MIILIARY SPECIFICATION

PUMPS, CENTRIGUGAL, SEWAGE SERVICE

FOR USE ON NAVAL SHIPS

1. SCOPE

1.1 Scope. This specification covers the requirements applicble to the design and construction of centrifugal pumps for sewage service onboard Naval ships.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

FF-B-171 - Bearings, Ball, Annular (General Purpose).
FF-B-185 - Bearings, Roller, Cylindrical, and Bearings, Roller Self-Allgning.
FF-B-187 - Bearings, Roller, Tapered.
TT-P-645 - Primer, Paint, Zinc-Chromate, Alkyd Type.
GGG-P-781 - Puller, Mechanical, Puller Attachment, Mechanical, and Puller Set, Mechanical .

MILITARY

MIL-B-857 - Bolts, Nuts and Studs.
MIL-S-901 - Shock Test, H. I. (High-Impact): Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-D-1000 - Drawings, Engineering and Associated Lists.
MIL-D-1000/2 - Drawings, Engineering and Associated Lists.
MIL-C-2212 - Controllers, Electric Motor, A.C. or D.C. and Associated Swtiching Devices, Naval Shipboard.
MIL-P-15024 - Plates, Tags and Bands for Identification of Equipment.
MIL-P-15024/5 - Plates, Identification.
MIL-M-15071 - Manuals, Technical: Equipment and Systems Content Requirements For.
MIL-E-15090 - Enamel, Equipment, Light-Gray (Formula No. 11) .
MIL-P-15137 - Provisioning Technical Documentation for Repair Parts for Electrical and Mechanical Equipment (Naval Shipboard Use).
MIL-P-15328 - Primer (Wash) Pretreatment, Blue (Formula No. 117-B For Metals).
MIL-P-16789 - Preservation, Packaging, Packing and Marking of Pumps General, and Associated Repair Parts.
MIL-M-17060 - Motors, 60-Hertz Alternating Current, Integral Horsepower (Shipboard Use).
MIL-L-17331 - Lubricating Oil.
MIL-M-17413 - Motor , Direct-Current, Integral H.P. (Shipboard Use).
MIL-P-17545 - Primer Coating Alkyd-Red Lead Type, Formula No. 116 and Formula No. 116D.
MIL-B-17931 - Bearings, Ball, Annular, for Quiet Operation.
MIL-G-18709 - Grease , Ball and Roller Bearing.
MIL-S-22473 - Sealing, Locking, and Retaining Compounds; Single-Component.
MIL-I-45208 - Inspection System Requirements.

STANDARDS

MILITARY

MIL-STD-167 - Mechanical Vibrations of Shipboard Equipment.
MIL-STD-271 - Nondestructive Testing Requirements for Metals.
MIL-STD-27B - Fabrication, Welding and Inspection and Casting Inspection and Repair for Machinery, Piping and Pressure Vessels in Ships of the United States Navy.
MIL-STD-438 - Schedule of Piping, Valves, Fittings and Associated Piping Components for Submarine Service.
MIL-STD-740 - Airborne and Structureborne Noise Measurements and Acceptance Criteria of Shipboard Equipment.
MIL-STD-777 - Schedule of Piping, Valves, Fittings and Associated Piping Components for Surface Ships.

MILITARY (continued)
MS16142 - Boss, Gasket Seal, Straight Thread Tube Fittings, Standard Dimensions for.
MS18229 - Plug for "O" Ring Gasket.

DRAWINGS

MILITARY
B-214 - Root Connections for Attaching Piping.
810-1385850 - Piping, Gage for All Services.

PUBLICATION

MILITARY
NAVSHIPS 0900-001-7000 - Fabrication and Inspection of Brazed Piping Systems.

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

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated the issue in effect on date of invitation for bids or request for proposal shall apply.

NATIONAL BUREAU OF STANDARDS
Handbook H28 - Screw Thread Standards for Federal Services.

(Application for copies should be addressed to the superintendent of Documents, Government Printing Office, Washington, D.C. 20402.)

HYDRAULIC INSTITUTE
Test Code of Standards - Centrifugal Pump Section.

(Application for copies should be addressed to Hydraulic Institute, 122 E. 42nd Street, New York, New York 10017.)

(Technical society and technical association specifiations and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Qualification. The pumps furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at time set for opening of bids (see 4.2 and 6.4).

3.2 General design. The design and construction of all pumps shall comply with the space and weight requirements when specified (see 6.1). The pump unit shall be designed to perform under the list, pitch, roll and trim conditions as specified (see 6.1). Pumps shall be capable of operating continuously at any point over the entire flow range and design conditions as specified (see 6.1). The motor pump unit shall be of heavy duty centrifugal, vertical or horizontal mounted ball bearing construction.

3.2.1 Reliability. The requirements of this specification are imposed exclusively to obtain equipment of the utmost reliability for the intended service, The assurance of maximum reliability shall be the paramount controlling principle in the design fabrication assembly and testing of this equipment. Users of and suppliers to this specification are urged to communicate to Naval Ship Engineering Center (NAVSEC) any findings related to the requirements or lack of requirements of this specification whereby improvement of equipment reliability can be achieved. The equipment specified herein shall be operated, maintained, and repaired onboard Navy ships. Attention is directed to the high equipment density of shipboard machinery spaces, to the fact that maintenance and repairs must be made underway in heavy seas, that equipment must operate unattended, and that maintenance personnel may not be seasoned mechanics. The requirements for maximum reliability directly relates to these shipboard environment and service conditions and they shall be fully considered in the pump design. The aspects of "human engineering" shall also be fully explored and considered in the equipment design to minimize the possibility of failure through improved operation and maintenance and to preclude personnel safety hazards, In no case shall parts be physically interchangeable or reversible unless such parts ae also interchangeable functionally and from considerations of strength.

3. 2.1.1 The equipment shall be designed for maximum repair access ibility, 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 shoulders , tongue and groove or other locating techniques whereby correct reassembly is repeatedly assured. In consonance with the concept of ease of maintenance and where not already specified, the pump designer shall consider all of the following features for incorporation in the design and technical documentation wherever such incorporation will significantly contribute to ease of maintenance without comprosmising performance reliability:

(a) Lifting lugs.
(b) Casing assembly quide pins.
(c) Alignment and positioning dowels.
(d) Jacking screws.
(e) Ease of access to couplings.
(f) Remakeable piping connections.
(g) Piping out of the way of maintenance access.
(h) Ease of seal cage, mechanical seal, bearing and wearing ring replacement.
(1) Spilt casings, bearing housings, etc.
(j) Guards over rotating, moving components.
(k) Warning plates to prevent casualties to personnel and equipment.
(1) Provisions for connecting instruments for performance evaluation.
(m) Attached instruments for monitoring performance.
(n) Visibility and access to attached instruments.
(o) Thoroughness of operating instructions.
(p) Thoroughness of preventive maintenance instructions.
(q) Explicit assembly and disassembly instructions.
(r) Exploded views of critical assemblies.
(s) Adequate system diagrams.

3.2.1.2 Each pump shall be designed to have a servi\ce 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 pumps. It shall be assumed that during the life of the pumps, parts subject to unavoidable wear and deterioration (with the exception of seals) will be replaced at intervals not shorter than three years. The parts subject to wear, deterioration and normally requiring replacement at three year intervals during the service life of the pumps (with the exception of seals) shall be designed for a life of 10,000 actual operating hours pumping sewage and they shall be identified in the appropriate drawings and manuals. The requirements set forth above shall not be construed or interpreted as a warranty requirement nor otherwise affect the manufacturer’s warranty.

3.2.2 Mounting.

3.2.2.1 Pump units shall be horizontal or vertical mounted, as specified (see 6.1) .

3.2.2.2 Unless otherwise specified in the contract or order, each horizontal flexible or ridid-coupled pump and separate driving unit, complete with all appurtenances, shall be mounted on a common bedplate.

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

3.2.2.4 Bedplates shall be sufficiently rigid to permit handling. shipment, and installation of the units onboard ship, to minimize misalignment of the assembled units; and such that the normal distortion, weaving or vibration of the supporting structures onboard ships cannot cause misalignment between the pumps and driving units. The driver shall be doweled and the unit realigned by the installing activity after final installation. The manufacturer shall furnish a warning plate indicating the above.

3.2.2.5 All bearing and seating surfaces of bedplates shall be finish machined.

3.2.2.6 Each component part of an assembled flexible coupled unit supported directly by a bedplate shall be doweled thereto to facilitate reassembly and maintenance of alignment except that final doweling of the driver shall be performed by the installing activity after final installation.

3.2.2.7 In the event special bulkhead mounting is required, sideplates shall be furnished subject to all conditions specified for bedplates (see 3.2.2.3 through 3.2.2.6).

3 .2.2.8 When motor driven pumps of the close-coupled type are specified, bedplates will not be required, except as otherwise specified (see 6.1). Each pump shall be provided with a support for bolting to the foundation to augment the support from the motor frame.

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

3.2.2.10 Special attention shall be given the design of close-coupled type pumps to insure that leakage from the pump shaft seal cannot enter motor frames or bearing brackets.

3.2.2.11 Eyebolts, lugs, holes, or other means suitable 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 examinations.

3.2.3 Bearings.

3.2.3.1 Types.

3.2.3.1.1 Radial and thrust bearings shall be rolling contact type.

3.2.3.1.2 Rolling contact bearings shall be in accordance with FF-B-171, FF-B-185 or FF-B-187. Rolling contact bearings shall be selected to result in a minimum B-10 life of 10,000 hours, calculated in accordance with FF-B-171, FF-B-185 and FF-B-187.

3.2.3.1.3 Rolling contact bearings Specially selected for quiet operation in accordance with MIL-B-17931 shall be used for pumps where required to meet special noise requirements.

3.2.3.1.4 Rolling contact bearing lubrication method shall prevent bearing failure resulting from over greasing.

3.2.3.1.5 Rolling contact bearings having a DN value in excess of 200,000 shall be oil lubricated unless the vendor can demonstrate to the command or agency concerned that the specific grease lubricated bearing application has been proven in previous Navy shipboard service.

Where :
D = Diameter of bearing bore in millimeters
N . RPM

3.2.3.2 Installation.

3.2.3.2.1 Bearings shall be installed an housings separated by suitable seals for adequate protection from gland leakage. In vertical, rigidly coupled pumps contact bearings, where used, shall be installed external to the pump between the coupling and gland seal. Means shall be provided to prevent escape of lubricant around the shaft. All baffles, wipers and related parts shall be readily renewable.

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

3.2.3.3 Thrust bearings.

3. 2.3.3.1 A thrust bearing shall be installed on pump or motor (if applicable) for counteracting any unbalanced hydraulic or mechanical thrust in either direction. In this connection consideration shall be given to the fact that rolling, pitching or list of a ship at sea may introduce thrust loads even though the unit is in hydraulic balance.

3. 2.3.3.2 Thrust bearings may be of the combined radial and thrust rolling contact type.

3.2.3.3.3 Combined radial and thrust bearings shall be type 134 in accordance with FF-B-171.

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

3.2.4 Lubrication.

3.2.4.1 The lubrication of ball bearing shall be with grease or oil as specified in MIL-G-18709 and MIL-L-17331, in accordance with FF-B-171.

3.2.4.2 All thrust bearing housings shall be so designed that the thrust bearings will be adequately lubricated immediately when the shaft starts to turn,

3.2.5 Piping and valves.

3.2.5.1 All valves, flanges, fittings and bolting shall conform to MIL-STD-777 for surface ships and as specified (see 6.1) , except tapered pipe threads are acceptable for use in grease fittings and nonpressurized connections. Fittings not covered by these specifications for application where ship connections are not involved shall be approved by the procuring agency (Government or shipbuilder).

3.2.6 Pump units which are required to be self-priming shall be of a type approved by NAVSEC.

3.2.7 Motors.

3.2.7.1 All motors for driving pumps shall be of the types and characteristics specified in the contract or order and shall conform to MIL-M-17413 or MIL-M-17060 as specified (see 6.1).

3.2.7.2 Motors shall be service A or service C as specified (see 6.1).

3.2.7.3 The horsepower (hp.) rating of each motor shall be not less than the maximum brake hp. of the driven pump under any conditions from shut-off to free delivery and shall be demonstrated on the performance curve, carried out to free delivery. The actual motor rating shall be in accordance with the Navy standard motor ratings as indicated in the applicable motor specification (see 3.2.7.1).

3.2.8 Controllers. All motor controllers shall be of the characteristics specified (see 6.1) and shall conform to MIL-C-2212.

3.2.9 Shock and vibration.

3.2.9.1 Pumps and drivers with all appurtenances and controls shall be capable of passing a shock test in accordance with MIL-S-901 as specified in 4.3.3.2.

3.2.9.2 Shock mounts (resilient mounts for shock attenuation) shall not be used. When noise attenuation mounts are specified, the pumps shall be designed to pass the shock test on the noise attenuation mounts.

3.2.9.3 Bolts designed to be stressed in shear shall be installed in holes with a minimum of clearance. Hole diameters shall be no more than 1/32 inch larger than the bolts for sizes up to and including 3/4 inch, and no more than 1/16 inch larger than bolts of greater than 3/4 inch size. Mounting bolts for fastening the equipment shall conform to grade 2 or better of MIL-B-857.

3.2.9.4 Pump units shall not be damaged or caused to malfunction either by the environmental vibrations specified in MIL-STD-167, or by internally excited vibrations. In lieu of the limits specified in MIL-STD-167, for internally excited vibration, the maximum allowable vibration (double amplitude) shall not l xceed 0.001 inch as measured on the bearing cap or 0.002 inch as measured on the rotating shaft adjacent to the bearing environmental vibration frequencies shall be as specified (see 6.1).

3.2.9.5 The design, construction and workmanship of the equipment shall be such that noise levels under all conditions of operation will meet the l irborne noise, fluidborne noise and structureborne vibration requirements as specified (see 6.1).

3.2.10 Casings.

3.2.10.1 The design of all flexible coupled pumps is to be such that the complete rotating element may be removed without disturbing the suction and discharge piping. All close-coupled and rigid-coupled pumps shall be designed to permit ready replacement of wearing parts.

3.2.10.2 Clearance shall be provided around bolt heads and nuts to permit the use of ordinary tools.

3.2.10.3 Pumps shall be fitted with flanged connections conforming to Drawing B-214 for suction and discharge pressure gages or MS connections in accordance with MS16142, as specified (see 6.1).

3.2.10.4 Casing fittings shall be as specified in 3.2.15.

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

3.2. 10.6 Casing thickness shall include an allowance for corrosion and the possibility of core shift.

3.2.11 Suction and discharge connections.

3.2.11.1 Suction and discharge connections shall be flanged for mating with flanges in accordance with MIL-STD-43B or MIL-STD-777 as applicable and as specified (see 6.1) . The thickness of the flanges shall be not less than that specified in the applicable specification or drawing.

3.2.11.2 Suction and discharge connections shall be located on the bottom or fixed half of casings except on close-coupled pumps.

3.2.12 Impellers and shafts.

3.2.12.1 Outside surface of impellers shall be smooth finished

3.2.12.2 Impellers shall be keyed on the shaft and securely held against lateral movement by locked nuts.

3.2.12.3 Impellers shall not be furnished with wearing rings. The repeller hub wearing surfaces shall have material thickness to permit reducing the diameter of the impeller hubs by as much as 0.050 inch to accommodate undersize casing wearing rings to restore design running clearance (if required) .

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

3.2.12.5 The shafts of close-coupled pumps shall be of one piece construction.

3.2.12.6 Shaft flingers shall be provided adjacent to stuffing boxes for all pumps. The flinger shall be so located that leakage which might occur between the stuffing box is not allowed to reach pump or motor ball bearings.

3.2.13 Stuffing boxes and mechanical shaft seals.

3.2.13.1 All pumps shall be provided with mechanical shaft seals. The gland of each seal, which shall be of solid construction, shall be designed to incorporate two or more rings of packing for use in the event of a mechanical shaft seal failure. Seal intervals shall be constructed of nickel-copper alloy. The stationary sealing face shall be constructed of tungsten carbide. The rotating sealing face shall be constructed of tungsten carbide or carbon.

3.2.13.2 The mechanical shaft seal shall be lubricated from a separate salt or fresh water source. A cyclone separator shall be provided if a salt water source is used, to clean the water source. A double shaft seal assembly may also be used, incorporating a pressurized, dead-ended lubrication space. The liquid being pumped may not be used to lubricate the shaft seal.

3.2,13.3 The design shall insure that positive liquid pressure is supplied to the seal faces under all conditions of operation, and that there is adequate circulation of the liquid at the seal faces to minimize the deposit of foreign matter on the seal parts. The pump certification data shall contain certification by the seal manufacturer that there will be adequate circulation of liquid and adequate lubrication at the seal faces when the seal is installed as shown on the drawing.

3. 2.13.4 Mechanical shaft seals shall be positioned on the shaft by means of stub or step sleeves. Mechanical shaft seals shall not be positioned by use of set screws alone.

3.2.13.5 All stuffing box glands shall be set up by nuts threaded on studs secured in the casings.

3. 2.13.6 Space shall be provided between bearings and stuffing boxes to permit easy inspection and overhaul of bearings and shaft seals.

3.2.14 Couplings.

3.2.14.1 For horizontal or vertical units requiring couplings, an all-metal flexible coupling shall be installedc between the pumps and driving units. Nonmetallic couplings may be used when specified in the contract or order.

3.2.14.2 All flexible coupling pump hubs shall be keyed to the shafts and secured by lock nuts. For pump shafts one inch in diameter and larger, the hubs shall be fitted on a taper with keys.

3.2.15 Fittings .

3.2.15.1 All horizontal and vertical pump casings shall be fitted with drain connections in accordance with MS16142 and MS18229 to permit the complete drainage of the pumps without disassembly of the pump.

3.2.15.2 The bottom of all drip pockets, if utilized, shall be tapped for drain connections.

3.2.15.3 All pumps shall be fitted with vent connections to prevent entrapment of air or vapor which would adversely affect the operation of the pump. Special attention should be paid to vent location so that the seal lubrication requirements of 3.2.13.3 are met during pump start up and operation.

3.2 .15.4 Pump discharge shall be provided with gage boss. Pressure gages when provided with the units shall be mounted in accordance with Drawing 810-1385850. Gages shall be positioned for accessibility for reading and maintenance. Gages shall be secured on the parent equipment in such a manner as to prevent vibration, breakage and disconnection.

3.2.16 Rotating assembly.

3.2.16.1 All rotors shall be dynamically balanced with all rotating parts connected thereto; for common shaft assemblies this requires dynamic balance with the rotating elements of the driving unit in place. However, rotating parts may be balanced individually provided that when assembled the unbalance shall not exceed the limits specified in MIL-STD-167.

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

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

3.2.16.2 Motor driven pumps shall be capable of reverse rotation for a period of 1 minute at maximum rated revolutions per minute (r.p.m.) without damage.

3.2.17 Threaded fasteners. Threaded parts such as bolts, studs and nuts shall conform to Handbook H28. The setting end of studs shall be class 5 fit or class 3 fit with locking resin in accordance with MIL-S-22473. The nut end shall be class 3 fit.

3.2.18 Painting.

3 .2.18.1 Pump external unmachined surface of ferrous metal parts, except corrosion - resistance steel, shall be thoroughly cleaned, and coated with paint in accordance with the following specifications

(a) One coat of pretreatment coating in accordance with MIL-P-15328.
(b) One coat of zinc chromate primer in accordance with TT-P-645 or one coat of red lead primer in accordance with MIL-P-17545.
(c) One finish coat of light gray equipment enamel in accordance with MIL-E-15090.

3.2.19 Welding and brazing.

3.2.19.1 Welding shall be in accordance with MIL-STD-278,

3.2.19.2 Silver brazed joints shall conform to the fabrication and inspection requirements of NAVSHIPS 0900-001-7000. However, where practical, the use of silver brazed joints should be avoided.

3.2.20 Identification plates.

3.2.20.1 Identification plates shall be furnished on each pump. They 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 are not acceptable.

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

3.2.20.3 Pump identification plates shall contain data as follows:

(a) Manufacturer's name.
(b) Manufacturer's model or type and size.
(c) Service application.
(d) Manufacturer's serial number.
(e) Sallent design characteristics.
  (1) Capacity in g.p.m.
  (2) Total head in pounds per square inch (p.s.i.).
  (3) Speed of shaft in r.p.m.
  (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) Federal stock number
(h) Section for Defense Contract Administration Services (DCAS) stamp.
(1) NAVSHIPS technical manual number.

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

3.2.21 Locking devices. Pump internal threaded fasteners and threaded machine elements shall be secured by locking devices where continuous operation under the conditions of shock, vibration and temperature specified herein depend on maintaining tight connections of parts. Set screws shall have locking devices.

3.2.22 Performance characteristics. The operating characteristics of the pumps and drivers shall be as specified (see 6.1) ,

3.2.23 Type driver. The type of driver shall be as specified (see 6.1).

3.2.24 Part interchangeability. All parts for pumps manufactured to the same drawings shall be interchanageable.

3.3 Detail requirements.

3.3.1 The design shall be of the single stage, single suction, volute type capable of passing 2-1/2 inch diameter spherical sewage solids.

3. 3.1.1 Pumps shall have constantly rising head capacity characteristic curves. Pumps with capacities of 50 g. p.m. or more shall have head capacity characteristic curves such that total head at shutoff iS not less than 10 percent above total head at rated capacity and the total flow at rated head, less 10 feet, is not greater than 250 percent rated flow.

3.3.1.2 Casing wearing rings shall be fitted in pumps where required by design.

3.3.1.3 Casing wearing rings shall be secured by means of set screws which are equally spaced or Interference fit.

3.3.1.4 Pump casing joints shall be made up using compressed asbestos sheet gaskets. "O" rings may be used to seal casing joints when approved by the command or agency concerned.

3.4 Materials.

3.4.1 The materials of the pump shall conform to the materials specified in 6.3. However, this specification is not intended to be restrictive provided proposed alternate materials will give equal or better service than the materials specified. Proposed alternate materials shall be subject to review by the procuring agency. Components of the pump for which specific materials are not specified shall be materials best suited for the service Intended. Materials which can be sensistized and are subjected to heat treatment in the sensistization range during fabrication shall be capable of passing 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.

3.5 Drawings. Drawings shall conform to the requirements of categories A, G, H, I and J, form 2 of MIL-D-1000 and types II and III of MIL-D-1000/2, as specified (see 6.1).

3.5.1 Drawing content.

3,5.1.1 General requirements.

3. 5.1.1.1 "Manufacturer's Use Only" notes. Information intended for manufacturer's use only shall be so designated Conversely, on a commercial drawing with wide usage it is permissible to designate portions thereon, "For Navy Use Only".

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

3.5.1.2 Sectional assembly drawings. Sectional assembly drawings shall include a sectional assembly with references to applicable detail drawings. All running clearances shall be shown and shall be dimensioned as radial clearances. (The radial clearance equals one half the diametral clearance.) Tightening torques and thread lubrication requirements for threaded fasteners shall be shown on the assembly drawing.

3.5.1.3 List of material. The list of material shall include every part required in the pump assembly, including those parts not required to be detailed. This may necessitate some side or partial views in order to show parts not otherwise shown in the main section view. The list of material shall include an indication of each part required by this specification to be furnished as an onboard repair part (this is not a repair parts list) . The list of material shall include the manufacturer's drawing number and service part number for all parts which detail drawings are required (see 3.5.1.4). Parts shall be named to indicate the function they serve.

3.5.1.4 Detail drawings. Detail drawings shall be furnished of all parts and subassemblies necessary or 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 casings shall be furnished, but the dimensioned development of cored hydraulic passages need not be shown. Subassemblies whose parts cannot be procured or serviced individually, should be shown as a single part and so indicated. Multidetail drawings are preferred, but monodetail drawings may be used.

3.5.1.5 Outline drawing and certification data.

3.5.1.5.1 Outline drawings and certification data shall be furnished as supplemental drawings to all sectional assembly and detail drawings. Separate outline drawings. drawing lists and certification data shall be furnished under each contract or order unless the complete equipments covered by the outlinge drawing and the referenced drawings are in fact identical in all respects.

3.5.1.5.2 Outline drawings in addition to the certification data required by MIL-D-1000/2 shall contain the following:

(a) Dimensional outline assembly drawing of the pump with its prime mover, bedplate and attached auziliaries.
(b) Complete performance data of pump, prime mover, and attached auxiliaries, if applicabel.
(c) Complete equipment performance curves, based on actual tests (the original submission may show design performance curves vice test curves) .
(d) Table of weights of individual components and weight of complete unit.
(e) Shipbuilders connections showing size, type and dimensions of flanges.
(f) Center of gravity of the pump component and of the complete assembly.
(g) Radii of gyration of complete assembly about each of the three principal axes (required only if equipment is sound isolated)
(h) Identification of system in which installed (if known).
(1) Critical speed.
(J) Maximum thrust load.
(k) The endurance test, high impact shock tests and nondestructive tests (if performed) and the NAVSEC or command or agency letters approving these reports or extension of any tests.
(1) In addition the outline drawing shall include overall dimensions of the complete unit including locating dimensions of all fittings and connectins, the space required for removal and replacement of parts for maintenance, and mounting information

3.5.1.6 Onboard repair parts list. A list of onboard repair parts shall be furnished. This list shall be prepared on Provisioning List forms in accordance with MIL-P-15137 (see 6.2). 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. This list is intended as a record of recommendations of the manufacturer and purchaser at the time of equipment drawings review. The list of onboard repair parts actually purchased shall be prepared as required by MIL-P-+5137 (see 6.2).

3.5.1.7 Basic design drawings. Basic design drawings covering pumps under this specification are intended for submittal to NAVSEC for review prior to and independent of invitations for bids. Each drawing may cover a range of sizes of pumps so long as they are of the same basic design.

3.5. 1.7.1 Contents of basic design drawings. These drawings shall consist of small scale (not necessarily to scale plan and elevation views showing over-all dimensions. If the plans cover a family of pump sizes all of the same design, the dimensions may be tabulated. The range of capacities, pressure and speeds shall be shown. The main part of these drawings shall be undimensioned sectional assembly with complete list of material which shall include every part required in the pump assembly. If materials of some parts may change with various pump characteristics or with differing fluids to be pumped, a table shall be included to show these variations. Alternate subassembly arrangement of different parts may be included as desired.

3.5.1.7.2 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 review by NAVSEC.

3.5.2 Material identification.

3.5,2.1 Preferred material reference. Where materials of identical or equal quality can be identified by more than one specification or standard, the drawings need reference only one such specification or standard. In selecting the specification or standard to be referenced the following is the order of preference:

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

3.5.2.2 Material substitutions. where materials other than covered by (a) , (b) and (c) of 3.5.2.1 are referenced, the drawings shall show the complete chemical and physical properties of the proposed material in addition, the drawings shall identify the material in terms of the nearest Federal or Military specificatin. in order to enable Naval repair facilities to make emergency repair as necessary from Navy material stocks.

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

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

3.5.4 Drawings of drivers and associated equipment shall he in accordance with the specifications covering those equpments.

3.6 Technical manuals.

3.6.1 Technical manuals arc to be furnished unless otherwise specified in the contract or order, and shall be in accordance with type I of MIL-M-15071. A separate manual shall be furnished for each different pump unit except in special cases when manuals covering more than one pump may be approved. Preliminary manuals shall be submitted to the procuring agency (Government or shipbuilder. for review and shall include all proposed sections com-plete. Unless otherwise specified (see 6.1), manuals shall include pump, driver, controls and all appurtenances and all applicable drawings. Performance curves for final manuals may be furnished as insert pages after delivery of hardware.

3.6.2 Manuals covering pumps driven by conventional electric motors with conventional controllers need not include operation and maintenance istructions covering the motors and controllers. They shall however inlude master drawings and certicication data covering the motors and controllers. Complete operation and maintenance instructions covering electrical equipment shall be included when specifically required by the contract or order.

3.6.3 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 suppled.

3.6.4 The alignment procedure in the technical manual shall describe in complete detail the means by which the required alignment of couplings and wearing rings is to be established. The manual shall prescribe the maximum prermissible measured eccentricities which can be tolerated in the aforementioned areas with the pump in the as-assembled condi-tion . Exceptions to any part of the aforementioned requirements in any specified area may be had only by providing for the procuring agency (Government or shipbuilder) approval a written technical justification for the said exception. The manual shall specify the maximum allowable clearances for wearing rings and sleeve bearings before the replacement of the part(s). In addition the manuals shall contain”

(a) Lubrication schedule (if required) including lubricant and procedure.
(b) Detailed shaft seal instructions.
(c) Torque values and sequence required to maintain proper seal and alignment.
(d) Infield dynamic balancing instructions where provisions for balancing infield are required.

3.7 Performance curves. The following curves shall be provided:

(a) Head versus flow.
(b) Hydraulic efficiency versus flow.
(c) Net positive suction head required under normal, maximum and minimum operating conditons.
(d) Brake hp. versus flow.

3.7.1 Design features. A brief discussion of the following design features shall be provided

(a) Those areas in which system design conditions. as furnished by the procuring agency (Government or shipbuilder) , 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 other design features which the manufacturer considers of siqnificant interest to describe the proposed unit.
(d) The galvanic compatibility of the materials used for parts in contact with the pumped fluid.

3.7.2 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.

3.7.3 Calculations shall be submitted to cover the following

(a) Shafting analysis of pump and driver assembly including calculation of critical speed. If calculations are done by a computer, results need only be submitted. The following shall form the basis of the critical speed calculation
(1) The effects of all major changes in shaft cross section moment of inertia shall be included.
(2) No support for the shaft shall be assumed other than at the desinated 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.
(b) Loads imposed on the bearings. The calculations shall include the following:
(1) Axial and radial loads and load directions. Loading should be calculated for the design point and also for the highest loaded conditions over the operating range. These loads shall include all operating loads together with those that might be induced by thermal expansion and by build-up of tolerances in the completed assembly. The radial loads at the impeller may 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 = repeller overall width including shroud, inches.
K = a constant which varies with capacity.

Unless data, supported by tests, justified the selection of a lower value, K shall be assumed in accordance with the following:

Casing type	At shut off	At rated flow	At 140 percent rated flow
Single volute	0.00024Ns less than 1500 0.36 for Ns of 1500 or greater	0.10	0.36

Where:

Ns = specific speed at the best efficiency point.

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

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

(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 interference 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 arc combined with operational environmental, and thermal loading.

3.7.4 Drawings shall be submitted to allow an independent review of the design. A sectional assembly and outline drawing with detail to fully present the unit is a minimum requirement . All dimensions and tolerances necessary to determine clearances between rotating and stationary parts, interferences fits and tolerance stack-ups shall be provided.

3.8 Design record. A design record when required shall be submitted to the command or agency concerned. This record shall be completed except as noted in 3.$1.2, and forwarded prior to unit delivery or at a tiem agreed to by the command or agency concerned?.

3.8.1 The design record shall conform to the following:

(a) The design 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 accepted design change.

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

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

3.9 Onboard repair parts and tools.

3.9.1 Onboard repair parts. A set of repair parts (onboard) shall be furnished in accordance with method B paragraph 3.3.2) of MIL-P-15137 (see 6.2) and for guidance purposes shall consist of the parts specified in table I and special tools and wrenches required for servicing of the pumps.

Table I - Onboard repair parts.

Name of part	Quantity per set
Internal water lubricated bearings Ball or roller bearings Mechanical seals "O" rings	100 percent complete replacement for all installed units per ship
Undersize casing wearing rings Coupling, complete Shaft sleeves	One to 4 units per ship: 100 percent replacement for one unit Over 4 units per ship: 100 percent replacement for two units
Rotors, completely assembled including shaft, impeller, casing wearing rings, keys, flingers, nuts, and complete coupling	100 percent replacement for one unit

3.9.1.1 The pump rotor assembly for flexible-coupled axially split case units shall be completely assembled ready for Installation in the unit for which intended and shall include any nonrotating parts which can be installed only by removing some rotating part or parts of the pump rotor.

3.9.1.2 Parts of the pump rotor for pumps without axially spilt casings shall be furnished disassembled. The shaft for close coupled motor driven pumps shall be furnished with motor rotor or armature.

3.9.1.2.1 The quantities of individual repair parts shall not be reduced because of duplication of parts furnished to make the rotor assembly except that standard casing wearing rings shall not be required.

3.9.1.3 Casing wearing rings shall be machined undersize by at least 0.030 inch on the radius in order to permit finish maching as required for replacement onboard ship.

3.9.1.4 Repair parts shall be processed in accordance with MIL-P-15137 (see 6.2).

3.9.2 Tools.

3.9.2.1 Special tools required for the maintenance and repair of the pump units shall be furnished. The number of sets of special tools shall be as specified (see 6.1).

3.9.2.2 The special tools shall include the following, as applicable:

(a) Complete set of special wrenches of forged steel with hardened jaws.
(b) One impeller pulling tool.
(c) One set of ball bearing pulling tools.
(d) Any other special tools necessary for the proper maintenance of the units in service.

3.9.2.3 Tools which are available in the Federal Supply Catalog, such as common wrenches and standard pullers, will not be required. (Copies of this catalog may be consulted in the Office of the DCAS.) Standard complete or limited sets of pullers or parts of puller sets in accordance with GGG-P-781 shall be identified as to the type and use in notes on the outline or section assembly drawings. Special tools shall be detailed and included in the list of material.

3.9.3 Each metal box containing onboard repair parts shall contain a list entitled "list of onboard repair parts." It shall be not less than nominal 8-1/2 by 11 inches in size.

3.9.3.1 The format of the list shall include a heading and columns of data for the items listed. The heading shall include titles and applicable entries similar to the following:

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 _____
Federal stock number _____
Additional columns may be used as applicable.

3.9.3.2 The list shall be so treated as to be resistant to oil, water and fading.

3.9.4 Repair parts for drivers and control equipment shall be furnished in accordance with the applicable specifications.

4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 The inspection requirements shall consist of the following:

(a) Qualification (see 4.2).
(b) Tests (see 4.3). To be conducted in a simulated saltwater sewage source.
(1) Shop tests. To be conducted on each pump supplied under the contract or order (see 4.3.1).
(2) Performance evaluation tests. To be conducted on one pump of each design and size on each contract or order (see 4.3.2).
(3) Design evaluation tests. To be conducted on one pump of each design and size (see 4.3.3).

4.1.2 Inspection system. The supplier shall provide and maintain an inspeciton system acceptable to the Government—for supplies and services covered by this specification. The inspection system shall be in accordance with MIL-I-45208 (see 6.1 and 6.2).

4.1.3 When specified (see 6.1), intended use makes it mandatory that the pump shall be free of all mercury contamination. During the manufacturing process, tests and examination, the product to be offered for acceptance shall not come in direct contact with mercury or any of its components nor with any mercury containing device employing a single boundary of containment. The manufacturer shall certify that the product, when shipped, is free from mercury contamination.

4.2 Qualification tests.[1/] Tests shall be performed at a laboratory satisfactory to NAVSEC on each design and size pump for which qualification is desired. Either horizontal or vertical units may be submitted. The several qualification tests on one pump design may be conducted concurrently, if practicable. The tests shall fully establish that the product has the reliability and performance capability specified herein. The following tests shall be performed:

(a) The performance evaluation tests specified in 4.3.2 through 4.3.2.3.
(b) The design evaluation tests specified in 4.3.3 through 4.3.7.4.

4.2.1 The potential supplier desiring qualification of a specific design and size pump shall submit design data and calculations, as specified in 3.7 through 3.7.4 to NAVSEC for review and design acceptance as a prerequisite to the performance of the qualification tests specified herein. The design record as specified in 3.8 through 3.8.2 shall be submitted upon completion of the qualification tests.

4.3 Tests. The procuring agency and Government representatives shall have the right to inspect the test facilities at the suppliers' plants and at the suppliers' subcontractors' plants, and to witness all tests specified herein. All failures, deficiencies and discrepancies revealed during the performance of the specified tests and the corrective measures taken shall be recorded and fully documented in the applicable test records and test reports. After correction of deficiencies, tests shall be repeated to the extent necessary to ascertain acceptability of the modified pump. Major failures indicative of the design deficiency (as distinguished from shop error or faulty workmanship) shall be reported to the procuring agency (Government or shipbuilder), before a correction is made. Except where specifically required herein to be tested with the actual driver, tests may be conducted using a substitute driver, provied the actual driver separately passes the tests required by its applicable specification.

4.3.1 Shop tests. Shop tests shall be performed on each pump being supplied (and subcomponents of each pump if applicable). Each shop test shall be fully documented by a prescribed test procedure and a written record of the performance and findings of each test. A compilation of the documentation of all the shop tests performed on each pump shall be furnished in duplicate to the cognizant Government quality assurance office and to the procuring agency (Government or shipbuilder) . The following shop tests shall be performed on each Dump:

(a) Hydrostatic pressure test (see 4.3.1.1).
(b) Over-speed test (see 4.3.1.2).
(c) Mechanical soundness and capacity test (see 4.3.1.3).
(d) Noise test (to be performed only when specified (see 6.1) (see 4.3.1.4).

1/ Application for Qualification tests shall be made in accordance with 'Provisions Governing Qualification SD-6" (see 6.4 and 6.4.1).

4.3.1.1 Hydrostatic pressure test. Each pump casing shall be tested hydrostatically to pressure one and one-half times the maximum discharge pressure but in no case less than 50 pounds per square inch gage (p.s.i.g.). The hydrostatic test pressure shall be maintained for at least 30 minutes or longer as necessary for examination of entire casing.

Acceptance criteria: The pumps shall exhibit no leakage through the casing material, or joints The leakage rate through the mechanical seal shall not exceed 5 drops per minute.

4.3.1.2 Over-speed test. Continuous shaft and rigid coupled pumps shall be tested with the driver Units separately driven through flexible couplings and geared units may be tested by separate pump, gear unit and driver over-speed tests. The dynamic balance shall be checked by the use of a vibration inculcator of the neon tube type whereby vibrations of an amplitude of 0.001 inch may be readily observed on a scale.

Acceptance criteria: The pump including driver and appurtenances shall exhibit no abnormal noises or roughness of operation. The maximum acceptable reading (double amplitude) of the vibration indicator shall not exceed 0.001 inch as measured on the bearing cap or 0.002 inch as measured on the rotating shaft adjacent to the bearings.

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

(a) Operate the pump continuously at maximum rated speed and capacity, with the pumped fluid at ambient temperature (see 6.1) until bearing temperatures stabllize as manifested by at least three consecutive equal bearing -temperature indications taken at intervals of not less than 15 minutes. The pump operation shall be fully monitored throughout this test for proper functioning of seals and bearing lubrication,. and for smooth running.

Acceptance criteria. Operation shall be without over-heating and shall be free of abnormal vibrations and noises. There shall be no abnormal leakage of water, grease or oil. Oil temperature rise in force feed lubricated bearings shall not exceed 50°F. in any bearing and shall not exceed a maximum temperature of 180°F. with inlet cooling water to the oil cooler at 85°F.

(b) Operate the pump at the maximum rated speed, from recirculation flow to as close to free delivery as practicable and with the specified suction conditions prevailing. The unit shall be operated at seven or more test points, throughout the full operating range to establish accurately the head-capacity curve at maximum rated speed. The unit shall be operated at each test point until the test values being measured stabilize.

Acceptance criteria: The pump shall deliver the rated capacity and head. The head-capacity curve at maximun rated speed shall conform to the specified requirements. The total head at all capacities on the curve shall not deviate by more than plus 5 percent of rated heads from the corresponding capacity on the head-capacity curve at maximum, rated speed established in the performance test specified in 4.3.2.1,

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

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

4.3.1.4 Noise test. When required (see 6.1), a noise test shall be conducted and reported in accordance with MIL-STD-740. The noise test stand details, instrumentation. and testing technique shall be submitted by the supplier for review acceptance by the procuring agency (Government or shipbuilder) prior to test commencement. Noise tests shall be performed with the driver furnished with the pump. 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 6.1).

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

(a) Performance test (see 4.3.2.1).
(b) Mechanical shaft seal and alignment procedure test (see 4.3.2.2).

4.3.2.1 Performance test. The performance test shall be conducted, recorded and reported in accordance with the requirements for the shop test specified in 4.3.1.3, except that in addition to the head-capacity curve at maximum rated speed, a full performance map shall be established. The proposed test procedure for this test shall be submitted to the procuring agency (Government or shipbuilder) for review and acceptance approximately at the tiem of drawing submittal. Test data shall be converted to specified operating conditions for plotting of all performance curves. The performance curves shall be determined at maximum and minimum operating speed for variable speed pumps and at each operating speed for multispeed pumps. The following curves shall be established:

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

Acceptance criteria: The acceptance criteria specified in 4.3.1.3 (a) and (b) shall be met . The performance map shall exhibit the specified pump performance characteristics. All controls and safety devices shall function reliably as intended throughout the full operating ranges of capacity and speed.

4.3.2.2 Mechanical shaft seal and alignment procedure test. The mechanical seal shall be installed, and alignment done precisely in accordance with the procedures to be used in technical manual. The mechanical seals shall be run in and the pump operated at maximum rated speed with the fluid pumped at maximum operating temperature. The tests shall verify seal installation procedures. Stuffing box leakage, if any, shall be determined. The dynamic balance shall be checked by use of a vibration indicator.

Acceptance criteria: Mechanical seal leakage shall not exceed 5 drops per minute. The vibrations shall not exceed the limits specified in 4.3.1.2.

4.3.2.3 Test reports for the performance evaluation tests shall be compiled into a single document. The document shall identify the pump by manufacturer's serial numbers of pump and driver, the contract or order number under which the tests were performed, the ship or class or ships for which the pump is intened if known, and the letter and date of test procedure acceptance. The test compilation document shall be distributed as follows:

(a) Two to each procuring agency (Government or shipbuilder).
(b) two to one of the following, as applicable:
Defense Contract Administration Services Region (DCASR).
Defense Contract Adminstration Services District (DCASD).
Defense Contract Administration Services Office (DCASO).
(c) Two to NAVSEC or the command or agency specified in the contract or order.

4.3.3 Design evaluation tests. One pump of each design and size complete with the driver and a appurtenances and controls shall successfully undergo the design evaluation tests specified herein. Design changes which in the opinion of the procuring agency (Government or shipbuilder) 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 procuring agency to require new design evaluation tests when an accumulation of several design changes, each of itself apparently not significant to pump reliability, collectively considered render suspect the validity of any one or all of the previously performed desgin evaluation tests. An endurance test need not be performed provided that the vendor can demonstrate to the satisfaction of the command or agency concerned that the pump to be offered has been proven satisfactory in previous Naval shipboard service under Conditions equally as strenuous as those specified in the

order ing data. The design evaluation tests shall consist of the following:

(a) Endurance test (see 4.3.3.1).
(b) Shock test (see 4.3.3.2).
(c) Inclined operation test (see 4.3.3.3).
(d) Vibration test (if specified in 6.1)(eee 4.3.3.4).

4.3,3.1 Endurance test. The pump shall be operated for a period of not less than 1000 hours of actual running time with a minimum of 100 starts to ascertain reliability of performance and operation.

4 .3.3.1.1 Prior to commencement of the endurance test and immediately after completion of the 1000 hour operating run, the pump shall be disassembled to the extent necessary and the critical dimensions and running clearance, of parts subject to wear, erosion and derangement, measured, calculated and recorded. All components such as pump impellers and casings subject to erosion, corrosion cavitation, and wear, the effects of which are not subject to routine measurement shall be listed in the inspection record and after completion of the test the condition of each component determined and recorded.

4 .3.3.1.2 During the initial and final hours of the endurance test run, capacity and noise test in accordance with 4.3.1 .3(b) and 4.3.1.4 shall be performed to determine the changes in the pump's performance characteristics and noise signature. Vibration measurements shall be taken at the bearing caps or housings of the pump and driver at equal speeds during the initial and final capacity test to deterimine the changes in mechanical operation.

4 .3.3.1.3 The endurance test shall not be continuous but shall be Interrupted by at least three rest periods of approximately 8 hours each. A minimum of 100 starts at full line voltage shall be performed during the course of the test. During an early part of the endurance test the pump shall be operated continuously for 24 hours at a capacity as near free delivery as possible at maximum rated speed, and specified temperature, submergence and suction conditions. During the latter part of the endurance test the pump shall be operated as near shut-off as possible for 12 hours continuously. The remainder of the endurance test shall be run at maximum rated speed and within plus 20°F. minus 0°F. of maximum specified liquid temperature. The pump shall be operated at one third, two thirds, and rated capacity in approximately equal time intervals. Operations at rated capacity shall be at minimum specified net positive suction head available, or maximum specified suction lift or vacuum, as applicable.

4.3.3.1.4 The pump shall be monitored during the endurance test to accurately record the conditions of operation, speed at which operated and the general performance observed. Data shall be collected and the pump examined at least twice per day of operation. For each periodic examination, in addition to all measured data, the record shall indicate the following:

(a) The conditions of the bearings.
(b) The airborne noise level (normal-abnormal) .
(c) The vibration level (normal-abnormal).
(d) The smoothness of operation (normal-abnormal).
(e) All other abnormal findings.
(f) All adjustments made.
(9) Changes made in the conditions or method of operation.
(h) Seal leakage rate.

4.3.3.1.5 Endurance test acceptance criteria:

(a) The head-capacity curve at maximum rated speed after 500 hours of pump operation shall conform to the specification requirements and shall show no abnormal deviations from the curve before the 1000 hour test.
(b) The unit performance and operation after 1000 hours of operation shall be unchanged and normal and meet all specification requirements.
(c) The unit operation at the end of the endurance test shall be smooth and shall exhibit noise and vibration levels that are normal and in conformance with the specification.
(d) Lubrication shall have remained satisfactory throughout the test period. Bearing temperatures shall have remained normal and shall be consistent with their respective bearing clearances and oil and grease limitations.
(e) The pump seal shall have performed as specified.
(f) The leakage rate from the mechanical seal shall not exceed 5 drops per minute.

(g) All components subject to attack from corrosion, erosion, cavitation, etc. shall be in a condition commensurate with 1000 hours of service.
(h) Wear rates for wearing parts, critical for proper operation shall show a rate of wear for the test period that shall be consistent with the specified design life requirements.
(i) No failures shall have occurred throughout the 1000 hour test.

4.3.3.1.6 Post endurance test procedure. The unit subjected to the 1000 hour endurance test shall be restored to the as-new condition by replacement of all parts worn beyond the as-new design tolerances. The restored unit shall successfully pass the shop tests specified in 4.3.1.1, 4.2.1.3(a) , and 4.3.1.4 if applicable. The shop test documentation shall indicate that the unit was subjected to the endurance test and subsequently restored, shop tested and that it shall be certified as fully conforming to the specification for unrestricted service.

4.3.3.2 Shock test. The pump shall undergo a shock test to ascertain that the pump has the necessary shock resistance. The shock test shall be performed in accordance with MIL-S-901 and the specific shock test requirements (see 6.1).

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

4.3. 3.2.2 Before and after the shock test, shop tests in accordance with 4.3.1.3 shall be performed to determine the changes in performance characteristics of the pump. Vibration measurements shall be taken at the bearing caps or housings of the pump and driver at equal speeds during the initial and final capacity test to determine the changes in mechanical operation.

4.3.3.2.3 The unit shall be mounted on the shock machine or barge essentially identical to the actual shipboard installation. The procuring agency (Government or shipbuilder) will furnish the supplier a drawing of the shipboard mounting arrangement. Horizontal pumps when tested in the inclined positin on the medium weight shock machine shall be oriented so that the direction of shock is perpendicular to the axis of pump rotation. The pump shall be in operation during the first and third blow in each orientation on the medium weight shock machine. The pumps shall be in operation during the first, third and fifth blows of the shock test on the floating barge.

4.3. 3.2.4 The pump shall be carefully observed during each shock blow and thoroughly examined visually after each blow. After each blow the unit shall be operated at as close to maximum rated speed as possible and checked for abnormal noises and vibrations and proper functioning of controls.

4.3.3.2.5 Shock test acceptance criteria. Shock test acceptance criteria shall be as follows:

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

4.3.3.2.6 Post-shock-test procedure. The shock tested unit, if it is to be supplied under a contract or order and if accepted by the procuring agency (Government or shipbuilder) shall be restored to the as-new condition by replacement of all parts damaged or distorted beyond the as-new design tolerances. All rolling contact bearings shall be replaced regardless of condition. The shock tested rolling contact bearings shall be destroyed. The restored unit shall successfully pass the shop tests specified in 4.3.1.1, 4.3.1. 3(a), and 4 .3.1.4, if applicable. The shop test documentation shall indicated that the unit was subjected to the shock test and subsequently restored, shop tested and examined. A Completed Part Examination Check list 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 specifications for unrestricted service.

4. 3.3.2.7 Pump units shall be shock tested with drivers unless otherwise approved by the command or agency concerned. Flexible coupled pumps shock tested with one driver will not be required to be shock tested again when supplied with a different driver of equal or less weight subject to approval of the command or agency concerned. Prime movers are subject to shock tests in accordance with the applicable equipment specifications (see 6.1).

4.3.3.3 Inclined o ration test. Vertical pumps shall be operated for not less than 30 minutes inclined at an angle from the normal equal to the maximum permanent list or trim as specified (see 6.1). Horizontal pumps shall be tested in accordance with the inclined operation test specified for the driving unit. Operation in the inclined position shall be as close to rated speed and capacity as practicable. The performance point shall be indicated in the test report. The pump shall meet all specified performance requirements without damage while operating in the inclined Position.

4.3.3.4 Vibration test. When specified (see 6.1), one pump of a quantity of identical pumps being supplied shall successfully undergo a vibration test in accordance with the requirements of MIL-STD-167 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 prviously tested, provided the previous tests included the frequencies specified (see 6.1).

4 .3.3.4.1 The unit shall be mounted on typical shipboard foundations during the vibration test or the shipboard mounting arrangement shall be simulated in springmass 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 supplier from furnishing equipment which can withstand the specified vibration inputs. Vibration test acceptance criteria shall be in accordance with MIL-STD-167.

4,3.3.5 Design evaluation test documentation. The test reports for the design evaluation tests shall be prepared in accordance with good 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. The report shall include a definite statement regarding conformance to the acceptance criteria specified herein and suitability of the unit for its intended application. Distribution of the test reports shall be as follows:

(a) Two copies to NAVSEC or the command or agency specified in the contract or order.
(b) Two copies to the procuring agency (Government or shipbuilder).
(c) Two copies to one of the following, as applicable:
Defense Contract Administration Services Region.
Defense Contract Administration Services District.
Defense Contract Administration Services Office.

4.4 Inspection of preparation for delivery. The packaging, packing, and marking shall be inspected for compliance with section 5 of this document.

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements. For the l xtent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.5.)

5.1 Preservation, packaging, packing and marking. The pump units, accessories and onboard repair parts shall be preserved, packaged, packed and marked in accordance with MIL-P-16789. The requirements and levels shall be as specified (see 6.1).

6. NOTES

6.1 Ordering data. Procurement documents should specify the following:

(a) Title, number, and date of this specification.
(b) General design required (see 3.2):
(1) Space and weight limitations.
(2) List, pitch, roll and trim conditions (see 3.2 and 4.3.3.3).
(3) Flow range and design conditions (see 3.2).
(4) Environmental vibration frequencies (see 3.2.9.4).
(5) Airborne, structureborne, and fluidborne noise requirements (see 3.2.9.5, 4.3.1 (d) and 4.3.1.4).
(6) Ambient temperature - normal, maximum and minimum.

(c) Horizontal or vertical mounting (see 3.2.2.1).
(d) Bedplates for close-coupled units (see 3.2.2.8).
(e) Valves, flanges, fittings and bolting required (see 3.2.5.1).
(f) Electrical characteristics (for motor drive), as required and applicable motor and controller specifications (see 3.2.7.1, 3.2.7.2 and 3.2.81:
(1) Voltage, phase characteristics and frequency.
(2) Service.
(3) Ambient temperature.
(4) Duty.
(5) Enclosure.
(6) Design of motors (a.c.).
(7) Bearings with any special characteristics shown.
(8) Insulation.
(g) Gage connections (see 3.2.10.3).
(h) Suction and discharge connections (see 3.2.11.1).
(i) Type of coupling (see 3.2.14.1).
(j) Operating characteristics (see 3.2.22):
Rated capacity and range of capacity.
(2) Rated total head at rated capacity.
(3) Liquid temperature - normal, maximum and minimum (see 4.3.1.3 (a)).
(4) Suction head available - normal, maximum and minimum.
(s) Fluid to be pumped.
(6) Specific gravity of fluid.
(7) Special performance requirements, if any.
(k) Drawings required (see 3.5).
(1) Manuals required or whether complete information needed (see 3.6.1).
(m) Pressure and temperature transients.
(n) Number of sets of special tools (see 3.9.2.1).
(o) Type of driver (see 3.2.23).
(p) Quality assurance provisions (see 4.1.2).
(q) Mercury prohibition (see 4.1.3) .
(r) Vibration tests required (see 4.3.3(d) and 4.3.3.4).
(s) Shock test (see 4.3.3.2 and 4.3.3.2.7).
(t) Preservation, packaging, packing, and marking required (see 5.1).
(u) Ship application.
(v) Unit performance requirements:
(1) Flow and pressure range.
(2) Arrangement and operating information, including parallel operation under roll and pitch transients.
(3) Temperature range, ambient and fluid.
(w) Manufacturer (pump or driver) responsible to the purchaser for compatibility of pump and driver and operation of the assembled unit.

6.2 Management control system documents. The following management control system documents should be included on DD Form 1660:

(a) MIL-P-15137 (see 3.5.1.6, 3.9.1 and 3.9.1.4).
(b) MIL-I-45208 (see 4.1.2).

6.3 The following table of pump materials shall be used by the manufacturer in selecting component part materials:

Table II - Acceptable materials for major pump parts.

Application 1/	Material	Applicable document 2/
Casing	Copper-nickel alloy	MIL-C-20159, type I (70-30 CuNi)
	Stainless steel (highly alloyed)	ACI CN-7M
	Gun metal	QQ-C-390, alloy D5 or ASTM B143, alloy 903
	Valve bronze	QQ-C-390, alloy D4 or ASTM B143, alloy 922
Casing bolts	Nickel-copper alloy	QQ-N-281 or ASTM B164, class A or B
	Nickel-copper-aluminum alloy	QQ-N-286

See footnotes at end of table.

Table II - Acceptable materials for major Pump parts (continued).

Application[1]	Material	Applicable document[2]
Impellers	Nickel-copper alloy	QQ-N-298, Comp. E
Casing wearing rings[3]	Nickel-copper alloy	QQ-N-288, comp. B or D
Shafts	Nickel-copper alloy	QQ-N-281, class A or ASTM B164, class A (cold drawn stress relieved)
	Nickel-copper-aluminum alloy	QQ-N-286, class A (cold drawn age hardened and bright-finished)
Bearing brackets and caps	Gun metal	QQ-C-390, alloy D5 or ASTM B143, alloy 903
	Valve bronze	QQ-C-390, alloy D4 or ASTM B143, alloy 922
	Copper-nickel alloy	MIL-C-20159, type I(70-30 CuNi)
	Aluminum bronze	MIL-B-23921
	Highly alloyed stainless steel	ACI CN-7M
Mounting brackets for close-coupled pumps[4]	Gun metal	QQ-C-390, alloy D5 or ASTM B143, alloy 903
	Valve bronze	QQ-C-390, alloy D4 or ASTM B143, alloy 922
	Copper-nickel alloy	MIL-C-20159, type 1 (70-30 CuNi) or type II (90-10 CuNi)
	Cast steel or structural steel	MIL-S-15083 or ASTM A362, grade 108
Studs, bolts, nuts and washers	Nickel-copper alloy	QQ-N-281 or ASTM B164, class A or B
	Nickel-copper-aluminum alloy	QQ-N-286
Shaft or impeller nuts, impeller washers and impeller keys	Nickel-copper alloy	QQ-N-281 or ASTM B164, class A or B
	Nickel-copper-aluminum alloy	QQ-N-286
Bedplates	Cast steel or structural steel	MIL-S-15083 or ASTM A362, grade 108

1/ Hardware or subassembly parts which are used in a major pump part listed in the table and which perform the same or similar functions as the major part (e.g.; casing drain plug) shall be of the material specified for the major part.

2/ Detail drawings and lists of material shall reference the specification followed in each case (preferably in the order specified in 3.5.2.1), and shall include the class, type or grade of material used in each case, as applicable.

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

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

6.4 With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in applicable Qualified Products List QPL-24475 whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products: List is the Naval Ship Engineering Center, Prince George'S Center, Center Building, Hyattsville. Maryland 20782, and information pertaining to qualification of products may be obtained from that activity. Application for Qualification tests shall be made in accordance with 'Provisions Governing Qualification SD-6" (see 6.4.1).

6.4.1 Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadalphia, Pennsylvania 19120.

6.5 Sub-contracted matarial and parts. The proparation for delivery requirements of referenced documents listed in section 2 do not apply when material and parts are procured by the supplier for incorporation into the equipment and lose their separate identity when the equipment is shipped.

Preparing activity:
Navy - SH
(Project 4320-N126)

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5 PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording

c. Reason/Rationale for Recommendation

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional

b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional

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