MIL-E-23457B(SHIPS)
3 March 1976
SUPERSEDING
MIL-E-23457A(SHIPS)
4 January 1965
(See 6.7 and 6.8)

MILITARY SPECIFICATION

ENGINES, DIESEL MARINE, PROPULSION AND AUXIILIARY, MEDIUM SPEED

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

1. SCOPE

1.1 This specification covers propulsion and auxiliary diesel engines rated below 1500 revolutions per minute (r/rein).

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 this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

F-F-351 - Filters and Filter Elements, Fluid Pressure: Lubricating Oil, Bypass and Full Flow.
O-A-548 - Antifreeze, Ethylene Glycol, Inhibited.
O-1-490 - Inhibitor, Corrosion, Liquid Cooling System.
O-S-588 - Sodium Chromate, Anhydrous, Technical.
HH-P-46 - Packing; Asbestos, Sheet, Compressed.
HH-P-151 - Packing; Rubber-Sheet, Cloth-Insert.
QQ-C-465 - Copper-Aluminum Alloys (Aluminum Bronze) (Copper Alloy Numbers 606, 614, 630, and 642); Rod Flat Products with Finished Edges (Flat Wire, Strip, and Bar), Shapes and Forgings.
MMM-A-260 - Adhesive, Water-Resistant (for Sealing Waterproofed Paper) .
MMM-A-1617 - Adhesive, Rubber Base, General Purpose.
PPP-B-1055 - Barrier Material, Waterproofed, Flexible.

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MIL-C-104 - Crates, Wood, Lumber and Plywood Sheated, Nailed and Bolted.
MIL-P-116 - Preservation-Packaging, Methods of.
MIL-B-131 - Barrier Materials, Watervapor-proof, Flexible, Heat-Sealable.
MIL-R-196 - Repair Parts for Internal Combustion Engines, Packaging of.
MIL-B-233 - Boxes, Repair Parts, Storage.
MIL-S-901 - Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-C-915 - Cable and Cord Electrical, for Shipboard Use General Specification for.
MIL-T-5624 - Turbine Fuel, Aviation, Grades JP-4 and JP-5.
MIL-L-9000 - Lubricating Oil, Shipboard Internal Combustion Engine, High Output Diesel.
MIL-C-9959 - Container, Shipping and Storage (Flexible, Reusable, Water-Vaporproof) .
MIL-E-10062 - Engines: Preparation for Shipment and Storage of.
MIL-G-12803 - Gasket Materials, Non-Metallic.
MIL-B-13239 - Barrier Material, Waterproofed, Flexible, All Temperatures.
MIL-M-15071 - Manuals, Technical: Equipments and Systems Content Requirements.
MIL-P-15137 - Provisioning Technical Documentation for Repair Parts for Electrical and Mechanical Equipment (Naval Shipboard Use) .
MIL-T-15377 - Temperature Monitor System Naval Shipboard.
MIL-C-15730 - Coolers, Fluid, Naval Shipboard: Lubricating Oil, Hydraulic Oil and Fresh Water.
MIL-S-16032 - Switches and Detectors, Shipboard Alarm System.
MIL-T-16049 - Tachometers: Electrical; Self-Generating; Mechanical, Fixed Mounting and Hand Held; and Vibrating Reed.
MIL-I-16165 - Interference Shielding, Engine Electrical Systems.

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MIL-C-16173 - Corrosion Preventive Compound, Solvent Cutback, Cold-Application .
MIL-F-16884 - Fuel Oil, Diesel, Marine.
MIL-I-17244 - Indicator, Temperature, Direct-Reading, Bimetallic, (3- and 5-Inch Dial) .
MIL-P-17286 - Propulsion and Auxiliary Steam Turbines and Gears (Including Repair Parts, Tools, Accessories and Instruments) ; Packaging of.
MIL-F-17555 - Electronic and Electrical Equipment, Accessories, and Repair Parts; Packaging and Packing of.
MIL-I-18997 - Indicator, Pressure, Panel Mounted or Case Supported, General Specification .
MIL-T-19646 - Thermometer, Remote Reading, Self-Indicating Dial, Gas Actuated.
MIL-F-20042 - Flanges, Pipe, Bronze (Silver-Brazing) .
MIL-F-20627 - Filter Assembly and Filter Elements, Fluid Pressure (for Engines with Liquid Fuel Injection Systems) .
MIL-F-20670 - Flanges, Pipe, Carbon Steel, 150 P.S.I., W.S.P. (For Naval Shipboard Use) .
MIL-L-21260 - Lubricating Oil, Internal Combustion Engine, Preservative and Break-In.
MIL-P-24212 - pressure Transducer Equipment (Electrical) (Naval Shipboard Use) .
MIL-W-24270 - Wells for Temperature Indicators or Thermal Elements: General Specification .
MIL-D-24304 - Differential Pressure Transducer Equipment (Electrical) (Naval Shipboard Use) .
MIL-M-24365 - Maintenance Engineering Analysis: Establishment of, and Procedures and Formats for Associated Documentation; General Specification for.
MIL-T-24387 - Temperature Measurement Equipment Signal Conditioner and Power Supply (Electrical) (Naval Shipboard Use) .
MIL-T-24388 - Thermocouples and Resistance Temperature Element Assemblies (Naval Shipboard Use).
MIL-I-24453 - Inhibitor, Corrosion, Soluble-Oil.
MIL-I-26860 - Inhibitor, Humidity, Plug, Color Change.
MIL-C-81751 - Coating, Metallic-Ceramic.

STANDARDS

MILITARY

MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-130 - Identification Marking of U.S. Military Property.
MIL-STD-167-1 Mechanical Vibration of Shipboard Equipment (TyPe I - Environmental and Type II - Internally Excited) .
MIL-STD-167-2 Mechanical Vibrations of Shipboard Equipment (Reciprocating Machinery and Propulsion System and Shafting) Types III, IV and V.
MIL-STD-278 - Fabrication Welding and Inspection; and Casting Inspection and Repair for Machinery, Piping and Pressure Vessels in Ships of the United States Navy.
MIL-STD-740 - Airborne and Structureborne Noise Measurements and Acceptance Criteria of Shipboard Equipment.
NIL-STD-777 - Schedule of Pipinq, Valves, Fittings, and Associated Piping Components for Surface Ships.
MIL-STD-1186 - Cushioning, Anchoring, Bracing, Blocking, and Waterproofing: with Appropriate Test Methods.
MS16142 - Boss, Gasket Seal Straight Thread Tube Fitting, Standard Dimensions for.
MS35802 - Filter Element, Fluid, Pressure-Oil, Full-Flow.

DRAWINGS

MILITARY

810-1385850 - Piping, Instrument Pressure Gage, for All Service.
810-1385917 - Temperature Indicator and Thermowell Selection.
5000-S4501-64492 - Arrangement for Lubrication Oil and Jacket Water Cooling for Internal Combustion Engines.

PUBLICATIONS

MILITARY
NAVSEA 0901-LP-412-0022 - Naval Ships Technical Manual, Chapter 9412 Diesel Engines (Propulsion and General Purpose) .

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the prcuring 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 herion. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
A320 - Alloy-Steel Bolting Materials for Low-Temperature Service.
B75 - Seamless Copper Tube.
B98 - Copper-Silicon Alloy Rod, Bar, and Shapes.
Bill - Copper and Copper Alloy Seamless Condenser Tubes and Ferrule Stock.
B135 - Seamless Brass Tube.
B139 - Phosphor Bronze Rod, Bar, and Shapes.
B171 - Copper-Alloy Condenser Tube Plates.
B283 - Copper and Copper-Alloy Die Forgings (Hot-pressed).
B584 - Copper Alloy Sand Castings for General Applications.
D189 - Conradson Carbon Residue of Petroleum Products, Test for.
D524 - Rams Bottom Carbon Residue of Petroleum Products, Test for.
D664 - Neutralization Number by Potentiometric Titration, Test for.
D874 - Sulfated Ash from Lubricating Oils and Additives, Test for.
D893 - Insoluble in Used Lubricating Oils, Test for.

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

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.)

UNIFORM CLASSIFICATION COMMITTEE
Uniform Freight Classification Rules.

(Application for copies should be addressed to the Uniform Classification Committee, Room 1106, 222 South Riverside Plaza, Chicago, Illinois 60606.)

NATIONAL MOTOR FREIGHT TRAFFIC ASSOCIATION INCORPORATED, AGENT
National Motor Freight Classification Rules.

(Application for copies should be addressed to the National Motor Freight Traffic Association, Inc., 1616 P Street, N.W., Washington, D.C. 20036.)

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

3. REQUIREMENTS

3.1 Sample for the first article inspection. Prior to beginning production a sample shall be tested as specfied in 4.4 (see 6.3).

3.2 Engine rating. The engine horsepower (hp) rating and speed shall be as specified (see 6.2.1) and indicated on the engine identification plate (see 3.11.1). This rated hp output, unless otherwise specified in the contract or order, corresponds to full-power operation of the ship, or it's equipment under ship trial conditions. This engine rated hp shall be not greater than the hp value chosen as the 100 percent "rated-load" condition for the endurance test specified in 4.4.2.2.

3.2.1 Acceptance requirement. Engines procured under this specification will be supplier's production models modified to be compatible with environmental conditions, maintenance procedures, and mission requirements peculiar to Navy surface ship applications. A production model of the engine at the time of bid shall have met at least one of the following requirements:

(a) The engine is essentially identical to an engine that has previously passed the first article test (see 4.4) , has been accepted for use by the Naval Ship Engineering Center (NAVSEC) at the same or a higher power rating and brake mean effect pressure (bmep) , and has proven satisfactory during service operation. Engines meeting this requirement need be subjected only to tests required by 4.5.

(b) The engine is a current production model which the supplier will certify and has a background of at least 10,000 hours in two different marine applications comparable to the intended use of the engine being procured. The units considered as verifying this experience factor shall be installed for a rated output at least equal to the rating in the procurement involved. The supplier shall on specified request, provide detailed information as to where the units are located, who operates them, and insofar as practical, how they are used. This information shall be used when desired to verify the suppliers stated compliance with this requirement. Engines meeting this requirement shall be subjected to the first article inspection specified in 4.4.

3.2.1.1 Engines not meeting prior testing or experience requirements specified shall not be considered in bids when this specification is invoked. Suppliers wishing to introduce such an engine into Navy marine service shall contact NAVSEC prior to bidding. The supplier shall furnish a comprehensive description of the engine design, copies of operating test reports, fuel and lubricating oil consumption, emission levels, and other evidence which would attest to the integrity of the engine. A determination will then be made as to any tests in addition to 4.4 which would be required.

Materials. Corrosion-resistant materials shall be used in sea water system piping and components. Coated or painted cast iron or other ferrous metals are not permitted.

3.3.1 Dissimilar metals. Contact between dissimilar metals shall be avoided in order to minimize galvanic corrosion. An interposing material which will minimize or eliminate this galvanic effect may be used.

3.3.2 Aluminum parts. Aluminum parts, other than pistons, blowers, and fuel pumps shall be protected from corrosion by one of the following methods:

(a) Exterior parts to be painted shall be anodized or treated with corrosion-resistant chemical film.

(b) Exterior parts to be left unpainted shall be anodized.

(c) Interior parts in contact with oil do not require treatment.

(d) Interior parts not in contact with oil shall be anodized or treated with corrosion-resistant chemical film.

3.3.3 Threaded holes in aluminum intended for bolts or screws for components or accessories normally removed or disassembled during routine maintenance or examination shall have steel inserts. Where insufficient basis metal exists, studs can be used without inserts. Dimensions, including thread data and length, and complete instructions covering the removal and replacement of all inserts used shall be included in the engine instruction manual (see 3.13) .

3.3.4 Magnesium alloys. Magnesium alloys shall not be used.

3.3.5 Coatings. Paint, plastic, or zinc coatings shall not be applied to the interior of gear cases, lubricating oil sumps, or any other interior surface that will be in contact with fuel, hydraulic, or lubricating oils.

3.4 Design.

3.4.1 Standard operating conditions. The following operating conditions shall be used for the design and testing of the engine and accessories:

(a) Ambient air temperatures . . . . . 100°F.

(b) Barometric air pressure (dry) . . . . . 29.92 inches mercury (Hg) .

(c) Fresh water from engine. . . . . 160°F (minimum) to 185°F (maximum).

(d) Maximum exhaust system back pressure . . . . . 1 inch Hg.
(e) Sea water inlet temperature. . . . . 90°F.
(f) Sea water outlet temperature . . . . . 130°F (maximum).
(g) Lubricating oil temperature from engine. . . . 160°F (minimum) to 190°F (maximum).
(h) Fuel temperature to engine . . . . . 115°F (maximum).
(i) Maximum intake air system depression using clean filter elements:
(1) Naturally aspirated . . . . . 15 inch water.
(2) Turbocharged. . . . . 8 inch water.

3.4.2 Inclination. Unless otherwise specified (see 6.2.1) , the engine, accessory components, and piping systems shall be capable of operating in accordance with all the requirements of this specification and without loss of fluids, loss of lubricating oil pump suction, and without the connecting rod and gears dipping into the oil under the following conditions:

(a) When the ship is permanently trimmed down by the bow or stern up to 5 degrees from the normal horizontal plane.
(b) When the ship is permanently listed up to 10 degrees to either side of vertical.
(c) When the ship is pitching 10 degrees up or down from the normal horizontal plane.
(d) When the ship is rolling Up to 45 degrees to either side of vertical.

3.4.2.1 Unless otherwise specified (see 6.2.1), the engine installation shall be horizontal.

3.4.2.1 Threaded fastening. Threaded hardware parts shall conform to Handbook H28. Nuts and other threaded fastenings on the engine and accessories shall be secured by wire, lockwashers, cotter pins, clips, or other means in such manner as to positively prevent the part working loose under operating conditions. Drain plugs shall be readily removable with general purpose wrenches.

3.4.4 Accessibility. Engine attached accessories such as pumps, blowers, turbo-chargers, intake air coolers, etc. shall be secured in such a manner as to permit maximum accessibility to the accessories and the engine. Engines shall be provided with openings with removal covers in the frame and crankcase above the mounting flange for servicing and examining the engine.

3.4.5 Timing marks. Means shall be provided to permit checking of valve and injection pump timing. Means for timing and barring the engine over by hand shall be incorporated in the engine design.

3.4.6 Craftshaft. Nuts on coupling flange bolts shall be accessible. Provision shall be made on the free end of the crankshaft for attaching a torsiograph drive.

3.4.7 Shock resistance. When specified (see 6.2.1) the propulsion unit including the engine, marine (if used) , attached and detached accessories shall meet the grade A requirements of MIL-S-901 as modified in 3.4,7.1 through 3.4.7.2.5. Auxiliary engines shall be tested under the shock requirements of the driven equipment.

3.4.7.1 Intended function. The intended function of a shockproof propulsion unit is to continuously deliver power conforming to required performance characteristics throughout and after being subjected to shock of the magnitude experienced during shock tests as specified in MIL-S-901. Further, a shockproof unit, when subjected to shock, shall not suffer damage to the extent that it creates a possible hazardous situation such as fire or injury to operating personnel, or such as to result in likely failure of major units if the unit is not immediately shut-down for corrective action. When tested in accordance with 4.4.2.9, the following damage shall not be permitted:

(a) Damage which causes or necessitates reduction of equipment output to a level below rated for any length of time within 30 days after attack.
(b) Damage that renders inoperative any item or device installed to protect the equipment or operating personnel, such as speed limiting governors, over-speed trips, high pressure relief valves, and low lube oil pressure alarms.
(c) Shock-induced actuation of safety devices specified in (b).
(d) Damage or shock-induced misadjustment of speed governing systems that results in inability to maintain speed automatically within the limits imposed by the individual equipment specifications until repairs or adjustments are made.

(e) Loosening or shifting of any item affixed to a rotating part.
(f) Damage that causes any assembly or subassembly to come adrift from any of its intended restraints.
(g) Damage that requires repairs of any type to be made before equipment operating parameters can be adjusted to suit operational requirements.
(h) Damage that creates a safety hazard to personnel or equipment.
(i) Complete fracture of any unit or welded assembly.
(j) Complete stripping or complete failure by gross distortion of all engaged threads (male or female) of any threaded part.
(k) Increase of dynamic unbalance of any rotating part or assembly to such an extent that the manufacturer must rebalance the affected item prior to delivery of the equipment to NAVSEC or prior to conducting field balancing operations.

3.4.7.2 Damage from shock tests as characterized or specified herein will be permitted to the extent or under the conditions listed for each item.

3.4.7.2.1 Damage that shortens the useful life of wearing parts by initiating or aggravating some long-term detrimental effect such as wear, fatigue, or erosion is permissible if the useful life of wearing parts is reduced by no more than 25 percent. (See note.)

NOTE : Due to difficulties associated with estimating reduction of useful life, equipment acceptability shall be determined with consideration for the accuracy of the estimate. In cases where it is especially difficult to estimate percent reduction of useful life, equipment will not be rejected for this cause unless the limits specified herein have been grossly exceeded. In cases where the availability of test or maintenance information permits a more accurate estimate of useful life reduction to be made, appropriately less leniency will be allowed when determining acceptability of the equipment on this basis.

3.4.7.2.2 Damage resulting in minor leaks of fluids or gases is permissible insofar as no portion of this specification is violated by any consequences of the leakage.

3.4.7.2.3 Damage that brings about a requirement to adjust control apparatus or equipment setpoints in order to regain the pre-attach mode of operation, or damage that brings about a requirement for timely repairs or compensatory action in order to prevent further (and eventually unacceptable) damage that is related to increased wear rates or other long term effects, is permissible only if the following conditions are met:

(a) If the damage or its effects are of such a nature that timely and proper damage diagnosis and compensation would certainly be made by ship’s force personnel familiar with the equipment. (For purposes of this specification; it is considered that misalinement (if any) or shafting cannot be corrected by ship's force).
(b) If the equipment status before adjustment/repairs are made is such that no portion of this specification is violated by the immediate effects of the damage or by requirements for repair of the damage.

3.4.7.2.4 Damage that results in continuous or intermittent rubbing contact between stationary and moving parts (during equipment operation) in areas where it was not originally intended that such contact be made is not permitted. NAVSEC will adjudicate on a case basis, rubs which quickly wear away without causing adverse effects that otherwise violate any portion of this specification.

3.4.7.2.5 Damage that brings about (until repairs are made) a requirement for slight to moderate increase of manual effort, maintenance, or attention on the part of equipment operators in order to maintain the operating mode or the machinery space environment may be permissible, when specifically agreed to by NAVSEC.

3.5 Reliability and maintainability

3.5.1 Reliability.

3.5.1.1 For purposes of this specification, reliability is defined as the measure of the engine’s ability to operate with no requirement for any service or repair attention long enough to complete its assigned mission, as specified in the ordering data (see 6.2.1) .

3.5.1.2 Reliability will be measured for Navy ship application by analysis of results of the 1000-hour endurance test conducted in accordance with 4.4.2.2. An acceptable level of reliability shall be demonstrated when the engine has completed the entire 1000-hour cyclic test with no forced shut-downs (see 4.4.2.2) . Repairs or adjustments shall not be

made to the engine during this test except as may be specifically approved on a case-by-case basis by NAVSEC, their designated representative or as authorized in 4.4.2.2.

3.5.2 Maintainability.

3.5.2.1 Maintenance engineering analysis (MEA). When specified (see 6.2.1), the supplier shall conduct before the design tests a MEA. The MEA shall be conducted for each functional system, equipment, unit, assembly, or subassembly which requires maintenance and the continued operation of which is essential to the successful completion of a mission itself. The supplier shall prepare an MEA report in accordance with the data ordering document included in the contract or order.

3.5.2.2 The design shall provide accessibility to all parts which require examination, preventative maintenance, or replacement in service with the minimum practicable need for disconnection or removal of another part or assembly. Access panels, covers, peep holes, etc. shall be employed to the fullest extent feasible and compatible with the intended examination or maintenance action. The envelope of the minimum required space around the unit which is needed for ease of maintenance shall be shown on the installation drawing (see 3.12.1).

3.5.2.3 All parts, including repair parts furnished under the same contract or order or manufactured to the same drawings shall be interchangeable without the necessity for further machining, selective assembly, or hand fitting of any kind to the fullest extent feasible.

3.5.2.4 Maintainability requirements shall be demonstrated during the post first article test and examination (see 4.4.4) . The supplier shall prepare a maintainability demonstration report in accordance with the data ordering document included in the contract or order.

3.6 System safety program. The supplier shall prepare a system safety program plan and system hazards analysis report in accordance with the data ordering document included in the contract or order (see 6.2.2) .

3.7 Construction.

3.7.1 Accessory equipment. Unless otherwise specified (see 6.2.1) the following accessory shall be furnished with each engine:

(a) Sea water pump (see 3.8.2.1).
(b) Fresh water pump (see 3.8.2.1).
(c) Lubricating oil pressure pump (see 3.8.4.1).
(d) Lubricating oil priming pump (see 3.8.4.5).
(e) Fuel supply pump (see 3.8.3.2).
(f) Fuel oil priming pump (see 3.8.3.4).
(g) Lubricating oil cooler (see 3.8.4.2).
(h) Fresh water/sea water heat exchanger (see 3.8.2.3).
(i) Lubricating oil filter(s) (see 3.8.4.3).
(j) Lubricating oil strainer (see 3.8.4.4).
(k) Intake air silencer (if required) (see 3.8.5.1).
(1) Intake air cooler (if turbocharged) (see 3.8...4).
(m) Fuel oil filter (see 3.8.3.3.2).
(n) Fuel oil strainer (see 3.8.3.3.1).
(o) Temperature regulator or thermostat (see 3.8.2.5).
(p) Governor (see 3.8.8).
(q) Overspeed trip device or governor (see 3.8.8.4).
(r) Starting system (see 3.8.7).
(s) Blower (if required for two cycle engines).
(t) Engine mounted controls (see 3.8.10).
(u) Lubricating oil low-pressure alarm switch (see 3.7.9.2 and 3.8.9.1).
(v) Fresh water high-temperature alarm switch (see 3.7.9.2 and 3.8.9.1).
(w) Fuel oil booster pump (if required).
(x) Fuel oil cooler (if required) (see 3.8.3.6).
(y) Cylinder test and indicator cocks.
(z) Engine turning or jacking device.
(aa) Remote shut-down system (see 3.7.10.3).
(bb) Turbocharger (if used) (see 3.7.3).
(cc) Instruments and panel (see 3.8.9).
(dd) Emergency shut-down device (see 3.8.10.3).
(ee) pyrometer (see 3.7.9 and 3.7.9.1).

other accessories or engine attached piping necessary for engine operation but which are not specified herein or in the contract or order shall be furnished by the engine manufacturer. Unless otherwise specified in the contract or order, piping including valve fittings and flanges, alarm systems, wiring, or mechanical linkage required to connect detached accessories, instruments, and controls to the engine, or to cooling water, fuel starting air, electrical, exhaust, or lubrication system will be furnished by the installing activity.

3.7.2 Guards and shields. Guards and shields shall be furnished as specified in 3.7.2.1 and 3.7.2.2

3.7.2.1 Gaurds. Guards for protection of personnel shall be provided for flywheels and other exposed parts. Where there are no feasible means for attaching the guard to the equipment, the guards will be furnished by the engine manufacturer and the installing activity will accomplish the installation.

3.7.2.2 Shields. Hot machinery surfaces shall be shielded or insulated so that no external surface of the machinery shall exceed a temperature of 204.4°C. Asbestos insulating products or materials shall not be used. Fuel and lubricating oil filters, strainer, lines or fittings, including gage lines, shall be located or shielded so that any leaks cannot drip or spray on any component with a surface temperature of 400°F or higher or into the engine intake.

3.7.3 Turbochargers. Turbochargers (if used) shall be capable of containing within the housing any parts of the rotating members which may become fragmented due to loosening, shattering, or over-speeding. The engine manufacturer shall confirm to the DCAS that this requirement is met by actual destructive testing or certified documented proof of prior testing. If this requirement cannot be met, the installing activity should be advised so that protective shielding can be installed.

3.7.4 Crackcase fumes. The engine manufacturer shall provide a system to dissipate through the engine intake or exhaust system all oil fumes generated by the engine in the crankcase and other areas.

3.7.5 Engine crankcase and air box explosion protective devices or design Diesel engines with cylinder bore diameter of 6 inches or greater shall be protected from the hazard of crankcase or air receiver explosions by one of the procedures specified in 3.7.5.1 through 3.7.5.5.

3.7.5.1 If the crankcase can be demonstrated by test (see 4.4.2.10) to withstand an internal gas gage pressure of 125 pounds per square inch (lb/in^2) without rupture, it shall be considered to be safe to contain a crankcase explosion and no other protection devices are required. For the purpose of this demonstration, the term crankcase shall be interpreted to include the entire engine structure that would be exposed to internal gas pressure in the event of a crankcase explosion.

3.7.5.2 If the integrity of the engine crankcase and related volume cannot be demonstrated as specified in 3.7.5.1, the engine shall be provided with spring loaded explosion relief valves, to provide a total relief area of at least 1-1/2 square inches (in^2) for each cubic foot (ft^3) of total crankcase volume. These relief valves shall be fully open at a crankcase gage pressure of 20 lb/in^2, and to close and seal the crankcase from air when the pressure has been relieved. The entire crankcase system in the terms of 3.7.5.1, including any access covers, shall withstand an internal gage pressure of at least 25 lb/in^2 without failure when explosion protection devices are used.

3.7.5.3 The air receivers of two cycle engines (only) of 6 inch diameter or larger cylinder sizes shall also be protected from air receiver explosions. If the air receivers, including all associated structure that would be subject to gas pressure in event of air explosion can be demonstrated by test (see 4.4.2.11) to withstand an internal gas gage pressure of 125 lb/in^2, no other air receiver explosion protection device shall be required.

3.7.5.4 If the pressure integrity requirements of 3.7.5.3 cannot be met, the air receiver shall be provided with an explosion relief valve or valves, having at least 1-1/2 in^2 of relief area per ft^3 of total air receiver system volume. These relief valves shall be tight at maximum air receiver operating pressure and to be fully open at a gage pressure of 20 lb/in^2 above that operating pressure level. The valves shall be capable of relieving the explosion and reseating tightly. When these explosion relief valves are

used, the entire receiver structure, covers, etc. which would be subject to the pressure of an air receiver explosion shall withstand a gage pressure at least 5 lb/in^2 above the pressure at which the relief valve is fully opened.

3.7.5.5 In addition to meeting all the requirements in 3.7.5.1 through 3.7.5.4, the crankcase and air receiver explosion valves shall include a flame arresting device which will contain or stop the emission of flame and burning oil through the valve in the event of an explosion. The valve design shall include blast deflectors which will direct explosion forces away from personnel who might be standing along side the engine. The lift area of the valve when open shall be at least twice the area of the valve seat in in^2. When tested in accordance with 4.4.2.12, the complete explosion valve with flame arresting device shall be subjected to at least three successive test explosions without loss of effectiveness and with no replacement of any valve assembly components or parts permitted between explosions. There shall be no evidence or egression of flame or burning oil.

3.7.5.6 Explosion relief valve test tank. The valve tank shall include as a minimum the following features:

(a) An ignition system capable of igniting the explosive mixture and continue ignition after the explosion until the tank is purged and filled with fresh air.
(b) Provisions to introduce an oil mist Society of Automotive Engineers ((SAE) 30 lubricating oil) heated to 150°F prior to, during, and after each explosion.
(c) Heating devices to maintain an internal tank temperature of 150°F to 200°F.
(d) Fan or other means of creating turbulence and thoroughly mixing the air/gas/oil mist mixture prior to the explosion.
(e) Vents to admit fresh air to purge the tank after the explosion.
(f) Instrumentation to measure the air/gas mixture in the tank prior to explosion.
(g) Instrumentation to measure and plot an explosion time/pressure curve to determine that valve opening, closing, and pressures developed are within the requirements of 3.7.5.2, 3.7.5.4 and 3.7.5.5.
(h) Photographic equipment to record the valve action and particularly the egress of flame or burning oil during explosion should it occur.

3.7.6 Welding. Welding and allied processes shall be in accordance with MIL-STD-278 unlessspecific waiver have been or are granted by NAVSEC.

3.8 Fluid piping systems.

3.8.1 Piping. Engine attached piping shall be strapped and supported by the engine structure to prevent vibration and reist shock. Take-down joints in fuel systems shall be kept to a minimum to reduce leaks. Connections from the engine to the ship's systems (i.e. exhaust, lubricating and fuel oil inlet and return, and the raw water supply and discharge) shall be in accordance with MIL-STD-777. Flange connections shall be either commercial or Navy type. If commercial flanges are supplied, each connection to ships piping systems shall be provided with a companion flange for welding to ships piping. Navy flanges for steel or nonferrous piping and fittings shall conform to MIL-F-20042 or MIL-F-20670, as applicable. Except as exempt (see 3.8.1.1), taper pipe threads are not permitted in engine piping systems, accessories, or driven equipment. Thread connections, where used, shall employ straight threads in accordance with MS16142.

3.8.1.1 Taper pipe threads are permitted in the following areas:

(a) Pipe plugs in sizes of 3/4 inch and below used for applications where design gage pressures do not exceed 50 lb/in^2. Plugs shall be seal welded or brazed, if possible.
(b) Instrumentation, controls, vent, filling, and drain connections where design gage pressures do not exceed 50 lb/in^2 and where fluids handled:

(1) are not toxic.
(2) are not dangerous.
(3) would not cause atmospheric contamination.
(4) would not create a fire hazard, and which would not cause, in the event of failure, a major breakdown of equipment nor create a hazard to the surrounding area nor affect the operation of other vital equipment.

(c) Pipe plugs internal to the engine.

3.8.2 Cooling water system. Engines shall operate with a closed fresh water cooling system in accordance with Drawing 5000-S4501-64492. Sea water piping shall be of 90-10 copper-nickel alloy. Fittings and valves shall be bronze.

3.8.2.1 Cooling water pumps. Fresh and sea water pumps shall be of the centrifugal type driven by the drive arrangement capable of preventing water leakage into the engine lubricating oil system. Where practical, the fresh and sea water pumps shall be interchangeable. Pumps for direct reversing engines shall be capable of operating in either direction. The pumps shall be so mounted or provided with a continuous vent to prevent the entrapment of air. A self-priming sea water pump shall be provided where pump lift requirements demand such a pump. Pumps which are not self-draining shall be provided with petcocks or other means of draining completely without the use of special tools. Special tools are defined as those tools not listed in the Federal Supply Catalog (copies of this catalog may be consulted in the office of the Defense Contract Administration Service (DCAS)). Engine manuals shall contain complete instructions covering draining of pumps. Sea water pumps shall be constructed of noncorrosive materials compatible with sea water. The use of cast iron in contact with sea water is not acceptable. Shaft seals for sea water pumps shall prevent any air from leaking into the pumps under a suction head of 15 inches of Hg.

3.8.2.2 Engine fluid coolers. The coolers specified in 3.8.2.3, 3.8.2.4 and 3.8.4.2 shall conform to MIL-C-15730 or shall be a commercial unit meeting the material and construction requirements of 3.8.2.2.1 and 3.8.2.2.2. When high-shock resistance is specified (see 6.2.1), coolers shall be in accordance with MIL-C-15730.

3.8.2.2.1 Materials. Commercial cooler materials shall be as specified in tables I and II, except 70-30 copper-nickel alloy may be used where 90-10 is specified. The manufacturer shall have the option of substituting commercial material having equal or better physical and chemical properties than the materials specified in the applicable documents listed in tables I and II. It shall be the responsibility of the engine manufacturer to satisfy the cognizant DCAS that this is the case.

Table I - Salt water coolant.

Part	Material	Applicable document
Tubes	Composition 90-10 copper-nickel alloy	ASTM B111
Shell hubs	Forged naval brass	ASTM B283, alloy 464
	Cast-bronze	ASTM B584, alloy 903 or 922
	Cast-brass	ASTM B584, alloy 857
Tube sheets 1/	Aluminum-bronze	ASTM B171, alloy 614 or 630
	Copper-nickel alloy	ASTM B171, alloy 706
	Wrought naval brass	ASTM B171, alloy 464
Water boxes	Forged naval brass	ASTM B283, alloy 464
	Cast-bronze	ASTM B584, alloy 903 or 922
	Cast-brass	ASTM B584, alloy 857
Shells	Brass tubing	ASTM B135
	Copper tubing	ASTM B75
Shell internals	Nonferrous	

See footnote at end of table.

Table I - Salt water coolant (con.) .

Part	Material	Applicable document
Bolts, studs, and nuts	Phosphor-bronze	ASTM B139
	Copper-silicon alloy	ASTM B98
	Aluminum-bronze, stress relieved, composition 5	QQ-C-465, alloy 614
Cap screws	Alloy steel	ASTM A320
Gaskets	Rubber, synthetic, cloth insertion	HH-P-151
	Asbestos, compressed	HH-P-46

1/ When design embodies a tube sheet integral with shell hub, materials listed for shell hubs can be used for tube sheets.

Table II - Fresh water coolant.

Part	Material	Applicable documents
Tubes	Admiralty metal	ASTM B111
Shell hubs	Forged Naval brass	ASTM B283, alloy 464
	Cast-bronze	ASTM B584, alloy 903 or 922
	Cast-brass	ASTM B584, alloy 857
Tube sheets 1/	Aluminum-bronze	ASTM B171, alloy 614 or 630
	Wrought Naval brass	ASTM B171, alloy 464
Water boxes	Forged Naval brass	ASTM B283, alloy 464
	Cast-bronze	ASTM B584, alloy 903 or 922
	Cast-brass	ASTM B584, alloy 857
Shells	Brass tubing	ASTM B135
	Copper tubing	ASTM B75
Shell internals	Nonferrous	
Bolts, studs and nuts	Phosphor-bronze	ASTM B139
	Copper-silicon alloy	ASTM B98
	Aluminum-bronze, stress relieved	QQ-C-465, alloy 614
Cap screws	Alloy steel	ASTM A320
Gaskets	Rubber, snythetic, cloth insertion	HH-P-151
	Asbestos, compressed	HH-P-46

1/ When design embodies a tube sheet integral with shell hub, materials listed for shell hubs can be used for tube sheets.

3.8.2.2.2 Construction. Coolers shall be capable of withstanding a hydrostatic gage pressure of 115 lb/in^2 on both the cooled and cooling side. Vent and drain connections shall be provided to permit complete venting and draining of both sides. Supports shall be provided for securing to a foundation. Coolers shall not be supported by plates or brackets in such a manner that the primary means of support is obtained from the bolts securing the shell end flange-tube sheet-water box flange joints.

3.8.2.2.2.1 Tubes. Coolers shall have straight tubes. Coiled or U-tubes are not permitted. Tubes shall be 1/4-inch outside diameter (o.d.) by 0.022-inch thick wall (24BWG) or 3/8-inch o.d. by 0.028-inch thick wall (22BWG). The minimum pitch for 1\4-inch tubes shall be 5/16-inch and 29/64-inch for 3/8-inch tubes.

3.8.2.2.2.2 Tube joint. Tubes shall be either roller expanded into the tube sheets or attached to the tube sheets by silver-brazing. When roller expanded, the minimum effective depth of expansion shall be one tube diameter. Provision shall be made for the support of the tubes and prevention of tube vibration.

3.8.2.2.2.3 Cooling surface. The amount of cooling surface installed in all coolers shall be based on the service (specified in 3.8.2.3, 3.8.2.4 and 3.8.4.2) applying a 10 percent fouling factor to the heat transfer coefficient for clean tubes.

3.8.2.3 Heat exchangers. Fresh water/sea water heat exchangers shall be sea water cooled and shall be in accordance with 3.8.2.2. The use of heat exchanger cores installed in expansion tanks or other enclosed areas in the cooling system is permitted provided the core construction and materials meet the requirements of 3.8.2.2.

3.8.2.4 Intercoolers When used, intercoolers (aftercoolers) shall be sea water cooled and shall be in accordance with 3.8.2.2. The use of intercooler cores installed in intake manifolds or other enclosed areas of the air intake system is permitted provided the core construction and materials meet the requirements of 3.8.2.2.

3.8.2.5 Water temperature control. Temperature regulator valves and thermostatic valves shall be either the fail-safe type which shall pass all the cooling water through the cooler in the event of failure of the thermostatic element or be provided with a manual “over-ride” for the thermostatic element.

3.8.2.6 Inhibitors. Engines shall be capable of operating using coolant inhibitors conforming to O-S-588 (chromate type) , MIL-I-24453 (non-toxic soluble oil type) , and 0-1-490 (compatible with ethylene glycol antifreezes).

3.8.2.7 Gasket and packing. Gaskets and packing used in the cooling system shall be of material resistant to deterioration by sea water or when any of the following are added to the fresh water system:

(a) Antifreeze compounds conforming to O-A-548.
(b) Corrosion inhibitor compounds conforming to O-S-588, MIL-I-24453, or 0-1-490.
(c) Preservative compounds conforming to MIL-C-16173 and MIL-L-21260.

3.8.3 Fuel system. Engines shall be capable of operating on fuel corresponding to both JP-5 of MIL-T-5624 and diesel fuel of MIL-F-16884. The fuel system shall include the following:

(a) Positive displacement type fuel pump.
(b) Relief valve connected to discharge into pump suction or supply tank.
(c) Priming pump.
(d) Filters.
(e) Necessary piping, valves, and fittings.

3.8.3.1 If leak-off from the injectors and fuel pump exceeds 2 percent of the supply pump capacity, necessary equipment shall be provided to automatically return leak-off fuel to the service tank.

3.8.3.2 Fuel pump. The engine driven positive displacement fuel pump shall have a suction lift capility of 48 inches.

3.8.3.3 Filtration. The fuel system shall be protected by a primary filter (strainer) ahead of the engine mounted fuel pump and a duplex secondary filter ahead of the fuel injection pump or unit injectors. If the fuel system is of such a design that the filter must be positioned on the suction side of the fuel pump, only the secondary filter is

required. Filters shall be constructed of brass, bronze, or other metals which are not readily corroded by sea water contaminated fuels. Coated steel or untreated aluminum are not acceptable. Filters shall include vents to permit the expulsion of air. Manually operated drain valves shall be provided to completely drain filter bodies without the use of tools.

3.8.3.3.1 Primary filter. Primary filters (strainers) shall be the simplex metal edge type with 0.003 to 0.0035 inch spacing, enclosed manually operated cleaning device and sediment drain. The term "metal edge" is defined as stacked metal discs or helically wound flat metal wire or metal ribbon media. Wire cloth, screen sintered metal, or perforated plate media are not acceptable for simplex strainers.

3.8.3.3.2 Duplex secondary filters. Duplex filters shall consist of two filter units connected to the common head or placed together equipped with a three-way plug valve, disposable filter elements, and mounting arrangement. The lever operated valve shall direct flow through one side to permit element change and cleaning of the other side without interruption of flow. Each side shall be sized to accommodate twice the full flow of fuel supplied to the engine fuel manifold supply line or supply header at rated load of the engine and employ drain valves to permit complete draining. Filter elements and materials used for metal parts and gaskets shall be in accordance with MIL-F-20627. Filter elements shall be rated at 150 gallons per hour (gal/hr) in lieu of the 50 gal/hr stated in MIL-F-20627.

3.8.3.4 Fuel oil priming pump. A hand operated fuel oil pump shall be furnished with the capacity to prime the engine fuel oil system within 2 minutes at an ambient temperature of 70°F.

3.8.3.5 Fuel consumption. 4.1 When engines are subjected to the first article inspection (see 4.4), fuel consumption shall be measured and recorded (see 4.4.2.3).

3.8.3.6 Fuel inlet temperature. The fuel temperature at the engine supply pump inlet shall not exceed 115°F. The installing activity, by the use of coolers or other means, shall insure that this requirement is met. Coolers, if used, shall be sea water cooled and shall be in accordance with 3.8.2.2.

3.8.4 Lubricating system. Lubricating oil shall conform to MIL-L-9000 for ambient condition above 20°F. The same grade of lube oil shall be used in the engine and attached accessories. Engines shall be provided with an oil level indicator, filling opening, and accessible sump drain connection or a sump pump to drain or clean the engine oil pan. Bayonet type oil level indicators shall be shielded to permit accurate readings while the engine is running. The lubricating oil system shall be arranged as shown on figure 1. Engines shall be provided with suction and pressure connections for priming and flushing the engine lubrication system.

3.8.4.1 Lubricating oil pumps. Pressure pumps, scavenging pumps, and piston cooling oils pumps shall be of the positive displacement type, driven by the engine. The scavenging pump, if required, capacity shall be approximately 1-1/4 times the capacity of the pressure pump and shall have an oil flow capable of scavenging the system from idle to rated-speed. A relief valve shall be provided for the outlet of each pump. If the pump suction incorporates a check valve, means shall be provided to prevent excessive build-up in the suction line in case the engine and pump are rotated backwards.

3.8.4.2 Coolers. Lubricating oil coolers shall be fresh water cooled and shall be in accordance with 3.8.2.2 The use of cooler cores installed in an enclosed area integral to the engine is permitted provided the core construction and materials meet the requirements of 3.8.2.2.

3.8.4.3 Lubricating oil filters. Engines shall use full-flow filter elements conforming to type IV of Full-flow filter relief valves shall be external of the filter case. Valves shall bypass oil when the pressure gage drop is between 20 and 25 lb/in^2. The valve closing gage pressure shall be not less than 20 lb/in^2. The filter inlet shall be internally baffled or so constructed to prevent the oil flow from impinging directly on the filter elements. The filter shall include a hand operated drain valve which shall completely drain the filter for servicing. The filter shall be the simplex type.

3.8.4.4 Lubricating oil strainers. Strainers shall be either the simplex metal edge type or the duplex metal edge or basket type. The strainer shall be sized to carry the full-flow of 150 standard saybolt universal (sSU) viscosity oil with a pressure gage drop of not more than 5 lb/in^2 with clean elements. The strainer bypass valve shall be set to

open within the differential gage pressure range of 20 to 23 lb/in^2 across the element, and shall be capable of passing the full oil flow with a total gage pressure drop through the bypass of less than 26 lb/in^2. Strainers shall include hand operated drain valves which shall permit complete drainage of the body(s) for servicing.

3.8.4.4.1 Simplex strainer. Simplex strainers shall be the metal edge type with 0.005 inch spacing and enclosed manually operated cleaning device. Wire cloth, screen, sintered metal, or perforated plate media are not acceptable for simplex strainers.

3.8.4.4.2 Duplex strainer. Duplex strainers shall consist of two filtering units connected by a changeover valve-. The arrangement shall employ a common head with integral valve or separate units piped together with an external valve. The changeover valve shall direct the oil flow through one side to permit cleaning of the other side without interruption of flow. Each side shall be sized to accommodate the entire lubrication oil flow to the engine. Filter elements shall be either the metal edge type (see 3.8.3.3.1), with or without manual cleaning device, or the wire screen basket type. Wire screen media shall be 100 mesh or smaller and shall be protected on both sides to prevent deformation at differential gage pressures up to 70 lb/in^2.

3.8.4.4.5 Lubricating oil priming pump. A lubricating oil pump shall be furnished capable of priming the engine lubricating oil system within 2 minutes at an ambient temperature of 70°F.

3.8.4.6 Spectrometric analysis. When engines are subjected to the first article inspection (see 4.4) , the engine lubricating oil shall be subjected to spectrometric analysis in accordance with 4.4.2.2.4.

3.8.5 Air intake systems. The combustion air shall be taken from the engine compartment or from installing activity provided ducts to the weather, as specified (see 6.2.1) .

3.8.5.1 When it is specified that the engine will take its combustion air from the engine compartment, the engine shall be provided with an effective air intake silencer and with a cleanable filter or screen necessary to protect the equipment from ingesting dirt. Oil bath filters or media that would support combustion or produce toxic fumes during a fire in the engine space are not acceptable. Suppliers wishing to offer media other than a metallic type or flameproof paper should receive NAVSEC approval before receipt of an order or invitation to bid. Filters shall incorporate a device which shall indicate when the element requires changing or cleaning. The intake system shall be directed or extended as necessary to avoid unnecessary heat transfer to combustion air from hot engine parts such as exhaust manifolds and turbocharger turbine casings.

3.8.5.2 When specified in the contract or order that the engine will take combustion air from installing activity provided ducts directly to the engine intake, the following equipment shall be furnished with the engine:

(a) An air filter shall be installed close to the engine.
(b) The filter elements shall withstand a uniformly distributed gage pressure of 5 lb/in^2 over the engine surface of the element.
(c) The area of the filter element shall be such that the air velocity at the face of the filter does not exceed 2000 feet per minute (ft/min) , or the pressure drop across the clean filter be more than 4 inches of water at rated output.
(d) A manometer or signal device shall be connected across the element to indicate when cleaning is required.
(e) The filter housing shall permit removal of the element for cleaning.
(f) The filter element shall be installed at an angle 90 degrees or less to the direction of air flow in order that impinging dirt will drop to the bottom of the duct on the upstream side of filter element.

3.8.5.3 Noise level requirements. When specified (see 6.2.1) , the design of the air intake silencer and shall be such that the near field airborne noise measurements taken at the silencer do not exceed those levels measured at all other locations near the engine. Measurements and instrumentation shall be in accordance with MIL-STD-740.

3.8.5.4 Blowers and air recievers. Means shall be provided for draining pockets in the blower housing and air receiver where oil or water may accumulate.

3.8.6 Exhaust system. Exhaust headers shall be fresh water cooled, insulated, or shielded. Asbestos insulating products and materials shall not be used. Provisions shall be made for draining the gas spaces or the header from either end. When required to be furnished with engines ((see 6.2.1), exhaust mufflers shall be in accordance with 3.8.6.1 and 3.8.6.1.1).

3.8.6.1 Exhaust mufflers. Mufflers shall be capable of reducing the overall noise of exhaust gases to the maximum decibel (dB) levels indicated in table III. The sound pressure levels shall be measured at a radius of 10 feet from the end and 2 feet above the muffler tail pipe with the engine running at rated-load and speed. Installed mufflers, including gaksets and hardware, shall be capable of withstanding a temperature of 1200°F for a period of 10 minutes. On or more cleanout openings, approximately 6 by 8 inches, shall be provided if the diameter of the muffler is 25 inches or larger.

Table III - Permitted airborne noise levels.

Center frequencies of standard octave bands (Hertz (Hz))

Hz	32	63	125	250	500	1000	2000	4000	8000
dB 1/	105	100	95	90	90	85	85	85	85

1/ In dB referred to as 0.0002 dynes/cm^2.

3.8.6.1.1 Dry mufflers. The muffler shall be the dry type with spark arrestor. All-metal parts shall be constructed of carbon steel ceramic coated in accordance with type II of MIL-C-81751. Drains for removal of water and oil and a soot collector for removal of carbon particles shall be included.

3.8.6.2 Exhaust emission. The engine shall keep exhaust smoke emission to a minimum. The Ringlemann smoke chart shall be the standard of comparison. During normal, constant operation at rated-speed, the smoke opacity shall not exceed Ringlemann No. 1. During a speed change, smoke opacity may exceed Ringlemann No. 2 for 5 seconds, then gradually return to less than Ringlemann No. 1 in less than 30 seconds.

3.8.7 Air starting. The air starting system for the engine shall consist of the starting motor or distributor, relay valve, manually operated control valve, and the necessary lines, connections, and fittings.

3.8.7.1 Cold starting. When tested in accordance with 4.4.2.4, the engine shall fire and continue to operate within 10 seconds after the starting mechanism is actuated. If cold starting aids are required, the identical starting aid equipment used during the tests shall be furnished as part of the complete package under the contract or order.

3.8.8 Speed governing system. Engines shall be equipped with a speed governing system and an indedepently driven ver-speed device. Governors shall be as specified (see 6.2.1).

3.8.8.1 Type I governors. Type I governors shall be furnished for constant speed engines.

3.8.8.1.1 Steady-state stability. When operating at all loads up to rated-load, the speed for any constant load shall be so controlled that the periodic or aperiodic oscillations of speed shall be not greater than plus or minus 0.50 percent of rated-speed.

The response of the governor shall be such that upon sudden application or loss of rated-load, the maximum momentary decrease or increase in speed shall not exceed 7 percent of rated-speed. In addition, the engine r/rein shall return to and remain within 1 percent of the final steady-state speed in not more than 5 seconds following a change in load.

3.8.8.2 Type II governors. Type II governors shall be furnished for variable speed engines.

3.8.8.2.1 Steady-state stability. When operating at all speeds and loads up to rated-load and speed, the periodic or aperiodic oscillations of speed shall be not more than plus or minus 1 percent of operating speed.

3.8.8.2.2 Momentary speed surge. The maximum deviation from normal speed, when full or partial rated-load is applied or removed suddenly, shall not exceed 10 percent of operating speed. The speed shall return to plus or minus 1 percent of operating speed in not more than 15 seconds following the change in load.

3.8.8.3.3 Type I and II governors. Governors for engines which are required to operate in parallel on a single propulsion shaft system shall be provided with a load limiter or fuel stop which will automatically control engine torque to safe limit. Regulating governors shall be provided with a steady-state speed regulation mechanism, adjustable from 0 to 5 percent of rated-speed.

3.8.8.3.1 Maneuverability of direct reversing engines. When tested in accordance with 4.4.2.8, the engine shall demonstrate capability of being completely reversed within the governor limitations specified in 3.8.8.3. Compressed air and time requirements shall be determined.

3.8.8.4 Overspeed protection. As protection against dangerous engine overspeed due to failure of the regulating governor its linkage or other engine malfunction, each engine shall be equipped with a separate and independent speed limiting device that will control the engine when it attempts to exceed 115 percent of its full rated-speed. The speed limiting device shall take control at overspeed and stop the engine completely by reducing the fuel injection output to zero or by blocking the engine's combustion air supply or both. This device shall require manual resetting. The speed limiting device shall not attempt to control the engine by any system that cuts off the fuel supply to the engine fuel pump. Governor and overspeed devices shall be tested in accordance with 4.4.2.6 and 4.4.2.7.

3.8.8.5 Low lubrication oil pressure protection. When specified (see 6.2.1) the engine shall be provided with device which will automatically shut-down the engine when the lube oil pressure drops to a point which will cause failure of the oil wetted wearing parts. The device shall actuate at a pressure as selected by the engine manufacturer to insure protection of the engine. The shut-down device shall be equipped with a manual override.

3.8.9 Instrumentation. Instruments shall be furnished with each engine for the following measurements:

(a) Pressure indicators:
(1) Fresh water pump discharge.
(2) Sea water pump discharge.
(3) Lubricating oil pressure pump discharge.
(4) Lubricating oil pressure at the engine inlet.
(5) piston cooling oil (if separate pumps are used).
(6) Fuel oil pump discharge.
(7) Fuel oil pressure at injection pump inlet or fuel header.
(8) Scavenging or supercharging air pressure.
(9) Starting air pressure at the engine.
(10) Lubricating oil pressure at the turbocharger or blower.

(b) Temperature indicators:
(1) Lubricating oil from engine.
(2) Fresh water from engine.
(3) Water from the intake air cooler (if used) (see note).
(4) Sea water to and from heat exchanger (see note).
(5) Fresh water to lubricating oil cooler (see note).
(6) Fresh water to the engine (see note).
(7) Lubricating oil to engine (see note).

Note: Temperature indicators shall be furnished for installation in ships piping by the installing activity.

(c) Alarms:
(1) Low lubricating oil pressure.
(2) High temperature cooling water.

(d) Electrical temperature pyrometer and selector switch:
(1) One thermocouple at each cylinder exhaust outlet and exhaust side of turbocharger (s).

(e) Tachometer:
(1) Engine speed.

(f) Time indicator or hour meter:
(1) Engine operating time.

3.8.9.1 Panel. An instrument panel shall be furnished with each engine capable of being mounted on the engine, off of but adjacent to the engine or located at the engine control stand. Panel mounted instruments shall be flush mounted and 3-1/2 or 4-1/2 dial

size. Instruments shall be accessible for reading from the operating station and for maintenance and calibration check. Instruments shall be in accordance with and installed in accordance with table IV as applicable:

Table IV - Panel.

Instrument	Applicable document	Remarks
Pressure instruments:		
Indicators	MIL-I-18997	Installed in accordance with Drawing 810-1385850.
Transducer	MIL-P-24212	
Differential pressure transducer	MIL-D-24304	
Alarm	MIL-S-16032	Alarm sensor shall be installed at the remote end of the lubricating oil system.
Temperature instruments:		
Direct reading (bimetallic)	MIL-I-17244	
Remote reading (filled system)	MIL-T-19646	
Electrical sensors	MIL-T-24388	
Signal conditioner and power supply	MIL-T-24387	
Thermowells	MIL-W-24270	Installation of thermowells shall be in accordance with Drawing 810-1385917.
Pyrometer (thermocouple and selector switch)	MIL-T-15377	Cabling to be furnished by installing activity
Alarm	MIL-S-16032	Sensor located in cooling water outlet
Cable	MIL-C-915	
R/min indicators [1/] Remote station indicator, when required.	MIL-T-16049, type IC/EFB	Range shall be not less than 25 percent above rated engine speed.
Timer [1/]	Totalizing 9999.9 hours electric, operates when engine is running.	Totalizes number of hours of engine operating time.

1/ Timer and tachometer may be combined.

3.8.9.2 Alarms. A low lubricating oil pressure alarm switch, connected to the remote end of the lubricating oil system, and a cooling water high temperature alarm switch with actuation bulb installed in the cooling water outlet, shall be provided. The low lube oil pressure alarm shall be set higher than the setting established for the automatic low lube oil pressure engine shutdown (see 3.8.8.5).

3.8.10 Control system. Unless otherwise specified (see 6.2.1), the engine shall be provided with attached control levers for starting, stopping, and speed regulation. Reversing engines or engines with reverse gears shall have the reversing control located adjacent to the throttle control. Levers necessary for operation of the engine shall be conveniently grouped at one end of the engine. Propulsion engines shall be provided with an indicator to indicate whether the reversing mechanism is set for ahead or astern rotation. For reversing engines, operating at rated output, the time from actuating the

reversing mechanism until the crankshaft changes direction of rotation shall not exceed 10 seconds. The governor fuel actuating shaft or fuel injection pump control linkage shall be provided with a pointer and a graduated scale to indicate pump rack position.

3.8.10.1 Auxiliary hand operation. When remote or power operation is required (see 6.2.1) for controlling or reversing the engines, auxiliary hand operation shall be provided. The design shall include means to prevent simultaneous power and hand operation. Hand or power operated control mechanism shall permit convenient operation by one man.

3.8.10.2 Interlock. Mechanisms for direct reversing engines shall be provided with an interlock which will prevent fuel injection to the cylinders before the crankcase has stopped rotating and the various mechanisms are set.

3.8.10.3 Emergency shut-down device. Engines shall be provided with an emergency shut-down device, operable—by a pull cable, which shall strip the fuel racks or shut-off the air and stop the engine without any damage within 60 seconds. The device shall be of a type which requires manual resetting before the engine can be restarted. When the engine takes combustion air from the engine compartment, the shutdown device shall, as a minimum, shut-off the air to prevent ingestion of Halon 1301. This device may be combined with the speed limiting device (see 3.8.8.4). The pull cable will be furnished by the installing activity.

3.8.11 Interference shielding. Electrical equipment and interconnections shall be interference shielded in conformance with MIL-I-16165.

3.8.12 Resiliently mounted equipment. When resiliently mounted equipment is specified (see 6.2.1)the following information shall be submitted as specified in 3.12 on a drawing headed "Mounting Installation Design Data":

(a) Speed range (for propulsion machinery and direct current (d.c.) generators) or synchronous speed (for alternating current (a.c.) generators of the unit) .
(b) Total weight of the mounted assembly in the operating condition. The weight shall include weight of subbase, service fluids, piping filters, and all other attached accessories.
(c) Location of the unit center-of-gravity in at least two planes.
(d) The moments of inertia and products of inertia of the mounted unit about three mutually perpendicular axis with the origin at the unit center-of-gravity and the orientation of the axis indicated with respect to the equipment and ship.
(e) The six natural frequencies (in Hz) of the unit.
(f) The type mounting used in performance of the calculation. For mounting other than approved Navy type, information relative to mount natural frequency, static load deflection, and transmissibility is required.
(g) List of assumptions made in calculating natural frequencies.

3.8.13 Torsional vibration. The engine manufacturer shall furnish a torsional vibration analysis in accordance with the data ordering document included in the contract or order, except that the actual torsiograph test is not required in cases where the engine manufacturer does not furnish the engine driven equipment.

3.9 Dimensions and weight. The dimensions and weight shall be as specified in 3.9.1 and 3.9.2.

3.9.1 Dimensions. As specified (see 6.2.1) , dimensions shall include projections of attached accessories, levers , and piping.

3.9.2 Weight. As specified (see 6.2.1) , weight shall be interpreted as the maximum weight of the engine in operating condition and shall include the weight of attached and detached accessories and service fluids.

3.10 Painting. Engines shall be painted in the same manner as for commercial delivery. Internal oil-wetted surfaces shall not be painted.

3.11 Designating and marking. Engines, components, and parts shall be marked for identification in accordance with MIL-STD-130.

3.11.1 Engines shall be provided with an identification plate secured to the engine in a visible and convenient location. Identification plates shall be of metal and shall show the following:

(a) Engine type.
(b) Serial number.

(c) National stock number.
(d) Contract number.
(e) Model number.
(f) R/rein.
(g) Brake horsepower (bhp) .
(h) Rotation.
(i) Bore.
(j) Stroke.
(k) Dry weight.

3.11.1.1 Navy identification plate rating. The hp rating indicated on the engine identification plate (see 3.11.1) shall be the engine full-power output if specified in the applicable contract. In cases where the contract does not specify engine full-power output, but does specify full-rated capacity of the driven equipment, the engine identification plate shall indicate the actual engine power required to drive the driven equipment at it's contract rated capacity. If no hp output equipment is indicated in the contract, the engine identification plate hp should be the hp value chosen as the "rated-load" during performance of the endurance phase of the first article endurance test (see 4.4.2.2) . In no case can the engine identification plate hp be greater than this rated (full) load figure of 4.4.2.2.

3.11.2 Complete accessory components such as pumps, coolers, filters, governors, electrical, and starting equipments shall be provided with identification plates showing manufacturer's name, model or part number, and capacities or ratings where applicable.

3.11.3 A plate with an arrow showing the direction of rotation shall be attached to the major output end of the engine. For engines procured under this specification, rotation is defined as being clockwise or counter-clockwise as viewed facing the major output end of the engine.

3.11.4 Repair parts shall be marked with the manufacturer's part number by casting, stamping, or etching. Where it is not practical to mark parts by any of these methods, the parts shall be identified by tags or printed description on the package.

3.12 Drawing. The supplier shall provide drawings in accordance with the data ordering document included in the contract or order (see 6.2.2) and as specified in 3.12.1 and 3.12.2.1. Drawings of production parts, components, or equipment applicable to a contract or order shall consist of the manufacturer's commercial shop drawings.

3.12.1 Installation drawing. After award of contract and within the time specified in the contract or order, the prime supplier shall submit installation drawings covering the exact engine, driven equipment, detached components, accessories, and controls to be furnished to the command or agency concerned. The prime supplier shall furnish one reproducible copy of the installation drawings to NAVSEC. Installation drawings shall include the following:

(a) Overall dimensions for the complete assembled unit.
(b) Foundation bolting dimensions.
(c) Wet and dry weights, including detached accessories.
(d) Center-of-gravity in at least two planes.
(e) Both minimum and desirable clearance for removal of parts such as cylinder heads, pistons, liners, cooler tube bundles, camshafts, pumps, and blowers.
(f) Bill of material describing make, model, and quantity of equipment and accessories being furnished.
(g) Capacity of blowers and pumps at rated engine speed and volume of exhaust gases at rated-speed and load specifying pressure and temperatures for which data apply.
(h) Show bhp, bmep, and r/rein.
(i) Location and size of pipe connections to engine and accessories.
(j) For engines having detached accessories:
  (1) Diagrammatic sketches of engine piping systems (e.g. sea and fresh water, lube oil, fuel oil, and air starting) indicating pipe sizes, type of fittings, and relative location of coolers, filters, valves, strainers, thermometers, and gages. Supplier furnished piping shall be shown by solid lines and installing activity furnished piping by broken lines.
(k) Heat balance chart (unless shown in the operators manual) .
(l) Rotation at power output.
(m) Gear reduction.
(n) Engine fluid capacities (including gear if furnished).
(o) Air consumption.

3.12.2 Microfilm aperture/tabulating cards and listing. The supplier shall prepare a complete set of engine drawings on microfirm aperture cards in accordance with the data ordering document included in the contract or order (see 6.2.2) and as specified in 3.12.2.1. Included shall be installation and assembly drawings together with detail drawings of all parts of the engine, gear and accessories not exempted herein. Drawings of items on Qualified Products Lists (QPL) and standard hardware that are fully described in bills of material and drawings of pieces used in the fabrication of welded parts shall not be included.

3.12.2.1 Accessory drawings. The following accessory drawings shall be furnished (if the accessory is used) :

(a) A cross-section drawing with bill of material shall be sufficient for the following:
(1) Regulating and overspeed governors.
(2) Cold start device.
(3) Lube oil filter.
(4) Thermostats or temperature regulators.
(5) Starting system components.
(6) Air intake filter/silencer.
(7) Pneumatic control devices.
(8) Fuel oil filter and strainer.
(9) Mufflers.
(10) Coolers.
(11) Water filter.

(b) An outline drawing shall suffice to complete drawing requirements for the following accessories:
(1) Tachometer.
(2) Tachometer generators.
(3) Pressure gages.
(4) Thermometers.
(5) Thermocouples.
(6) Flexible exhaust hose.
(7) Expansion tanks.
(8) Valves (relief safety, throttling, regulating, reducing, and similar types) .

3.13 Manuals. The supplier shall prepare manuals in accordance with the data ordering document included in the contract or order (see 6.2.2) and specified as in 3.13.1 through 3.13.2.3.

3.13.1 Manuals shall include the following:

(a) Engine installation drawing.
(b) Table of normal clearances, diameters and thickness for new parts, and maximum allowable clearances and wear limits for all wearing parts.
(c) Torque settings of important threaded hardware.
(d) For a complete propulsion or generator unit including one or more engines, couplings, generator, or reverse reduction gear; the manual shall include complete and comprehensive alinement instructions for the entire plant. The instruction shall cover original alinement procedure with maximum limits for radial and axial deviation and information for alinement checks after installation. A machinery layout sketch showing locations of measurements and space for recording measurement shall be provided.

3.13.2 Validation. The supplier shall be responsible to validate or have validated the information contained therein for all manuals supplied. In those cases where validation is performed at a subsupplier's plant, the prime supplier is responsible for the quality of the technical manual information and shall provide verifiable evidence of the adequacy of the validation performed. Validation shall be completed and all corrections made and validated prior to presentation of the technical manual to the Government for verification. Personnel performing the validation shall be on a technical level equivalent to the intended user of the technical manual. Technical manuals or any part of a technical manual that has been validated for any other Government requirement need not be re-validated. Validation shall include the following:

(a) All written information, engineering drawings and art work in the manual shall be compared to the related physical equipment or system to assure that they do, in fact, actually delineate that equipment or system.

(b) Demonstrate by actual performance all instructions and procedures in the manual on the equipment supplied except for the following:
(1) Destructive testing or destructive disassembly is not required.
(2) Boring, grinding, or other shaping repair procedures need not be actually executed.
(3) Checking for accessibility may be determined by measurement, observation, and reference to drawings.

3.13.2.1 A validation page shall be included in each manual supplied, inserted immediately after the title page, including the following information:

(a) Supplier's full identification (if other than prime, full identification of both must be indicated) .
(b) Contract number(s).
(c) Chapters and sections validated and the date each was accomplished.
(d) Chapters and sections not validated.
(e) Name, signature, and authority of validating officer.

3.13.2.2 Validation of engine dimensional clearances. The supplier shall be responsible for validating the external systems (i.e. starting, cooling water, fuel, lubricating oil, air intake, exhaust, drive systems, and mechanical or electrical accessories) of each engine and provide minimum and desirable dimensional clearance requirement data to facilitate access to various parts of each when adjustments and repair are needed.

3.13.2.3 Validation of special tools dimensional clearances. The supplier shall validate the correct operation of all special tools associated with each engine and provide minimum and desirable dimensional clearance data required for each special tool to optimize accessibility in performing the necessary maintenance and repair functions.

3.14 Repair parts. Repair parts shall be furnished in accordance with MIL-P-15137 (see 6.4).

3.14.1 The engine manufacturer shall determine and base his recommendations as to the repair parts, gaskets, and all other consumables except fuel and lubricants, which would be required to support each engine unit with all its components and equipment for a period of 90 days. This recommendation shall assume that operation during the 90 days is at a constant 80 percent load, 100 percent speed condition, and the materials list shall include not only the items to be replaced because of wear or breakage, but also all items such as gaskets, filters, etc., which are consumed in the course of the examination adjustments, and maintenance operations he recommends for the proper care of the equipment.

3.14.2 In addition to the requirements of 3.14.1, the supplier shall list the insurance items which he recommends to be carried onboard ship which would in his opinion, provide an optimum "get home" capability during the above same 90 day operation (mission) .

3.14.2.1 Subject to the requirements of 3.14.1 and 3.14.2, the following criteria shall be used in determining recommended onboard repair parts and related consumables:

(a) Demand based items (items having a predicted usage of at least one unit in 90 days for all installations onboard a ship).
(1) Provide an effectiveness (filling of demands onboard) of 90 percent for a period of 90 days.
(2) Be predicated on combat consumption rates wherever such rates can be ascertained.
(b) Insurance items (items which do not have a predicted usage onboard ship of at least one in 90 days).
(1) Only those insurance items essential to end item performance and vital to the support of the primary mission of a ship or unit or vital to the safety and welfare of personnel onboard ship shall be provided.
(2) Insurance items shall be included in minimum depth (either unity or minimum replacement unit to meet potential 90 day combat requirements) .

3.15 Workmanship. Castings shall have a workmanlike finish and shall be free from sand, shrinks, cold shuts, cracks, harmful porosity, and other defects which make the castings unsuitable for the intended purpose. Runners, risers, fins, and other cast-on pieces shall be removed. Sharp edges on projections shall be removed from stamping or forgings in the finished part. Machined surfaces shall have sharp edges broken or chamfered. Weld shall be free of weld spatter or slag. Forgings shall be free from seams, cracks, scale, fins, porosity, hard spots or excessive inclusions, segregations, or other defects.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility 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 Inspection system. The supplier shall provide and maintain an inspection system in accordance with the data ordering document included in the contract or order (see 6.2.2) .

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

(a) First article inspection (see 4.4) .
(b) Quality conformance inspection (see 4.5).

4.3 Visual and dimensional examination. Each engine shall be subjected to a thorough visual and dimensional examination to ascertain that the material, workmanship, and construction are in conformance with the requirements of this specification not involing tests and specified drawings. The examination shall apply equally to service components and repair parts.

4.4 First article inspection. First article inspection shall be conducted on the first application of an engine by the command or agency concerned. Inspection shall consist of the examination of 4.3 and tests specified in 4.4.2 through 4.4.2.12. Where a supplier has previously conducted first article inspection in accordance with the requirements of this specification on an identical engine, the final report covering the previous testing shall be furnished to NAVSEC for review and certification. If the engine for which extension of first article inspection is proposed is identical to the engine previously tested except for the number of cylinders, rated hp and speed; or if the proposed engine has been modified and is not part for part identical to the previously tested engine, the supplier shall furnish a complete description of the changes, reports of testing conducted by the supplier, and any other evidence to substantiate functional identicality. The command or agency concerned reserves the right to require complete retesting after review of the changes, final report of previous testing, or service experience. All testing shall be monitored by the cognizant DCAS.

4.4.1 First unit test conditions.

4.4.1.1 The dynamometer load for the engine shall be such as to insure that the engine identification plate output as specified in the contract or order can be obtained under standard conditions. The dynamometer load necessary to satisfy this requirement shall be determined using the following formula:

$$Bhp_d = \frac{Bhp}{\frac{29.92}{P_o}\sqrt{\frac{T_o}{560}}}$$

Where:

Bhp_d = Dynamometer load (observed).

Bhp = Engine identification plate output.

P_o = Observed ambient pressure in inches of Hg (dry barometer) .

T_o = Observed ambient temperature (absolute) .

The correction factor shall be applied for all dynanmmeter test loads.

4.4.1.2 The exhaust back pressure at the engine exhaust outlet for rated-load and speed shall be adjusted to 1 inch Hg by use of an orifice or restriction in the exhaust line. The restriction shall remain during all tests.

4.4.1.3 The temperature of the sea water to the engine shall be a minimum of 90°F.

4.4.1.4 The engine fresh water shall be treated with a soluble oil inhibitor conforming to MIL-I-24453.

4.4.1.5 Fuel used during the tests shall be diesel fuel conforming to MIL-F-16884 with a minimum sulphur content of 0.7 percent. A laboratory analysis of a sample taken from each lot of fuel used shall be included in the final report.

4.4.2 Test.

4.4.2.1 Torsiograph. When required (see 6.2.1) , torsiograph tests shall be conducted in accordance with type III of MIL-STD-167-2.

4.4.2.2 Endurance. Engines shall be run for 125 eight-hour cycles as follows:

(a) 2 hours at rated-load and speed.
(b) 1 hour at 85 percent load and rated-speed.
(c) 10 minutes at minimum or zero load and rated idling speed.
(d) 1 hour and 50 minutes at rated-load and speed.
(e) 10 minutes at minimum or zero load and rated idling speed.
(f) 30 minutes operation at 50 percent load and 75 percent rated-speed for propulsion engines and rated-speed for constant speed engines. (Propulsion engines shall be operated in reverse.)
(g) 10 minutes at minimum or zero load and rated idling speed.
(h) 10 minutes at 85 percent load and rated-speed.
(i) 1 hour and 50 minutes at 110 percent rated-load at rated-speed.
(j) 10 minutes shut-down (minimum between each cycle).

Engines may be shut-down, as required, between each complete cycle or full cycles may be run on a continuous basis. However, forced shut-down(s) , as defined below, which cause cessation of the endurance test will require the test to be repeated starting from the first cycle.

(a) A forced shut-down of the test engine due to failure of a part or component that cannot be corrected or repaired within 2 hours from shut-down or
(b) Two forced shut-downs of the test engine for any length of time due to failure of the same part or component, or
(c) Any forced shut-down of the test engine which requires access to the internal parts of the crankcase, geartrain (accessory drive), or to the camshaft, cylinder liners, pistons, valves, and rings.

At the end of each of the last ten cycles of the test the engine shall be stopped utilizing the emergency shut-down device.

4.4.2.2.1 Compression pressures for each cylinder at idling speed, and firing pressure at rated-load and speed shall be obtained after endurance tests on all engines over 6 inch bore.

4.4.2.2.2 The method of assembly and the tightness of joints in the engine piping system, after being fully assembled on the engine, shall be tested under pressure equal to a test pressure 50 percent in excess of the working pressure prior to the endurance test.

4.4.2.2.3 During the endurance test, the fuel consumption and exhaust gas temperatures for runs not less than 1/2 hour shall be recorded. Fuel pump rack setting, if available, shall be recorded for all test loads.

4.4.2.2.4 Spectrometric oil analysis. Lubricating oil samples shall be taken from the lube oil scavenge line before the lube oil filter with the engine running. The oil must be circulating and at operating temperature. Samples shall not be taken from a gage line.

4.4.2.2:4.1 Sampling intervals. Samples shall be drawn during the 2 hours at rated-load and-speed period of the first and last cycle specified in 4.4.2.2 and during the same period of each ten cycles during the test (total 14 samples).

4.4.2.2.4.2 A spectrometric analysis of each oil sample taken in accordance with 4.4.2.2.4.1 shall be made. The concentration of elements in p/m of oil wetted wearing parts shall be recorded. The analysis shall identify and measure the following elements, as applicable, in p/m with the degree of accuracy indicated in 4.4.2.2.4.3:

(a) Iron (Fe).
(b) Lead (Pb) .
(c) Copper (Cu).
(d) Chromium (Cr) .
(e) Aluminum (Al) .
(f) Nickel (Ni).
(g) Silver (Ag).
(h) Tin (Sri).
(i) Silicon (Si).
(j) Sodium (Na).

4.4.2.2.4.3 Degree of accuracy. Degree of accuracy shall be as follows:

Standard reference specimen (Range in p/m)	Standard deviation (Maximum in p/m)
3-9	1.5
10-19	2
20-49	3
50-99	5
100-199	8
200-500	15

4.4.2.2.5 Lubricating oil analysis. Samples of the lubricating oil used during the test shall be subjected to a laboratory analysis and the results included in the final report. A sample shall be taken from the new oil before the test. Additional samples shall be taken just prior to oil changes and at the end of the test.

4.4.2.2.5.1 The analysis shall consist of the following tests conducted in accordance with the indicated ASTM test method:

Test	ASTM No.
Total acid number	D664
Total base number	D664
Carbon residue	D189 or D524
Sulphated ash	D874
Pentane and benzene insoluble	D893, procedure B

4.4.2.3 Fuel consumption. Fuel consumption tests of 1/4 hour duration with time intervals between each run for stabilization of operating conditions, shall be made on propulsion engines at 100, 90, 70, 50, and 30 percent rated-speed for each load of O, 40, 80, 100, and 110 percent of rated hp. If the engine cannot be operated continuously at 30 percent rated-speed, the lowest safe operating speed shall be substituted. For speeds below rated-speed, 100 percent bhp shall be defined as maximum bhp which the engine can carry safely and meet the exhaust emission limits of 3.8.6.2 with a clear exhaust. Fuel consumption shall be corrected for the difference in high heat value of the fuel actually used during the test and the standard 19,350 British thermal unit (Btu) per pound.

4.4.2.4 Cold starting. Engines shall be subjected to a cold starting test (see 3.8.7.1). Prior the test, the engine shall have been shut-down for at least 12 hours. Cold water at temperature not exceeding 35°F shall be circulated through the engine for at least 1 hour or until all parts of the engine are cooled to a uniform temperature. The engine shall fire and continue operating within 10 seconds after starting mechanism is set in operation. If cold starting aids are required, the identical starting equipment shall be furnished as part of the package under the contract. The minimum quantity of air expressed in ft^3 of air at a gage pressure of 14.7 lb/in^2 and 68°F for the start shall be determined.

4.4.2.5 Normal starting. Immediately following the cold starting test (see 4.4.2.4), nine consecutive starts shall be made under normal ambient conditions. The average time required to start the engine, and the minimum starting r/rein shall be determined. The engine shall fire and continue operating within 5 seconds after the starting mechanism is engaged.

4.4.2.5.1 Air starting test data. The following data shall be obtained:

(a) The minimum quantity of air, expressed in ft^3 of free air at gage pressure of 14.7 lb/in^2 and 68°F necessary for each of ten successive starts, including the cold start.
(b) The minimum air starting pressure at which the engine will start within the 5 second time limits.

4.4.2.6 Regulating governor. Tachographic records of engine speed changes shall be made to determine compliance with 3.8.8.

4.4.2.7 Overspeed limited device. During the overspeed test, the regulating governor shall be made inoperative. The engine speed shall be increased above rated-speed until the overspeed limiting device acts to determine the r/rein at which the overspeed device is set.

4.4.2.8 Maneuver test for direct reversing engines. The direction of rotation of the engine shall be reversed by power a total of 100 times. Full-load shall be applied between each reversal. The time for reversal shall be determined to demonstrate compliance with 3.8.8.3. The total quantity of air used in the 100 reversals shall be recorded and the average quantity for each reversal calculated in ft^3 of free air at a gage pressure of 14.7 ib/in2 and 68°F. The minimum air pressure and time at which a reversal can be accomplished shall be determined.

4.4.2.9 Shock tests. Shock tests shall be conducted in accordance with the grade A, hull mounted requirements of MIL-S-901 and as amplified herein. The complete propulsion unit including the engine, marine gear (if attached directly to the engine) , instruments, controls, and attached and detached accessories shall be tested as a principal unit using the heavy-weight shock machine specified in MIL-S-901. Assemblies and subassemblies comprising the complete propulsion unit to be tested shall be those actually made for and furnished under the contract.

4.4.2.9.1 Preparation for shock tests. The engine manufacturer shall carefully examine the unit in order to detect any flaws or undesirable conditions that might contribute to shock damage or be mistaken for shock damage during the post test examination. Instrumentation and pretest measurements shall be as follows:

(a) Velocity pickups, high speed movies, instruments for monitoring unit operation, and provisions for remote shut-down.
(b) Scribe lines or punch marks shall be made to indicate the exact location of attached accessories, components, and major housings to detect any movement during the test.
(c) Crankshaft deflection shall be checked by the engine manufacture.
(d) Initial start-up and checkout shall be conducted under the guidance of the engine manufacturer's representative.

4.4.2.9.2 Mounting. The propulsion unit shall be mounted on the floating test platform at the same rake angle as the intended ship installation. Detached accessories shall be mounted on a fixture capable of accommodating the accessory and shall be welded to the inner deck, if deck mounted, or to the side of the barge.

4.4.2.9.2 Test procedure. During the five shots specified in MIL-S-901, the combination of engine operation mode and horizontal distance of the charge shall be rated idle speed at 60, 40, and 20 feet and shut-down at 30 and 25 feet. During and after the shots where idling is specified, the engine shall continue to run for a minimum of 5 minutes. Minor damage that does not impair the operation of the engine may be corrected during the test. Major damage as described in 3.4.7.1 shall be cause for termination of the tests. The decision as to whether damage is major or minor shall be made by the representative(s) of the command or agency concerned and engine manufacturer at the test site. In case of disagreement, the matter shall be referred to the command or agency concerned for final decision.

4.4.2.9.3.1 Where the total weight of the propulsion unit is less than 6000 pounds, the medium-weight shock test machine described in MIL-S-901 may be used. The engine shall run at idle speed during the three blows where the engine is mounted in its normal operating rake angle and shut-down during the three shots where the engine is inclined 30 degrees.

4.4.2.9.4 Post shock inspection. After completion of the shock tests the propulsion unit shall be returned to the supplier for inspection in accordance with MIL-S-901 and as amplified herein. Upon receipt at the suppliers plant and prior to removal from the carrier, the unit shall be given a visual examination to assure no damage occured during transit. The post test inspection shall consist of the following:

(a) Visually examine the complete unit for breakage, distortion, cracks, leaks, and relative movement between components, housings, major assemblies, and accessories.
(b) Remove inspection covers and visually examine accessible internal areas for damage.
(c) Measure and record the crankshaft deflection.
(d) Conduct hydrostatic tests of piping systems and coolers at a gage pressure of 100 lb/in^2.
(e) If the examination thus far reveals no damage that would prevent full-power operation, the engine shall be subjected to the operating tests specified in 4.5.1 and 4.5.2. For this test, the detached accessories shocked with the engine shall be used. During the test, instruments and controls shall be checked for damage and accuracy. The engine shall be stopped using the emergency shut-down device.
(f) Disassemble the unit and examine bearings and moving parts for excessive wear or damage attributed to shock. The internal surfaces of the block and housings shall be examined for evidence of shifting, rubbing, momentary contact of moving parts, and cracks.

4.4.2.9.5 Post shock test report. A detailed report shall be submitted to the command or agency concerned for approval. The report shall include the following:

(a) Results of the examination during and after the tests.
(b) photographs to show damaged parts and evidence of movement of parts.
(c) The suppliers recommendations for design improvement to “shock harden” the unit.

4.4.2.9.6 Disposition of shock tested proulsion unit. Shock tested units can be delivered under a contract or order providing the following requirements are met:

(a) Damage resulting from shock is corrected. The method of correction shall be approved by the command or agency concerned.
(b) Bearings shall be replaced where examination reveals obvious but minor damage. Where major damage to bearings is discovered, redesign corrective action shall be taken and approved by NAVSEC.
(c) Any design improvements necessary to shock harden are incorporated into the unit.
(d) The reworked unit passes the duplicate engine tests specified in 4.5.1 and 4.5.2.

4.4.2.9.7 Marking. Installation drawings covering the unit and detached accessories shall include the following information:

(a) Class of shockproofness.
(b) Reference to shock test reports and approval letter or shock design calculations and approval letter.
(c) If shock tested, the following additional information shall be included:
  (1) Type of mounting fixture used (refer to MIL-S-901).
  (2) Equipment class.

4.4.2.10 Crankcase integrity. The crankcase area, as defined in 3.7.5.1, shall be subjected to an internal air gage pressure of 125 lb/in^2 without rupture or distortion.

4.4.2.11 Air receiver integrity. The air receiver area, as defined in 3.7.5.3, shall be subjected to an air gage pressure of 125 lb/in^2 without rupture or distortion.

4.4.2.12 Explosion relief valve. Explosion valves shall be tested to demonstrate the requirements of 3.7.5.2, 3.7.5.4 and 3.7.5.5. The valve to be tested shall be of the same design and materials as the valve to be furnished under the contract. The valve shall be mounted on a test tank with a volume available for a gas/air mixture of 1 ft^3 per 1.5 in^2 of relief valve seat area. Lubricating oil may be used to adjust the tank volume. To simulate actual crankcase and air receiver operating conditions, an oil mist heated to

150°F shall be sprayed into the tank prior to, during, and after the explosion. The explosive media shall-be-propane or natural gas and air at as near a stiochiometric mixture as required to produce explosive gage pressure of at least 80 lb/in^2 if the mixture at atmospheric pressure were ignited in the test tank, sealed and not relieved or vented (a mixture of 22 percent natural and 78 percent air has proven satisfactory) . Immediately after the explosion, the ignition system shall remain operational and the tank slowly purged with fresh air so that a condition is created for a possible secondary explosion.

4.4.2.12.1 Explsion relief valve test procedure. The valve shall be subjected to three successive test explosions under the conditions specified in 4.4.2.12. Two of these shall be photographed with the room dark to detect any egress of flame or burning oil. The third explosion shall be photographed with proper photogenic lighting. After each explosion the valve shall be examined for compliance with 3.7.5.5. Photographs, instrumentation readings, and description of visual examination shall be included as part of the final report (see 4.4.5) .

4.4.3 First article test report. The supplier shall prepare a first article test report in accordance with the data ordering document included in the contract or order (see 6.2.2) and as specified in 4.4.3.1 through 4.4.3.3.

4.4.3.1 Temperature and pressure readings necessary for complete evaluation of the engine performance including ambient room temperature, barometric pressure, and relative humidity shall be entered on the test sheets. Fuel consumption in pounds-per-hour (lb/hr) shall be entered for all runs of a duration for engine conditions to become stabilized. Additions of lubricating oil and oil changes shall be recorded. Readings of instruments shall be recorded at intervals not exceeding 1 hour. When a phase of a test is of such short duration that operating temperatures cannot be stabilized, no reading is required.

4.4.3.2 Fuel consumption. The recorded data shall be submitted in tabular form, and in the form of curves as follows:

(a) Specific fuel consumption in lb/hr, exhaust gas temperature, injection pump rack position (if practical), and air box pressure versus bhp. Data shall include all speeds and loads specified in 4.4.2.2.
(b) Fuel consumption at no-load in lb/hr versus speed.
(c) With bhp as the ordinate and r/rein as the abscissa, draw lines of constant bmep, and super impose curves of constant fuel consumption.
(d) To determine the control of the load limiter (when applicable) on engine output, a curve of maximum bhp or bmep versus r/rein for the operating range of the engine shall be furnished.

4.4.3.3 Spectrometric analysis. The following information/data shall be provided:

(a) List of oil wetted wearing parts and corresponding wear metal elements.
(b) Recommended limits in p/m of the wear elements/metals listed in (a). It is the intent to use these values as a basis to segregate normal from abnormal operating machinery.
(c) Tabulation of the analysis data recorded in accordance with 4.4.2.2.4.2. Tabulation shall include such related and pertinent data as chemical and physical characteristics of the lubricating oil used during the test, initial quantity of oil in the system, hours of operation from start of test at which oil was added/changed, and applicable quantity of oil added/changed.

4.4.4 Post first article examination. After completion of all tests, the engine shall be disassembled and examined. After the crankshaft deflection has been measured and recorded, all cylinders shall be opened, pistons pulled, and the cylinder bores, pistons, piston rings, wrist pins, and crankpin bearings examined for defects and measured for wear. Gear train covers and all crankcase covers shall be removed for examination of internal parts. The engine shall be barred over during examination to determine extent of backlash in gear trains. The reverse-reduction gear, if furnished, shall be examined and measured for wear. Mating surfaces of gears and all bearings shall be checked for distress such as pitting and galling. Excessive wear, broken or damaged parts, scored cylinders, burned valves, or signs of severe stress or excessive wear shall be cause for rejection of the unit. Excessive wear is defined as wear in excess of the engine manufacturer's published wear limit for the particular part. The post first article examination of the engine will include examination of cavitation erosion damage to liner and cylinder block surfaces in contact with engine cooling water. If the examination does indicate some cavitation erosion effects or damage to these liner and cylinder block surfaces in contact with engine cooling water, it will be necessary for NAVSEC to evaluate the condition of these surfaces, considering all available

evidence which would indicate the effect of this cavitation erosion problem on the life and reliability of the engine and its parts in Navy marine service. The cavitation erosion problem if evidenced, will be considered sufficiently severe to cause rejection of the engine if, in the opinion of NAVSEC, based on evidence presented by the engine manufacturer and observed in the test engine that cavitation erosion would reduce the time between overhaul of the engine in our service as expected from normal wear, or cause the cylinder block or frame to be unuseable after less than four major overhauls.

4.4.4.1 Special tools furnished with the engines shall be tried out on the engine during the post trial examination, before examination can be considered complete.

4.4.5 Post first article report. The supplier shall prepare a post first article report in accordance with the data ordering document included in the contract or order (see 6.2.2). The complete first unit test-report shall include the following data:

(a) Analysis of diesel fuel (see 4.4.1.5).
(b) Compression and firing pressures (see 4.4.2.2.1).
(c) Results of piping pressure test (see 4.4.2.2.2).
(d) Endurance test fuel consumption and exhaust gas temperatures (see 4.4.2.2.3).
(e) Lubricating oil analysis (see 4.4.2.2.5).
(f) Fuel consumption test results (see 4.4.2.3).
(g) Air requirements for cold start (see 4.4.2.4).
(h) Air requirements for normal start (see 4.4.2.5.1).
(i) Regulating and overspeed governor data (see 4.4.2.6 and 4.4.2.7).
(j) Time and air requirements for reversing test (see 4.4.2.8).
(k) Results of crankcase integrity test (see 4.4.2.10).
(l) Results of air receiver integrity test (see 4.4.2.11).
(m) Results of explosion relief valve test (see 4.4.2.12.1).
(n) Spectrometric analysis (see 4.4.3.3).
(o) Results of post first article examination (see 4.4.4) .

Final acceptance will be made by NAVSEC, Hyattsville, Maryland.

4.5 Quality conformance inspection. Production engines, duplicates of one that has passed the first article tests (see 4.4), shall be tested as specified in 4.5.1 and 4.5.2. For these tests, the supplier may use his standard commercial test cells, detached accessories, diesel fuel, lubricating oil, coolants, and instrumentation.

4.5.1 Performance test. Each variable or constant speed engine shall be operated for one test cycle in accordance with 4.4.2.2. The engine shall be capable of maintaining the following:

(a) Specified loads and speeds.
(b) Pressures and temperatures specified by the engine manufacturer in the instruction manual.
(c) Smoke emission limitations specified in 3.8.6.2.

4.5.2 Governor test. The response of regulating and overspeed governors shall be tested as specified in 4.4.2.6 and 4.4.2.7.

4.6 Auxiliary engines shall also be tested in accordance with the combined unit test specifications.

4.7 Inspection of preparation for delivery. Preservation-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 extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.6.)

5.1 Preservation-packaging. Preservation-packaging shall be level A or C, as specified (see 6.2.1).

5.1.1 Level A.

5.1.1.1 Basic engine unit. The basic engine unit including driven equipment shall be cleaned and preserved in accordance with type V, method II, of MIL-E-10062 to the extent specified. Preservatives identified by “P numbers” in this specification shall conform to

the corresponding "P number" and applicable specifications in MIL-P-116. Manifolds, pumps, turbochargers, and other attached accessories shall not be removed from the engine during cleaning and preservation unless the removal is considered essential for complete coverage of the preservative.

5.1.1.1 Lubricating oil, fresh and sea water system. Preservative type as applicable, grade 30 in accordance with MIL-L-21260, shall be used throughout the engine and gear, fresh water, sea water, and lubricating oil systems in lieu of the P-2, P-3, P-5, and P-9 preservative specified in MIL-E-10062. When required, engine manufacturers may revise MIL-L-21260 by imposing a maximum zinc content limit. Clean filter elements shall be installed in the fuel and lubricating oil systems after preservation is completed. In addition, the fresh water system with thermostats removed, shall be drained and completely dried with warm air prior to preservation. If it is impractical to perform a drying-out procedure, the cooling system shall be flushed with a soluble oil conforming to MIL-I-24453, which will emulsify the water and remove it on draining. The system shall then be flushed with the specified preservative and the thermostats replaced. The preservative oil shall be drained from all systems including the crankcase.

5.1.1.1.2 Fuel oil system. Preservative in accordance with MIL-L-21260, type as applicable, grade,10, shall be used throughout the fuel system. A substitute, satisfactory to the command or agency concerned, may be used for those fuel systems where passages and orifices are so small as to prevent pumping of the preservative throughout the system. A mixture of four parts diesel fuel and on part P-10 is satisfactory. Injectors shall not be removed from engines for the purpose of preservation.

5.1.1.1.3 Valve mechanism. Access covers shall be removed and all surfaces within the valve compartment, Including rocker mechanisms, valve stems, springs, guides, push rods, and the inside face of the cover plate shall be coated with P-10 preservative.

5.1.1.1.4 Transmission and transfer case. Transmission and transfer case and any other gear trains not lubricated by the main engine lubricating system shall be drained of lubricant and all surfaces within the housing coated with P-10.

5.1.1.1.5 Packaging. Engine units shall be individually unit protected in accordance with MIL-P-116, method II to insure optimum desiccation, engine inlets and outlets shall not be sealed. As specified (see 6.2.1), one of the two packaging methods shall be used.

(a) Method IIa - noreusable floating bag. The flexible barrier bag shall conform to the requirements of MIL-P-116 and MIL-B-131, class 1. Humidity indicators shall conform to MIL-I-26860, (plug type) . Projections and sharp corners of the engine unit shall be cushioned as specified in 5.2.4. Wherever hold-down bolts go through the barrier bag, gaskets fabricated of material conforming to G-1123 of MIL-G-12803 shall be secured to both the inside and outside of the bag with adhesive conforming to MMM-A-260 for fiber gaskets and MMM-A-1617 for rubber gaskets. Desiccant shall be uniformly distributed throughout the package to obtain optimum effectiveness.

(b) Method IIa - reusable floating bag. A reusable container conforming to MIL-C-9959, type III, shall be used.

5.1.1.2 Detached instruments, accessories, repair parts, and tools. Detached instruments, accessories, repair parts, and tools shall be preserved-packaged level A in accordance with MIL-R-196 or MIL-E-17555, as applicable. Unless used in sets, pairs, or quantity greater than one or as specified in the contract or order, detached instruments, accessories, repair parts, and tools shall be individually preserved-packaged. When specified (see 6.2.1) , onboard repair parts and tools shall be packed in repair parts stowage boxes conforming to type M or W of MIL-B-233.

5.1.1.2.1 Index list. An index list shall be inserted in each shipping container containing repair parts or tools accompanying the equipment or procured as a set or kit. The list shall be placed in a transparent waterproof bag and heat sealed. The list shall be placed in the index list support located on the interior side of the repair parts box cover or placed in the inside of the box for quick accessibility. The list shall completely itemize the contents of the container.

5.1.1.2.2 Cushioning. Contents of repair parts boxes and unit packages shall be cushioned in accordance with the applicable commodity specification and as specified in 5.2.4.

5.1.2 Level C. Preservation-packaging of engine units, detached components, accessories, repair parts, and tools shall afford protection against corrosion, deterioration, and

and physical damage during shipment from the supply source to the first receiving activity for immediate use.

5.2 Packing. Packing shall be level A or C, as specified (see 6.2.1) .

5.2.1 Basic engine unit.

5.2.1.1 Level A. Each unit shall be packed in a reusable plywood sheathed crate conforming to type II, class 2, style a or b of MIL-C-104. Each unit shall be anchored, blocked, and braced within the shipping container to resist shock and prevent damage during shipment and storage. Anchoring, blocking, and bracing shall be in accordance with 5.2.4 and the appendix to MIL-C-104. Crates shall be provided with an inspection port for use in viewing the humidity indicator mounted in the barrier material. The rubbing strip of MIL-C-104 shall be 3 inch in lieu of 2 inch thick material.

5.2.1.2 Level C. Packing shall be accomplished in a manner which will insure acceptance by common carrier, at lowest rate, and will afford protection against physical or mechanical damage during direct shipment from the supply source to the installing activity for early installation. The shipping containers or method of packing shall conform to the Uniform Freight or National Freight Classification Rules or other carrier regulations, as applicable to the mode of transportation.

5.2.2 Detached instruments, accessories, repair parts, and tools. Detached instruments, accessories, repair parts, and tools shall be packed level A or C, as specified (see 6.2.1) in accordance with MIL-R-196 or MIL-E-17555, as applicable. Rough handling test as specified in MIL-E-17555 is not required. Repair parts and tools shall be separately packed and shipped concurrently with the basic equipment, set, or system. Detached instruments and accessories shall be packed separately and secured in the engine shipping crate if space permits or shipped concurrently with the basic equipment.

5.2.3 Repair parts boxes. Repair parts boxes (see 5.1.1.2) when required, shall be packed in accordance with MIL-P-17286.

5.2.4 Anchoring, blocking, bracing, and cushioning. Anchoring, blocking, bracing, and cushioning of engine units, detached components, accessories, repair parts, and tools shall be in accordance with MIL-STD-1186 and the applicable comnmodity or container specification and appendix thereto. In addition, the following is mandatory for cushioning materials when used:

(a) Use of loose excelsior or shredded newspaper is prohibited unless such are enclosed in a sealed, waterproof barrier conforming to PPP-B-1055 or MIL-B-13239.

(b) Polystyrene “loose-fill” materials for level A packing applications such as cushioning, filter, dunnage, etc., is prohibited. Unless approved by the procuring activity (see 6.2.1), use of polystyrene “loose-fill” for Packaging and packing under 5.1.2, 5.2.1.2, and 5.2.2 (level C) for applications such as cushioning, filler, dunnage, etc., is prohibited. When approved for use under 5.1.2, 5.2.1.2, and 5.2.2 (level C) packages and containers (interior and exterior) shall be marked or labeled as follows:

“CAUTION

Contents cushioned etc., with polystyrene (loose-fill) material.
Not to be taken onboard ship.
Remove and discard loose-fill material before shipboard storage.
If required, recushion with cellulosic material bound fiber,
fiberboard, or transparent flexible cellular material.”

5.3 Marking.

5.3.1 Standard marking. In addition to any special marking or instructions required herein or by the contract or order (see 6.2.1) , unit and intermediate packages and exterior shipping containers shall be marked in accordance with MIL-STD-129.

5.3.2 Special markings.

5.3.2.1 Method II. Method II packages shall be marked in accordance with MIL-STD-129.

5.3.2.2 Shipping containers. Shipping containers shall have the following markings:

(a) Adjacent to method II markings:

"STORE RIGHT SIDE UP - WARNING - SEE UNPACKING INSTRUCTIONS."

(b) Apply adjacent to the identification marking on the side of the container:

"CAUTION - THIS EQUIPMENT MAY BE SERIOUSLY DAMAGED UNLESS UNPACKING INSTRUCTIONS ARE CAREFULLY FOLLOWED. UNPACKING INSTRUCTIONS ARE LOCATED (state where located) ."

(c) "REUSEABLE INTERIOR AND EXTERIOR CONTAINER (when applicable) ."
(d) Handling and structural markings as applicable (see MIL-STD-129 and appendix to MIL-C-104).

5.4 Special instructions.

5.4.1 Preserved engines. Engines preserved level A shall be tagged as follows:

"The fluid systems of this engine have been preserved with type P-10 preservative. No special depreservation procedures are required with the exception of fresh water system. Depreservation of the fresh water system shall be in accordance with NAVSEA 0901-LP-412-0002. "

5.4.2 Depreservation. The equipment supplier shall provide any additional depreservation instructions for systems or accessories when such instructions would not be applicable to 5.4.1 or would be necessary due to design peculiarities of his equipment. Instructions shall be packaged in a transparent waterproof plastic bag, minimum 4 mil thick. Closure shall be by heat sealing. The shipping container in which the instructions are packed shall be marked to so indicate.

5.4.3 Unpacking. Unpacking instructions shall be provided for complex equipment or systems and floating bag type packs, the instructions shall contain the following information:

"To unpack remove the top and sides, leaving the unit resting on the bottom of the packing case. Remove the packing case and slip the unit off the base. In unpacking the item, the following precautions shall be observed to prevent possible damage:

(a) Observe the arrows marked on the shipping container. These point to the cover which can be removed most readily.
(b) Remove nails with a nail-puller only.
(c) Remove screws with a screwdriver only.
(d) Never pound or hammer the shipping container.
(e) Keep all levers and crowbars away from the interior of the container.
(f) Seal all engine openings upon removal of barrier bag."

5.4.3.1 These instructions shall be placed in a sealed waterproof envelope prominently marked "UNPACKING INSTRUCTIONS" and firmly affixed to the outside of the shipping container in a protected location, preferably adjacent to the identification marking. If the instructions cover a set of equipment packed in multiple containers, the instructions shall be affixed to the number one container of the set or system.

5.4.4 Technical manuals. Depending on the type of packaging specified for the engine unit, the accompanying technical manuals shall be packaged as specified in 5.4.4.1 through 5.4.4.3.

5.4.4.1 Nonreuable bags. Manuals shall be packaged in transparent plastic bags, minimum 4 mil thick and heat sealed. Manuals shall not be placed within the sealed MIL-B-131 bag used to encase the engine unit but placed on the inside of the plywood crate. Packing list shall indicate the approximate location of the manuals. The container shall be marked "Manuals Enclosed". For ease of removability, the location of the manual(s) shall be such that they are readily accessible when the container is opened.

5.4.4.2 Reuable bag. Technical manuals shall be placed in the pocket provided on the outside of the reusable bag. The pocket(s) shall be marked "Manual Enclosed".

5.4.4.3 Bulk shipment. Technical manuals shipped in bulk quantities shall be packaged and packed in accordance with the requirements of MIL-M-15071.

6. NOTES

6.1 Intended use. The engines are intended for use in Naval surface ships, large boats, and landing craft as propulsion *or* powering auxiliary equipments. This specification covers two or four stroke cycle engines, incline, vee, or opposed piston block configurations, liquid cooled, naturally aspirated, supercharged, or turbocharged.

6.2 Ordering data.

6.2.1 Procurement requirement. Procurement documents should specify the following:

(a) Title, number, and date of this specification.
(b) Engine rated horsepower and speed (see 3.2).
(c) Inclination, if other than as specified (see 3.4.2 and 3.4.2.1).
(d) When shock resistance is required (see 3.4.7).
(e) Definition of assigned mission (see 3.5.1.1).
(f) Whether MEA is required (see 3.5.2.1).
(g) Accessory equipment furnished, if other than as specified (see 3.7.1).
(h) High-shock resistance required (see 3.8.2.2).
(i) Source of engine air (see 3.8.5).
(j) Airborne noise measurements, if required (see 3.8.5.3) .
(k) Exhaust muffler, if required (see 3.8.6).
(1) Type of governor required (see 3.8.8) .
(m) Whether engine low lubricating oil pressure shut-down is required (see 3.8.8.5).
(n) Operating controls, if other than as specified (see 3.8.10) .
(o) Whether auxiliary control is required (see 3.8.10.1).
(p) When resiliently mounted equipment is required (see 3.8.12).
(q) Dimensions and weight (see 3.9.1 and 3.9.2).
(r) Torsiograph tests, if required (see 4.4.2.1) .
(s) Level of preservation and packaging required (see 5.1) .
(t) Packaging method required (see 5.1.1.1.5).
(u) Type of parts stowage boxes, if required (see 5.1.1.2) .
(v) Level of packing required (see 5.2).
(w) Level of packing required for detached instruments, accessories, repair parts, and tools (see 5.2.2).
(x) When use of polystyrene "loose-fill" materials are permitted (see 5.2.4) .
(y) Special markings required (see 5.3.1).

6.2.2 Contract data requirements. When this specification is used in a procurement invoking the data requirment clause of the Armed Services Procurement Regulations (ASPR) paragraph 7-104.9(n) and which incorporates a DD Form 1423 Contract Data Requirements List (CDRL), the data requirements identified below will be developed as specified in the cited Data Item Description (DID) and delivered in accordance with such CDRL. When the ASPR provisions are not invoked, the data specified below shall be delivered in accordance with the contract requirements.

Specification paragraph	Data requirements	Service	Applicable DID	Options
3.5	Plan, system safety program	SH	UDI-H-23390	---
3.5	Report, system hazards analysis	SH	UDI-H-23391	---
3.5.2.1	Reports, maintenance engineering analysis	SH	UDI-L-26377	---
3.5.2.4	Maintainability demonstration	SH	UDI-R-23565	---
3.8.13	Analysis, torsional vibration for propulsion system	SH	UDI-T-23715	___
3.12	Drawings, engineering, and associated lists	SH	UDI-E-23174	Categories A, B, D, G, and H; form 2 and 3; type 2; class 2
3.12.2	Microfilm, aperture/tabulation cards and listing	SH	UDI-E-23140	---
3.13	Manual, technical, standard, basic issue	SH	DI-M-2043 DI-M-2044	--- ---
4.1.1	Inspection system program plan	SH	DI-R-4803	---
4.4.3 and 4.4.5	Report, first article test	SH	UDI-T-23450	---

(Copies of DID's required by the supplier in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer. Unless otherwise indicated, the issue in effect on date of invitation for bids " or request for proposal shall apply.)

6.3 First article inspection. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection as to those bidders offering a product which has been previously procured 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 procurement.

6.4 Management control documents. The following management control document shall be included on the DD Form 1660:

(a) MIL-P-15137 (see 3.14).

6.5 Bid data. Complete engine and accessory data should be furnished with bids in accordance with figure 2. This information is of value to the shipbuilder for piping and structural design purposes. Shipbuilders should furnish copies of figure 2, covering the engine, as advance information to establish engine-to-hull records to the Naval Ship Engineering Center, Center Building, Prince Georges Center, Hyattsville, MD 20782, Attn: SEC 6146

6.6 Sub-contracted material and parts. The preparation 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.

6.7 Supersession data. Requirements pertaining to type B engines are as specified in MIL-E-24455 (SHIPS), dated 24 September 1971.

6.8 THE MARGINS OF THIS SPECIFICATION ARE MARKED "#" TO INDICATE WHERE CHANGES (ADDITIONS, MODIFICATIONS, CORRECTIONS, DELETIONS) FROM THE PREVIOUS ISSUE HAVE BEEN MADE. THIS WAS DONE AS A CONVENIENCE ONLY AND THE GOVERNMENT ASSUMES NO LIABILITY WHATSOEVER FOR ANY INACCURACIES IN THESE NOTATIONS. BIDDERS AND CONTRACTORS ARE CAUTIONED TO EVALUATE THE REQUIREMENTS OF THIS DOCUMENT BASED ON THE ENTIRE CONTENT IRRESPECTIVE OF THE MARGINAL NOTATIONS AND RELATIONSHIP TO THE LAST PREVIOUS ISSUE.

Preparing activity:
Navy - SH
(Project 2815-N129)

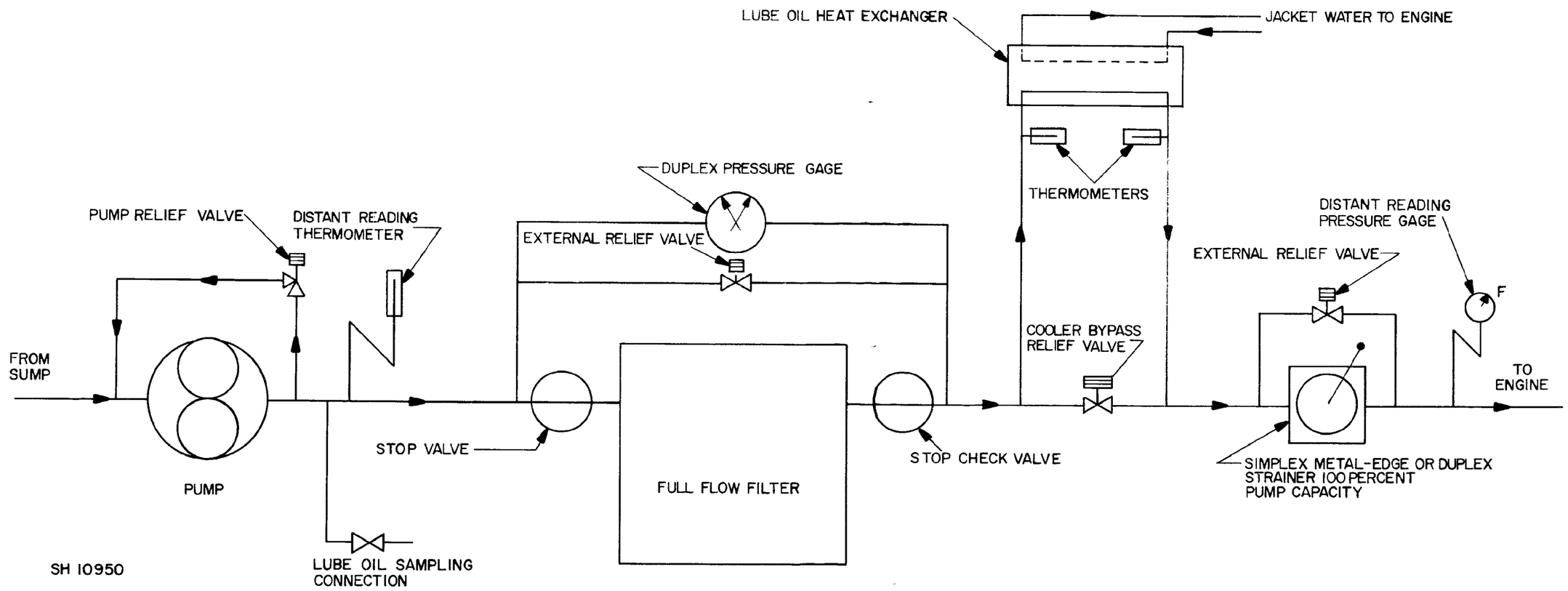

Figure 1 - Full flow lube oil filter system.

Manufacturer _____ Model _____

Continuous duty rating. BHP _____ RPM _____ BMEP _____

Bore and stroke _____ No. of cylinders _____ Type _____

Overall dimensions: Length _____ Width _____ Height _____

Weights: Engine only wet-dry _____ Subbase _____ Accessories _____

Lubricating systems: Wet sump _____ Dry sump _____ Capacity _____

Accessory equipment (show applicable data)

Item	Type or Manufacture	Capacity or range
Pressure pump(s) Lube oil		
Scavenging pump Lube oil		
Sea water pump		
Fresh water pump		
Fuel pump		
Lube oil cooler		
Heat exchanger		
Starting system (cubic ft/start)		
Specific fuel consumption		
At rated load, lbs/bhp/hr		
Muffler (size and weight)		
Control system		
Vol of exhaust gas at rated load		
Blowers or turbochargers		

Note: Outline drawings shall be submitted with bids, showing overall dimensions and weights. Materials of engine blocks, frames, or structural supports and mounting flanges shall be specified on the descriptive literature.

Figure 2 - Engine data to be submitted with bids.

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER: MIL-E-13456B

2. DOCUMENT TITLE:

3a. NAME OF SUBMITTING ORGANIZATION:

b. ADDRESS (Street, City, State, ZIP Code):

4. TYPE OF ORGANIZATION (Mark one)

- ☐ VENDOR
- ☐ USER
- ☐ MANUFACTURER
- ☐ OTHER (Specify):

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

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

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

c. MAILING ADDRESS (Street, City, State, ZIP Code) – Optional

8. DATE OF SUBMISSION (YYMMDD)

DD FORM 82 MAR 1426 PREVIOUS EDITION IS OBSOLETE.

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