. Where practical, the number of threads protruding shall not exceed five; however, in no case shall thread protrusion exceed ten threads. Washers shall not be used for the sole purpose of lessening thread protrusion.

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

3.2.11.1 Flanged connections. Pumps shall be fitted with flanged connections conforming to NAVSHIPS Drawing B-214 for suction and discharge pressure gauges or MS connections in accordance with MS 16142, as specified (see 6.2).

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

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

3.2.13 Turbines.

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

3.2.13.2 Turbine deviations.

3.2.13.2.1 Continuous shaft. Deviations from the turbine design specifications in accordance with MIL-T-17523 to permit a design incorporating a continuous shaft and overhung turbine wheel are acceptable subject to approval by the design review activity.

3.2.13.2.2 Temperature limitation. For a temperature limitation of 650 degrees Fahrenheit (°F), rotors and shafts shall be forged steel in accordance with grade C of MIL-S-860. For a temperature limitation of 1050 °F, the rotors and shafts shall be of forged steel in accordance with grade F of MIL-S-860.

3.2.13.2.3 Safety factors. When material is subjected to a design temperature in excess of 650 °F, the design of the parts concerned shall be based upon appropriate safety factors determined by:

a. Yield strength
b. Stress rupture (40,000 hours)
c. Creep (0.1 percent) (40,000 hours).

3.2.13.2.4 Blades and rotors. Blades and bladed rotors shall be designed so that the average stress in the most highly stressed cross-section of the blades or bladed rotor, under design operating conditions, shall not exceed a stress value corresponding to a minimum calculated factor of safety of 2.0 based upon:

a. The yield strength (0.2 percent offset) of the material
b. Stress rupture of the material.

3.2.13.2.5 Calculations. The turbine manufacturer shall furnish calculated curves of horsepower (hp) versus steam consumption and hp versus speed both with and without the use of hand overload nozzle valves (if installed).

3.2.14 Motors.

3.2.14.1 Type. Motors for auxiliary oil pumps shall be totally enclosed fan-cooled with sealed insulation service A and shall be in accordance with MIL-M-17413 or MIL-M-17556 for dc or with MIL-M-17059 or MIL-M-17060 for ac motor (see 6.2).

3.2.14.2 Insulation. Motor insulation shall be in accordance with MIL-E-917. Regardless of class of insulation used, motor temperature rise at rated full motor load shall not exceed 70 degrees Celsius (°C) in 50 °C ambient in accordance with class B insulation of MIL-M-17060.

3.2.15 Controllers. Motor controllers shall be in accordance with MIL-C-2212 for ac and dc and shall have the characteristics as specified (see 6.2).

3.2.16 Painting. For units operating at a temperature of 300 °F or less, all external unmachined surfaces of ungalvanized ferrous metal parts shall be thoroughly cleaned and coated with one coat of pretreatment in accordance with DOD-P-15328, one coat of zinc chromate primer in accordance with TT-P-645 or red lead primer in accordance with formula 84 of TT-P-645, followed by a finish coat of light gray equipment enamel in accordance with MIL-E-15090. For pumps operating at a temperature over 300 °F, whether insulated or not, all external unmachined

surfaces of ferrous metal parts shall be thoroughly cleaned and coated with two coats of heat-resisting paint in accordance with TT-P-28.

3.2.16.1 External painting. External surfaces of nonferrous parts shall not be painted.

3.2.17 Identification plates.

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

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

3.2.17.3 Plates. Pump identification plates shall contain data as follows:

a. Manufacturer's name

b. Manufacturer's model or type and size

c. Service application

d. Manufacturer's serial number

e. Salient design characteristics:

(1) Capacity in gallons per minute (gal/min)

(2) Total head in pounds per square inch (lb/in^2)

(3) Speed of shaft in revolutions per minutes (r/min)

(4) Brake hp

(5) Test pressure

(6) Special data vital to the unit:

(a) Suction pressure

(b) Submergence

(c) Impeller diameter

f. Contract number and item number for multiple unit orders

g. National stock number

h. Section for Defense Contract Administration Services Management Area (DCASMA) stamp

i. NAVSEA technical manual number

j. Certification data drawing number.

3.2.17.4 Driving and accessory units. 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.

3.2.18.1 Connections. Valves, flanges, fittings, and bolting for pipe connections shall be in accordance with MIL-STD-777 and as specified in the contract or order (see 6.2). All pump flanges except for welded connections shall have a face circular lay finish in accordance with MIL-STD-777.

3.2.18.2 Fittings. Tapered pipe threads are prohibited except for grease fittings located in nonmoving parts. Fittings not covered by these specifications for application when ship connections are not involved shall be submitted for review by the design review activity.

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

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 **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.

3.3 **Detail requirements.**

3.3.1 **Mounting.** Pumps shall be horizontally mounted.

3.3.2 **Performance characteristics.**

3.3.2.1 **General.** The performance characteristics of the pump shall be as specified (see 6.2).

3.3.2.2 **Suction.** Pump suction conditions shall be as specified (see 6.2).

3.3.2.3 **Head-capacity curve.** The head-capacity curve of the pump shall rise continuously from rated capacity to shut-off so that, at constant rated speed, the shut-off pressure will be at least 15 percent greater than at rated capacity.

3.3.2.4 **Rated capacity.** At constant rates speed the pumps shall develop 120 percent rated capacity at a pressure not less than 80 percent of rated discharge pressure.

3.3.2.5 **Parallel operation.** Pumps shall be designed to operate satisfactorily in parallel with other pumps without surging under all conditions of operation from shut-off to full capacity when operating under any of the following methods of control of the driving unit:

a. Unit operating at constant speed under control of speed limiting governor
b. Unit operating at variable speed under control of pressure governor.

3.3.2.6 **Steam pressure drop.** The steam pressure drop through the pump pressure regulating governor shall be considered when rating turbine driven pumps.

3.3.2.7 **Series operation.** Pumps shall be designed to operate in series with class E pumps in accordance with MIL-P-18472.

3.3.3 **Casings.**

3.3.3.1 **Design.** The casings shall be designed to facilitate the ready removal and replacement of pump shaft, internal bearings, impellers and turbine rotor.

3.3.3.2 **Thickness.** Casing thickness shall include an allowance for corrosion and the possibility of core shift. The minimum casing thickness shall be 1 inch.

3.3.3.3 Strength. Casings shall be sufficiently rugged to withstand without fracture or appreciable distortion the strains to which they may be subjected. The nozzle loadings to which the pump will be subjected will be calculated by the shipbuilder and forwarded to the pump contractor by the contracting activity (see 6.2).

3.3.3.4 Clearance. 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.)

3.3.3.5 Fitted bolts and dowel pins. Fitted bolts or dowel pins shall be provided to 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.

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

3.3.3.7 Drains and vents. Casings of pumps shall be fitted with drain and vent connections. Drain connections shall be in accordance with MS 16142 and MS 18229 and shall permit complete drainage of the pump without disassembly of the pump.

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

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

3.3.3.9.1 Spare rings. Spare casing wearing rings (see 6.5.2) shall be machined undersize by at least 0.050 inch on the diameter in order to permit finish machining during shipboard installation to mate with used impellers.

3.3.3.10 Joint gaskets. Pump casing joints shall be made up using compressible sheet gaskets.

3.3.4 Suction and discharge connections.

3.3.4.1 Flanging. Unless otherwise specified (see 6.2), suction and discharge connections shall be flanged for mating with flanges in accordance with MIL-STD-777.

3.3.4.2 Nozzles. The suction and discharge nozzles shall face vertically upward.

3.3.5 Impellers.

3.3.5.1 Type. Unless otherwise specified in the contract or order (see 6.2), impellers shall be of the closed type. Outside surface of impellers shall be smooth finished.

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

3.3.5.3 **Hub surfaces.** Impellers shall not be fitted with wearing rings. The impeller hub wearing surfaces shall have material thickness to permit reaching the diameter of the impeller hubs by as much as 0.050 inch to accommodate undersize casing wearing rings to restore design running clearances.

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

3.3.6 **Shafts.**

3.3.6.1 **Threading.** Shaft threading shall be counter to the direction of rotation.

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

3.3.6.3 **Flingers.** Shaft flingers shall be provided adjacent to the gland. 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 the bearings.

3.3.6.4 **Keys.** Keys shall be used in the shaft to prevent relative rotation between the impeller and shaft.

3.3.7 **Rotating assembly.**

3.3.7.1 **Dynamic balance.** Rotors shall be dynamically balanced with all rotating parts connected thereto. However, rotating parts may be balanced individually provided that, when assembled, the imbalance shall not exceed the limits in accordance with MIL-STD-167-1.

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

3.3.7.3 **Maximum operating speed.** The pump design shall be such and calculations shall be made to demonstrate that the maximum operating speed of the pump will be not less than 120 percent of the first critical speed.

3.3.7.4 **Balancing.** Pumps shall be hydraulically balanced.

3.3.8. **Pump seals.**

3.3.8.1 Leakage. Pump seals shall be designed to ensure that leakage is reduced to a minimum and cannot reach the bearings, be thrown over bearing housings, or enter the driving units. Ample drip pockets, spray shields, and drains shall be provided.

3.3.9 Couplings. Couplings are not used in this design since both the pump impeller and turbine wheel utilize a common shaft.

3.3.10 Material. The materials of the pump shall conform to the materials specified in table I. However, this specification is not intended to be restrictive provided proposed alternative materials will give equal or better service than the material specified. Proposed alternative materials shall be subject to approval by the design review activity. 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 pass the intergranular corrosion tests of the base material specifications. Particular attention should 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 (see 6.3).

3.3.10.1 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.

3.3.10.2 Mercury prohibition. When specified (see 6.2), pumps, drivers, and auxiliary parts furnished by the pump contractor shall be free of mercury contamination and free of functional mercury (see 6.3). 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.

3.3.11 Part interchangeability. All parts for pumps manufactured to the same drawings shall be interchangeable. In no case shall parts be physically interchangeable or reversible unless such parts are also interchangeable functionally and from considerations of strength.

3.4 Tools. Tools which are available in the Federal Supply Catalog, such as common wrenched and standard pullers and extractors, will not be required. Standard complete or limited sets of pullers or extractors or parts of puller sets in accordance with GGG-P-781 or GGG-E-950 shall be identified as to type and use in notes on the outline or sectional assembly drawings. Special tools shall be detailed and included in the list of material. Special tools required for the maintenance and repair of the pump units shall be furnished. The number of sets of special tools of the pump units shall be as specified (see 6.2). Special wrenches shall be of forged steel with hardened jaws. Special tools are defined as those tools not listed in the Federal Supply Catalog (see 3.3.3.4).

TABLE I. *Pump materials.*

Application[1]	Material[2]	Specification	ASTM or other designator
Casings	Steel casting[4]	MIL-C-24707/6	CA-15[3]
	Forged steel	MIL-S-860, C1 B or C	A 193, C1 2 or 3
	Forged steel[4]	DOD-F-24669/6	A 336, class F6
Casing bolts	Steel, carbon or alloy	MIL-S-1222, grade 4, B7, or B16	A 194, grade 4, 7, or or 7M; A 193, grade B7 or B16
	Forged steel	MIL-S-860, C1 B, C, D, E	A 276, type 302 or 304
Casing wearing rings[5]	Steel casting[4]	MIL-C-24707/6	CA-15
	Stainless steel	QQ-S-763, class 410	A 276, type 410
	Stainless steel	Ni-Cr-Mo-Sn-Bi	Waukesha 88
	Stainless steel	Ni-Sn-Pb-Zn-Mn	Waukesha 23
Balance drum	Stainless steel	QQ-S-763, class 440A	A 276, type 440A
Diffusers	Steel casting[4]	MIL-C-24707/6	CA-15
	Steel casting[6]	MIL-C-24707/5	A 743, grade CF8
	Steel casting	17-4 PH, Cond H-1025	AMS5355 or 5398
Impellers	Steel casting	17-4 PH, Cond H-1025	AMS5355 or 5398
	Steel casting[7]	MIL-C-24707/6	CA-15
Shafts	Forged steel	MIL-S-860, grade C	–
Bedplate	Cast steel	MIL-C-24707/1	A 27, grade N-2
	Structural steel	–	–

[1]If accessory parts, such as vent petcocks and drain plugs, are subject to galling, they shall be of a more noble material than the major part or have a difference of not less than 50 Brinell hardness number (Bhn).
[2] Detail drawings and lists of material shall reference the specification followed in each case (preferably in the order specified in appendix A, 30.2.1) and shall include the class, type, or grade of material.
[3]CA-15 is a designation for an alloy as specified by the Alloy Casting Institute.
[4]Twelve percent chrome.
[5]A wearing ring and its opposing surface shall be of dissimilar material or shall have a difference in hardness of not less than 50 Bhn.
[6]Eighteen percent chrome.
[7]Twelve percent chrome hardened to not less than 250 Bhn or more than 300 Bhn.

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 the specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must 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 acceptance of defective material.

4.1.2 Test instrumentation. All instruments used in performance acceptance tests shall be calibrated before and after tests. No instruments containing mercury shall be used in the manufacture or testing of any equipment destined for installation on a nuclear powered ship. This point shall be covered in the manufacturer's inspection system procedures.

4.1.3 Variations. No variations or deviations from approved design drawings will be permitted (see appendix A, 30.1.2).

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

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

4.3 First article inspection. First article inspection shall be performed on each class (see 6.3 and appendix C). The several first article tests on one pump design may be conducted concurrently, if practicable. The following tests shall be performed:

a. Performance evaluation tests specified in 4.6.6 through 4.6.6.3 and the examination specified in 4.5

b. Design evaluation tests as specified in 4.6.7 through 4.6.7.4.1.

4.3.1 First article inspection shall include all sizes of each class.

4.4 Quality conformance inspection. Each pump (and subcomponents of each pump, if applicable) shall be examined as specified in 4.5 and tested as specified in 4.6.1 through 4.6.5 (see 6.3 and appendix C).

4.5 Examination. Pumps shall be examined in accordance with a completed parts examination checklist accompanying each part or assembly. The examination shall be performed by inspection personnel not engaged in the fabrication and assembly of the part. The specific attributes which determine the part's acceptability are:

a. *Dimensions.* Dimensions 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.* Materials shall be visually examined for compliance with approved design drawings. Any appearance of nonconformance shall be further verified by appropriate tests.

c. *Cleanliness.* Examination for cleanliness shall apply equally to parts examination prior to assembly as well as subassemblies of 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 or 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 preservation used, the methods 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 checklist.

4.6 Test methods (see 6.8).

4.6.1 Hydrostatic pressure test. Pressure boundary parts shall be tested hydrostatically to a pressure one and one-half times the maximum discharge pressure, 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.

4.6.2 Overspeed and other turbine driver tests.

4.6.2.1 Overspeed. Each unit shall be tested in the shop of the manufacturer or contractor at 25 percent above the speed corresponding to full load rating by a continuous nonstop run of at least 30 minutes. This test shall check operation and smoothness of running. While running at this speed, the pump need not be loaded except as necessary to prevent injury.

4.6.2.2 Casings. Unless otherwise specified (see 6.2), all turbine casings other than steam chests, including all fittings and connections subject to steam pressures, shall be tested hydrostatically to a pressure at least 50 percent greater than the maximum working pressure, but in no case less than 50 lb/in^2.

4.6.2.3 Steam fittings. Inlet steam fittings and connections, such as steam chests, throttle valves, and nozzle chambers, shall be tested hydrostatically after assembly to a pressure of 2060 lb/in^2 for turbines operating off a 1200 lb/in^2 steam system and to a pressure 1000 lb/in^2 for turbines operating off a 600 lb/in^2 steam system.

4.6.2.4 Oil supply piping. Installed lubricating oil supply piping shall be tested under a hydrostatic pressure of at least 150 lb/in^2 or five times the maximum working pressure for piping close to hot surfaces. Inspection shall be made for leakage at joints and fittings. Drainage piping may be tested at the same pressure or separately at 100 lb/in^2.

4.6.2.5 Oil cooler piping. Oil cooler circulating piping shall be tested with the cooler or tested separately at 100 lb/in^2.

4.6.2.6 Sumps. Oil sumps shall be tested by filling with water and carefully inspecting for leakage; any leakage shall be corrected.

4.6.2.7 Auxiliary equipment. Each auxiliary lubricating oil pump, driving motor, and motor controller shall be tested in accordance with requirements of the applicable military specification.

4.6.3 Mechanical soundness and capacity test. This test shall be conducted 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 shall be performed as follows:

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

Acceptance criteria: Unit operation shall be without heating and shall be free of vibrations in accordance with MIL-STD-167-1 and noises in accordance with MIL-STD-740-1. Oil temperature rise in force-feed lubricated bearings shall not exceed 40 °F with inlet cooling water to the oil cooler at 85 °F. Controls and attached instruments shall function as specified and be in calibration. There shall be no leakage of water or oil that is not dictated by design.

b. Operate the pump at the maximum rated speed with the pumped fluid at maximum normal temperature from recirculation flow to as close to free delivery as practicable and with the minimum specified suction pressure prevailing. The unit shall be operated at seven or more test points throughout the full operating range to establish accurately the head-capacity curve at maximum rated speed. The until shall be operated at each test point until the test values being measured stabilize. In addition to the above testing, determine the required net positive suction head (NPSH) at maximum rated speed at maximum flowrate.

Acceptance criteria: The pump shall deliver the rated capacity and head. The head-capacity curve at maximum rated speed shall satisfy the specified requirements. The total head at all capacities on the curve shall not deviate by more than plus 5 percent of rated heads. In no case shall the pump deliver less than the rated head. The required NPSH shall not exceed the minimum NPSH available as specified (see 6.2).

4.6.4 Noise tests. When specified (see 6.2), airborne and structureborne noise tests shall be conducted in accordance with MIL-STD-740-1 and MIL-STD-740-2 (see 6.3). Noise tests shall be performed with the driver furnished with pump, and tests shall be conducted on all units. Airborne noise tests shall be conducted on the lead unit only on each contract or order.

Acceptance criteria: The unit shall meet the noise level limits specified (see 6.2).

4.6.5 Non-destructive inspection and ultrasonic inspection. Non-destructive inspection, welding, and inspection of welds shall be in accordance with MIL-STD-278 and MIL-STD-271.

4.6.6 Performance evaluation tests.

4.6.6.1 Turbines. Turbines shall be tested as required in accordance with MIL-T-17523.

4.6.6.2 Performance evaluation. One complete pump of each size on each contract or order shall successfully undergo the performance evaluation tests to establish the complete pump performance map and to ascertain compliance with the specified performance requirements. These tests shall include a continuous operating run at rated capacity, pressure, and speed for 100 hours.

4.6.6.3 Governor adjustment. The functioning of the speed governors shall be carefully observed during these tests, and all adjustments that may be necessary to ensure satisfactory operation of all normal operating speeds shall be made before the units are accepted. The governors shall function as specified in the turbine specifications. When pressure regulating governors are specified, the foregoing requirements shall apply to this equipment also, and compliance with the governor specifications shall be demonstrated.

4.6.6.3.1 Test sequence. Performance acceptance tests for the pump and turbine shall be conducted at the same time and shall include the inclined operation tests as specified for the driving unit. For inclined operation tests, the unit shall be run at maximum operating speed, but need not be fully loaded.

4.6.6.4 Test objective. Performance acceptance tests shall adequately demonstrate the ability of the pump to handle its rated capacity of specified liquid at the maximum temperature and minimum suction head.

4.6.7 Design evaluation tests. One pump of each type, design, and size complete with the driver and all appurtenances and controls shall successfully undergo the design evaluation tests specified herein (see 6.3). Design changes which in the opinion of the design review activity 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 activity 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 the contractor can demonstrate to the satisfaction of the design review activity concerned that the pump to be offered has been proven in previous Navy shipboard service under conditions equally as strenuous as those specified (see 6.2). The design evaluation tests shall consist of the following:

a. Endurance test (see 4.6.7.1)
b. Shock test (see 4.6.7.2)
c. Inclined operation test (see 4.6.7.3)
d. Vibration tests (if specified (see 6.2 and 4.6.7.4).

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

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

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

4.6.7.1.3 Operating variation. The endurance test shall not be continuous but shall be interrupted by at least three rest periods of a minimum of 8 hours each. The remainder of the endurance tests shall be run at maximum rated speed and within plus 20 minus 0 °F of maximum specified liquid temperatures. The pump shall be operated at one-third, two-thirds, and rated capacity in approximately equal time intervals. Operations at rated capacity shall be at minimum specified NPSH available or maximum specified suction lift or vacuum, as applicable.

4.6.7.1.4 Test monitoring. The pump shall be monitored during the endurance test to accurately determine the conditions of operation, the capacity delivered, the total head developed, the speed at which operated, and the general performance observed. This shall be done and the pump inspected at least twice per day of operation. For each periodic inspection, in addition to all measurements, the following shall be determined:

a. The amount of gland leakage collected and drained by the collection area.

b. The conditions of bearing (by audible noise; by feel; and by bearing temperature by means of a probe if the design includes provisions for a probe, otherwise by means of a surface pyrometer on a normally exposed surface; no disassembly required).

c. The airborne noise level in accordance with MIL-STD-740-1

d. The vibration level in accordance with MIL-STD-167-1

e. All other abnormal findings

f. All adjustments made

g. Changes made in the conditions or method of operation.

4.6.7.1.5 Endurance test acceptance criteria:

a. Head-capacity curve at maximum rated speed after 500 hours of pump operation shall conform to the specification requirements and shall show no abnormal deviations from the curve before the 500-hour test.

b. Unit performance and operation after 500 hours of operation shall be unchanged and normal and meet all specification requirements.

c. Unit operation at the end of the endurance test shall be smooth and shall exhibit noise and vibration levels that are in accordance with the specification.

d. Lubrication shall have remained satisfactory throughout the test period. Bearing temperatures shall have remained within 35 °F and shall be consistent with their respective bearing clearances and oil limitations (temperature inlet 120 °F–130 °F and drain 165 °F maximum).

e. Running clearances shall not increase more than 50 percent.

f. Components subject to attack from corrosion, erosion, cavitation, and so forth shall be in a condition commensurate with 500 hours of service.

g. 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.

h. No failures shall have occurred throughout the 500-hour test.

4.6.7.1.6 Post endurance test procedures. The unit subjected to the 500-hour endurance test shall be restored to the as-new condition by replacement of all parts worn beyond the as-new design tolerances. The restored unit shall successfully pass the tests specified in 4.6.1, 4.6.3.a., and 4.6.4, if applicable.

4.6.7.2 Shock test. The pump shall undergo a shock test to ascertain that the pump has the necessary shock resistance. The shock test shall be performed in accordance with MIL-S-901, grade A, and the specific shock test requirements (see 6.2).

4.6.7.2.1 Internal derangement. Before and after the 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. The condition of each component and assembly shall be determined and recorded. Shafts, impellers, turbine rotors, and motor rotors shall be inspected by one of the applicable non-destructive test procedures, other than radiography, in accordance with MIL-STD-271.

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

4.6.7.2.3 Test conditions. 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 with a drawing of the shipboard mounting arrangement and foundation's stiffness.

Horizontal pumps, when tested in the inclined position on the medium weight shock machine, shall be oriented so that the direction of shock is perpendicular to the axis of the pump rotation. The pump shall be in operation during the first, third, and fifth blows of the shock test on the floating barge. Variable speed pumps shall be operated at the minimum speed and pressure required to ensure lubrication of bearings and wearing parts. Other pumps shall be operated at the lowest rated speed.

4.6.7.2.4 **Examination.** The pumps 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 noises in accordance with MIL-STD-740-1 and vibrations in accordance with MIL-STD-167-1 and proper functioning of controls. Turbine driven pumps may be air driven. Tightening of bolts following each shock blow is allowed provided loosening is not caused by bolt elongation. Each loose bolt shall be removed, measured, and its location identified. This procedure shall be conducted following each shock blow. If any bolt loosens after each blow, or if a loose bolt affects the operation of the equipment as determined by a post shock operational test, the equipment manufacturer shall establish a corrective procedure.

4.6.7.2.5 Shock test acceptance criteria are as follows:

a. There shall be no breakage of parts, including mounting bolts.

b. There shall be no distortion or derangement of any part which would render the unit incapable of performing as specified.

c. The amplitude of vibration after test at maximum rated speed shall be less than twice the amplitude measured at the same speed before the test.

d. Adequate lubrication to all bearings shall be maintained.

e. Critical dimensions and running clearances shall be maintained.

f. There shall be no significant change in the head-capacity curve.

4.6.7.2.6 **Post shock test procedure.** The shock tested unit, if it is to be supplied under a contract or order, shall be restored to the as-new condition by replacement of all parts damaged or distorted beyond the as-new design tolerances. Rolling contact bearings shall be replaced regardless of condition. The shock tested rolling contact bearings shall be destroyed. The restored unit shall successfully pass the tests specified in 4.6.1, 4.6.3.a., and 4.6.4, if applicable.

4.6.7.2.7 **Drivers.** Pump units shall be shock tested with drivers. Prime movers are subject to shock tests in accordance with applicable equipment specifications.

4.6.7.3 Inclined operation test. Pump shall be tested in accordance with the inclined position equal to the combination of the maximum permanent list and trim specified (see 3.2) and shall be as close to rated speed and capacity as practicable. The performance points shall be determined. The pump shall meet specified performance requirements (see 3.2) without damage while operating in the inclined position.

4.6.7.4 Vibration test. When specified (see 6.2), one pump of a quantity of identical pumps being supplied shall successfully undergo a vibration test in accordance with MIL-STD-167-1, type I, and as supplemented in the contract or order. The vibration test need not be repeated on subsequent contracts or orders for pumps of identical design to those previously tested, provided the previous tests included the frequencies specified (see 6.2).

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

4.7 Inspection of packaging. Sample packages and packs, and the inspection of the preservation-packaging, packing, and marking for shipment and storage shall be in accordance with the requirements of section 5 and the documents specified therein (see 6.3).

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the packaging requirements of references documents listed in section 2, see 6.10.)

5.1 Preservation, packing, and marking. Pump units and accessories shall be preserved level A or C, packed level A, B, or C as specified (see 6.2), and marked in accordance with MIL-P-16789.

6. NOTES

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

6.1 Intended use. Pumps covered by this specification are intended for boiler feed service on board Naval ships.

6.2 Ordering data.

6.2.1 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 and 2.2)

c. Whether first article is required (see 3.1)

d. Space and weight requirements (see 3.2)

e. Flow range (see 3.2)

f. Whether noise attenuation mounts are to be used (see 3.2.3.2)

g. Environmental vibration frequencies (see 3.2.3.4 and 4.6.7.4)

h. Airborne and structureborne noise requirements (see 3.2.5 and 4.6.4)

i. List, pitch, roll, trim, and other ship attitude conditions (see 3.2.7 and 4.6.7.3)

j. Ordering data for the auxiliary oil pump motor (see 6.2 of the applicable specification: MIL-M-17059, MIL-M-17060, MIL-M-17413, or MIL-M-17556) (see 3.2.8.2 and 3.2.14.1)

k. If threaded fastener lengths are to be other than specified (see 3.2.10.1)

l. Gauge connections (see 3.2.11.1)

m. Ordering data for the turbine (see 6.2 of MIL-T-17523) (see 3.2.13.1)

n. Ordering data for electrical controllers, if required (see 6.2 of MIL-C-2212), including variable speed controllers (see 3.2.15)

o. Additional requirements for valves, flanges, fittings, and bolting for pipe connections (see 3.2.18.1)

p. Performance characteristics (see 3.3.2.1, 3.3.2.2, 4.6.3, and appendix B, and appendix C)

(1) Rated capacity and range of capacity

(2) Rated total head at rated capacity

(3) Fluid to be pumped

(4) Specific gravity of fluid

(5) Temperature of fluid – normal, maximum, and minimum

(6) Suction head available – normal, maximum, and minimum

(7) Casing design and test pressures

(8) Special performance requirements, if any (such as maximum shutoff head)

q. Casing nozzle loadings (see 3.3.3.3)

r. If suction and discharge connection requirements are other than specified (see 3.3.4.1)

s. If impellers are to be other than specified (see 3.3.5.1)

t. Mercury prohibition (see 3.3.10.2)

u. Number of sets of special tools (see 3.2 and appendix A)

v. Drawings required (see appendix A)

w. Whether technical manuals are required (see 6.9)

x. Scope of technical manuals (see appendix D)

y. Whether complete information for electrical equipment is required in technical manuals (see appendix D)

z. Quantity and distribution of technical manuals (see appendix D)

aa. Hydrostatic pressure test requirements (see 4.6.2.2)

bb. Whether noise test is required (see 4.6.4)

cc. Shock test requirements (see 4.6.7 and 4.6.7.2)

dd. Vibration test requirements (see 4.6.7.4)

ee. When packaging technical data is not required (see 5.1)

ff. Preservation and levels of packaging, packing, and marking (see 5.2)

gg. Identification of contracting activity and design approval activity (see 6.7).

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 (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's 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 and appendix A	DI-DRPR-80651	Engineering Drawings	Level 2 or 3
3.2 and appendix B	DI-GDRQ-80650	Design Data and Calculation	–
3.2.7, 3.3.10, and 3.3.10.2	DI-E-2121	Certificate of Compliance	–
4.3, 4.4, and appendix C	DI-MISC-80653	Test Reports	–
4.6.4	DI-HFAC-80270	Equipment Airborne Sound Measurement Plan	–
4.6.4	DI-HFAC-80273	Equipment Structureborne Vibratory Acceleration Measurement Plan	–
4.6.7	UDI-T-23732	Procedures, Test	–
4.7	DI-PACK-80120	Preservation and Packing Data	
6.5	DI-V-7000	Supplementary Provisioning Technical Documentation	–
	DI-V-7001	Manufacturer's Commercial Manual (Provisioning)	–
	DI-V-7002	Provisioning Parts List	–
	DI-V-7003	Short Form Provisioning Parts Listing	–
	DI-V-7006	Interim Support Items List	–
6.9	DI-L-2101	Standard, Technical and Maintenance Overhaul and Repair (TRS)	–

The above DID's 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 DID's 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 (see appendix D). 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 Provisioning. Provisioning Technical Documentation (PTD), spare parts, and repair parts should be furnished as specified in the contract (see 6.3).

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

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

Table II. *On board repair parts.*

Name of part	Quantity per set
Sleeve bearings Pivoted segmental bearings Rotary shaft seals (if used) Casing wearing rings	One to four units per ship; 100 percent replacement for one pump
Diaphragm bushings Attached lubricating pumps complete with drive shafting and gears Lubricating pump gears or rotors Pressure breakdown drum bushings	Five to eight units per ship; 100 percent replacement for two pumps
Rotors, complete for pump and turbine, to be furnished disassembled Diffusion vanes	100 percent replacement for one pump

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

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

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

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

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

6.6 **First article.** When first article inspection is required, the contracting officer should provide specific guidance to offerors whether the item(s) should be a preproduction sample, a first article sample, a first production item, a sample selected from the first ____ production items, a standard production item from the contractor's current inventory (see 3.1), and the number of items to 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.

6.7 **Definitions.** As used herein, "contracting activity" refers to the activity purchasing the equipment covered by this specification. The contracting activity may be the Government or a shipbuilder. The "design review activity" refers to the activity responsible for controlling the technical requirements for design and testing of the equipment. The design review activity is generally a Government command or activity such as NAVSEA or an authorized representative. Communication with the design review activity should be handled through the contracting activity (see 6.2).

6.8 Tests. The contracting activity and Government representatives will have the right to examine the facilities at the contractor's plants and at the contractor's subcontractor's plants, and to witness all tests specified herein. Failures, deficiencies, and discrepancies revealed during the performance of the specified tests and the corrective measures taken should be recorded and fully documented in the applicable test records and test reports (see 6.3). After correction of deficiencies, tests should 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) should be reported to the design review activity before a correction is made.

6.9 Technical repair standard. A technical repair standard shall be prepared upon initial introduction of a new equipment or introduction of an equipment that has an approved TRS if major or minor configuration changes have been approved that would effect the adequacy of the standard for use in new equipment repairs (see 6.3).

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

6.10 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.

6.11 Subject term (key word) listing.

Bedplate
Casing
Impeller
Radial sleeve bearing
Steam turbine

6.12 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-N243)

APPENDIX A

ENGINEERING DRAWINGS TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix covers the technical content requirements that shall be included on drawings when required by the contractor or order. This appendix is mandatory only when data item description DI-DRPR-80651 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

MILITARY

MIL-STD-1388-2	DOD Requirements for a Logistic Support Analysis Record
MIL-STD-1561	Provisioning Procedures, Uniform Department of Defense

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

30. DRAWINGS

30.1 Drawing content. Unless other specified (see 6.2), drawings shall contain the unique features specified below.

30.1.1 General requirements.

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

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

30.1.2 Design drawings. Design drawings shall consist of the drawings described in 30.1.2.1 through 30.1.2.4.

30.1.2.1 Sectional assembly drawings. Sectional assembly drawings shall include a sectional assembly with references to the list of material for identification of individual parts. Running clearances shall be labeled and dimensioned as diametral clearances (the difference between diameters of mating parts). This may necessitate some side or partial view in order to show parts

not otherwise shown in the main section view. Tightening torques with tolerances and thread lubrication requirements for threaded fasteners shall be shown on the assembly drawing.

30.1.2.2 List of materials. The list of materials shall include every part required in the pump assembly, including those parts not required to be detailed. The list of material shall include an indication of each part required by this specification to be furnished as an on board repair part (this is not a repair parts list). The list of materials shall include the manufacturer's drawing number and service part number for all parts for which detail drawings are required (see 30.1.2.3) as well as quantity required, material type, and material specification for all parts. Parts shall be named to indicate the function they serve. Parts for which detail drawings are not required shall be identified as to dimensions. The list of materials may be shown on the sectional assembly drawing.

30.1.2.3 Detail drawings. Detail drawings shall show all parts and sub-assemblies necessary for evaluation of the equipment, and of all parts necessary for maintenance and overhaul of the pumps. Details of these parts shall be so complete as to permit emergency manufacture by a Naval shipyard without assistance from the original manufacturer. Details of pump casing shall be included, but the dimensioned development of cored hydraulic passages need not be shown. For all cast parts, the minimum section thicknesses shall be dimensioned and toleranced. Sub-assemblies whose parts cannot be acquired or serviced individually shall be shown as a single part and so indicated. Multi-detail drawings are preferred, but monodetail drawings may be used.

30.1.2.3.1 Impeller machining and inspection drawings. Detail drawings shall explicitly require that each impeller, including spare and replacement impellers, be dynamically balanced to less than the maximum ounce-inch residual imbalance in accordance with MIL-STD-167-1 (type II) for the impeller's weight and rotational speed.

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

30.1.2.4 Outline drawings and certification data.

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

30.1.2.4.2 The outline drawings, in addition to the certification data required (see 6.3), shall contain the following:

APPENDIX A

a. Dimensional outline assembly drawings of the pump with its prime mover, bedplate, and attached auxiliaries

b. Complete performance data of pump, primer mover, and attached auxiliaries, if applicable

c. Complete equipment performance curves, based on actual tests (the original submission may show design performance curves vice test curves

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

e. Shipbuilder's connection showing size, type, and dimensions of flanges

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

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

h. Identification of system in which installed

i. Critical speed

j. Maximum thrust loads

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

l. Overall dimensions of the complete unit, including location of all fittings and connections, the space required for removal and replacement of parts for maintenance, and mounting information.

30.1.2.5 On board repair parts list. A list of on board repair parts shall accompany the outline drawings. This list shall be prepared on provisioning list forms in accordance with MIL-STD-1388-2 and MIL-STD-1561. This list shall be furnished whether or not the parts are required in the pump contract or order. This list shall not be modified to indicate parts or quantities of parts furnished under supplementary or separate contracts or orders. The list is intended as a record of recommendations of the manufacturer and purchaser at the time of equipment drawing approval. The list of on board repair parts actually purchased shall be prepared in accordance with MIL-STD-1388-2 and MIL-STD-1561 (see 6.5.2).

APPENDIX A

30.1.3 Basic design drawings. Basic design drawings covering pumps under this specification are intended for submittal to the design review activity prior to and independent of invitations for bids. As such, these are different from design drawings as described in 30.1.2. Each drawing may be a range of sizes of pumps, so long as they are of the same basic design.

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

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

30.2 Material identification.

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

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

30.2.2 Material substitutions. Where materials other than those covered by a., b., and c. of 30.2.1 are referenced and approved by the design review activity, the drawings shall show the complete chemical and physical properties of the approved material. In addition, the drawings shall identify the material in terms of the nearest Federal or Military specification, in order to enable Naval repair facilities to make emergency repairs as necessary from Navy material stocks.

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

APPENDIX A

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

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

APPENDIX B

DESIGN DATA AND CALCULATIONS TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix covers information that shall be included in the design data and calculations when specified in the contract or order. This appendix is mandatory only when data item description (DI-GDRQ-80650 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. DESIGN DATA AND CALCULATIONS TECHNICAL CONTENTS

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

30.2 Design performance curves. The following shall be prepared:

a. Head versus flow

b. Hydraulic efficiency versus flow

c. Net positive suction head required versus flow

d. Brake Hp versus flow. This curve shall demonstrate that the motor is not overloaded under any condition of suction head, discharge head, or free delivery possible within the pump application.

30.3 Design features. A discussion of the following design features shall be prepared:

a. Those areas in which system design conditions, as furnished by the design review activity, adversely affect pump reliability or result in abnormal design features

b. Steps required for disassembly and reassembly (including alignment) to perform routine maintenance

c. Any design features which the manufacturer considers of significant interest to describe the proposed unit

d. Whether the specified rated capacity and range of capacity (see 6.2) will result in shipboard operation at capacities that will cause pump internal recirculation (suction or discharge) sufficient to degrade pump life, performance or reliability.

30.4 Materials. Use of materials other than as specified herein shall be justified. It is not intended that materials which conform to and are used as specified herein shall require justification.

30.5 Calculations. Calculations shall be prepared to cover the following:

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

(1) The effects of all major changes in shaft cross section moment of inertia shall be included.

(2) No support for the shaft shall be assumed other than at the designated bearings.

(3) All masses in the rotating system, including the effect of entrained fluids, shall be lumped at discrete points along the shaft.

(4) No support for any shafting shall be assumed to be provided by additional shafting when two sections of shafting are separated by a flexible coupling, nor should any flexibility in bending or shear be assumed for a rigid coupling.

(5) For pumps which operate under variable speed conditions, the operating speed shall be construed to be the maximum operating speed.

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

(1) Axial and radial loads and load directions. Loading shall be calculated for the design point and also for the highest loaded conditions over the operating range (see 6.2). These loads shall include all operating loads together with those that might be induced by thermal expansion, by bearing preload, by build-up of tolerances in the

completed assembly, and by ship roll, pitch, list, and trim. The radial hydraulic loads at the impeller shall be calculated by the following:

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

where:

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

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

Casing type	At shutoff	At best efficiency point	At 140 percent best efficiency point
Single volute	0.00024Ns for Ns less than 1,500 0.36 for Ns of 1,500 or greater	0.10	0.36
Double volute	0.11	0.05	0.10
Concentric and modified concentric	0.15	0.15	0.15
Vaned diffuser in volute	0.15	0.07	0.15
Vaned diffuser in concentric	0.07	0.03	0.15

where:

Ns = specific speed at the best efficiency point.

(2) Effects of thrust reversal where conditions which might cause thrust reversal exist.

APPENDIX B

(3) Effects of roll, pitch, list, and trim of the ship (including gyroscopic effects) shall be considered in the bearing design.

(4) Bearing clearances ratios, L/D ratio and characteristic numbers, lubricant flow, and temperature rise (water-lubricated bearings).

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

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

(1) There will be no interferences between rotating and stationary parts as-assembled.

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

30.6 Design record. A design record shall be prepared. This record shall be completed except as noted in 30.6.2 and forwarded prior to unit delivery or at a time agreed to by the design review activity.

30.6.1 Content. The design record shall contain the following:

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

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

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

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

APPENDIX C

TEST REPORTS TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix covers information that shall be included in the test reports when specified in the contract or order. This appendix is mandatory only when data item description DI-MISC-80653 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. TEST REPORTS

30.1 First article inspection report. The first article inspection report shall cover the following examinations and tests:

a. Performance evaluation tests specified in 4.6.6 through 4.6.6.3 and the examination specified in 4.5

b. Design evaluation tests as specified in 4.6.7 through 4.6.7.4.1.

30.2 Quality conformance inspection report. The quality conformance inspection report shall cover the examinations and tests specified in 4.5 and 4.6.1 through 4.6.5. Quality conformance inspection shall be fully documented by a prescribed test procedure and a written record of the performance and findings of each test. A compilation of the documentation of all the quality conformance tests performed on each pump shall be furnished.

30.3 Technical content requirements.

30.3.1 Examination. Pumps shall be examined in accordance with a completed parts examination checklist accompanying each part or assembly. The checklist 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 arranged in tabular form, calling forth separately the following examination assignment, each accompanied by the specific attributes of acceptability which shall be checked or measured, and the findings recorded:

a. Dimensions
b. Materials
c. Cleanliness
d. Missing parts

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e. Assembly
f. Alignment
g. Adjustment
h. Preservation.

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

30.3.2 **Mechanical soundness and capacity test.** This test shall be conducted, recorded, and reported in accordance with the centrifugal pump Rating Standard and Test Code of the Hydraulic Institute, to the extent that these standards are applicable and are not in conflict with the requirements specified herein. The test report for each pump shall include, as a minimum, the following data:

a. Identification of the pump and its steam turbine driver by manufacturer's drawing number and serial number

b. Identification of the diameter of the impellers

c. A dimensioned sketch of the test loop showing the following:

(1) Location of the pump

(2) Location of all instrumentation

(3) Distance (vertical and along the pipe axis) from the suction and discharge gauge taps to the pump suction and discharge flanges

(4) Vertical distance from the gauges to the elevation datum to which they are calibrated

(5) Azimuthal location of the gauge taps on the pipe circumference

(6) Location and orientation of any elbows in the pump suction piping.

d. Test loop water temperature

e. A list of test instruments, including the following:

(1) Date of last calibration

(2) Advertised accuracy

(3) Size (such as 0.25 lb/in^2) of the smallest graduation on the readout scale

(4) Range (such as 0−10 lb/in^2) of the readout scale

(5) Unit (such as lb/in^2) of measurement, including the water temperature to which the gauge is calibrated if the gauge is calibrated in feet of water rather than lb/in^2.

f. Data sheets of all recorded data, with the unit of measurement identified for all data

g. Sample calculations for each type of calculation converting the raw data to the specified conditions. The sample calculations shall show the conversion in sufficient detail, including all temperature and density corrections, to permit an independent reviewer to verify the calculations.

h. Copy of the specific table of water properties used in the calculations and a reference to the source of that table

i. Plot of the measured head-capacity curve corrected to the specified operating conditions following the method described in the sample calculations.

30.3.3 Noise tests. Noise test details, instrumentation, and testing techniques in accordance with MIL-STD-740-1 and MIL-STD-740-2 shall be submitted to the contracting activity prior to testing for approval.

30.3.4 Performance evaluation tests. Sufficient data shall be taken during the tests to prepare pump characteristic curves as specified in 30.3.4.1. In all cases, the test data shall be corrected to the specified operating conditions as to steam pressure and temperature, exhaust pressure, temperatures, specific gravity, suction head, as specified (see 6.2); such conditions shall be clearly shown on the data sheets. Test data and curves shall be complete over the entire range of capacities from shut-off to as near to free delivery as possible.

30.3.4.1 Test curves. The following test curves shall be prepared for constant speeds of approximately 90, 100, and 110 percent of the speed corresponding to full rating:

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a. Capacity versus total head

b. Capacity versus overall efficiency

c. Capacity versus brake hp (using calculated data required under 3.2.13.2.5)

d. Capacity versus steam consumption.

30.3.4.2. **Supplemental curves.** The basic test curves required in 30.3.4.1 shall be supplemented by the following curves:

a. Capacity versus r/min

b. Capacity versus steam consumption of constant discharge pressure of 80, 90, and 100 percent of normal discharge pressure

c. Capacity versus NPSH.

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

30.3.5.1 **Post endurance test procedures.** The quality conformance test documentation shall indicate that the unit was subjected to the endurance test and subsequently restored, tested, and it shall be certified as fully conforming to the specification for unrestricted service.

30.3.5.2 **Shock test.** Following each shock blow, each loose bolt shall be removed, measured, its location identified, and the information documented. If any bolt loosens after each blow, or if a loose bolt affects the operation of the equipment as determined by a post shock operational test, the equipment manufacturer shall provide a corrective procedure which shall be included in the shock test report. Quality conformance test documentation shall certify that the unit was subjected to the shock test and subsequently restored, tested, and inspected in accordance with this specification. A completed parts examination checklist shall be supplied and shall identify the parts which were replaced (such as the bearings) and shall certify that the unit fully conforms to the specification for unrestricted service.

30.3.5.3 **Inclined operation test.** The performance points shall be indicated in the test report.

APPENDIX D

MANUAL TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix covers information that should be included in the technical manuals when required by the contract or order. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

20.1 Government documents.

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

SPECIFICATIONS

MILITARY

MIL-M-15071 Manuals, Technical: Equipments and Systems Content Requirement for

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

30. MANUAL CONTENTS

30.1 Format and scope. Unless otherwise specified (see 6.2), technical manuals shall be prepared in accordance with type I of MIL-M-15071. The modification and clarifications specified in 30.2 through 30.5 shall apply. A separate manual shall be furnished for each different pump unit except in special cases when manuals covering more than one pump may be approved. Preliminary manuals shall be prepared for approval and shall include all proposed sections complete. Unless otherwise specified (see 6.2), manuals shall include pump, driver, controls and all appurtenances, and all applicable drawings. Performance curves for final manuals may be furnished as insert pages after delivery of hardware.

APPENDIX D

30.2 **Turbine driver.** Manuals covering pumps driven by turbines shall include drawings and full operation and maintenance instructions covering the turbines, governors, and any other applicable accessories.

30.3 **Electric motor driver.** Manuals covering pumps incorporating conventional electric motors with conventional controllers need not include operation and maintenance instructions covering the motors and controllers. They shall, however, include master drawings and certification data covering the motors and controllers. Complete operation and maintenance instructions covering electrical equipment shall be included when specifically required (see 6.2).

30.4 **Illustrations.** Each manual shall include not less than the following illustrations covering the pump and driver:

a. Sectional assembly drawing

b. Outline drawing

c. Complete list of material corresponding to the sectional assembly drawing

d. Certification data

e. A minimum of two photographs of the complete unit, pump, and driver, taken 180 degrees apart on a horizontal plane. Where several sizes of identical design units are being supplied, photographs of one design unit only need be supplied.

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

a. Lubrication schedule including lubricant and procedure

b. Torque values and sequence required to maintain proper seal and alignment

c. In field dynamic balancing instructions.

30.6 The quantity and distribution of manuals shall be as specified (see 6.2.2).

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of 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.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER	2. DOCUMENT DATE (YYMMDD)
	MIL-P-22302A(SH)	19 April 1991

3. DOCUMENT TITLE
PUMPS, CENTRIFUGAL, BOILER FEED, SINGLE STATE, NAVAL SHIPBOARD USE

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE (Include Area Code)	
Technical Point of Contact (TPOC): Mr. Cesar Arceo (SEA 56Y21)	(1) Commercial TPOC: 703-602-6826	(2) AUTOVON 8-332- 6826
c. ADDRESS (Include Zip Code) Commander, Naval Sea Systems Command Department of the Navy (SEA 55Z3) Washington, DC 20362-5101	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	

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