MIL-E-17341C(SHIPS)
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SUPERSEDING
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3 December 1962
(See 6.4)

MILITARY SPECIFICATION

ENGINES, GAS TURBINE, PROPULSION

AND AUXILIARY NAVAL SHIPBOARD

1. SCOPE

1.1 Scope. This specification covers gas turbine engines for propulsion, generator, and auxiliary drive for marine service.

1.2 Classification. Engines shall be either of the following types as specified (see 6.1).

Type A - Engines shall normally be used in low usage rate applications such as for boat, hydrofoil, and boost power propulsion and for emergency generator drive.
Type B - Engines shall normally be used in high usage rate applications such as for main ship propulsion and for ship service generator drive.

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.
PPP-B-1055 - Barrier Material, Waterproofed, Flexible.

MILITARY

MIL-C-104 - Crates, Wood, Lumber and Plywood Sheathed, Nailed and Bolted.
MIL-P-196 Preservation, Methods Of.
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-A-907 - Antiseize Compound, High Temperature.
MIL-D-1000 - Drawings, Engineering and Associated Lists.
MIL-D-1000/2 - Drawings, Engineering and Associated Lists.
MIL-L-2104 - Lubricating Oil, Internal Combustion Engine (Heavy Duty).
MIL-C-5541 - Chemical Films and Chemical Film Materials for Aluminum and Aluminum Alloys.
MIL-E-5607 - Engine, Gas Turbine, Preparation for Storage and Shipment of, Process for.
MIL-T-5624 - Turbine Fuel, Aviation, Grades JP-4 and JP-5.
MIL-E-8594 - Engine, Aircraft, Turboprop, Model Specification for (Outline and Instructions for Preparation).
MIL-A-8625 - Anodic Coatings, For Aluminum and Aluminum Alloys.
MIL-F-8901 - Filter/Separators, Aviation and Motor Fuel, Ground and Shipboard Use, Performance Requirements and Tests Procedures for.
MIL-L-9000 - Lubricating Oil, Internal Combustion Engine, Diesel.
MIL-C-9959 - Container, Flexible, Reusable, Water-Vaporproof.
MIL-B-13239 - Barrier Material, Waterproofed, Flexible, All Temperatures
MIL-M-15071 - Manuals, Technical Equipments and Systems Content Requirements for.

MILITARY (Cont'd)

MIL-P-15137 - Provisioning Technical Documentation for Repair Parts For Electrical and Mechanical Equipment (Naval Shipboard Use).
MIL-C-15730 - Coolers, Fluid, Industrial, 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.
MIL-C-16173 - Corrosion Preventive Compound, Solvent Cutback, Cold-Application.
MIL-P-16304 - Pyrometers, Indicating.
MIL-T-16420 - Tube, 70-30 and 90-10 Copper Nickel Alloy, Seamless and Welded.
MIL-F-16884 - Fuel Oil, Diesel, Marine.
MIL-I-17244 - Indicators, 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-E-17555 - Electronic and Electrical Equipment, Accessories, and Repair Parts; Packaging and Packing of.
MIL-L-17672 - Lubricating Oil, Hydraulic and Light Turbine, Noncorrosive.
MIL-I-18997 - Indicator, Pressure, Panel Mounted or Case Supported, General Specification.
MIL-T-19646 - Thermometers, Remote Reading, Self-Indicating Dial, Gas Actuated.
MIL-F-20670 - Flanges, Pipe, Carbon Steel 150 P.S.I., W.S.P. (For Naval Shipboard Use).
MIL-C-21121 - Coolers, Fluid, Industrial; Lubricating Oil and Fresh Water, Naval Shipboard.
MIL-F-21467 - Fittings, Flareless, Fluid Connection (Shipboard Use).
MIL-L-23699 - Lubricating Oil, Aircraft Turbine Engines, Synthetic Base.
MIL-M-24100 - Manuals, Orders and Other Technical Instructions for Equipments and Systems.
MIL-M-25394 - Manual, Technical, Overhaul Instructions and Intermediate Maintenance Instructions (for Engines).
MIL-H-25579 - Hose Assembly, Tetrafluoroethylene, High Temperature, Medium Pressure.
MIL-M-38761 - Microfilming, and Photographing of Engineering/Technical Data and Related Documents: PCAM Card Preparation, Engineering Date Micro-Reproduction System, General Requirements for, Preparation of.
MIL-M-38761/2 - Microfilming and Photographing of Engineering/Technical Data and Related Documents: PCAM Card Preparation, Engineering Data Micro-Reproduction System: Microfilm Aperture and Tabulating Cards for Naval Ship Systems.
MIL-I-45208 - Inspection System Requirements.
MIL-F-52308 - Filter Element, Fluid Pressure.

STANDARDS

MILITARY

MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-130 - Identification Marking of U.S. Military Property.
MIL-STD-167 - Mechanical Vibrations of Shipboard Equipment.
MIL-STD-810 - Environmental Test Methods.
MIL-STD-1186 - Cushioning, Anchoring, Bracing, Blocking and Waterproofing; With Appropriate Test Methods.

PUBLICATIONS

MILITARY

AF - NAVY AERONAUTICAL BULLETINS
ANA 182 - Material Changes and Substitutions, Aircraft Engine Parts (Production Contracts).
ANA 445 - Engineering Changes to Weapons, Systems, Equipments and Facilities.

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

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

AMERICAN GEAR MANUFACTURER'S ASSOCIATION (AGMA)
Standards and Technical Publications Index.

(Application for copies should be addressed to the American Gear Manufacturer's Association, Standards Department, 1330 Massachusetts Avenue, N. W., Washington, D. C. 20005.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
D-1018 - Hydrogen in Petroleum Fractions, Test for.
D-1740 - Luminometer Numbers of Aviation Turbine Fuels, 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.

FEDERAL AVIATION ADMINISTRATION (FAA)
T50-C42 - Fire Protection Sleeves.
T50-C53A - Fire Protection Sleeves.

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

UNIFORM CLASSIFICATION COMMITTEE
Uniform Classification Rules.

(Application for copies should be addressed to the Uniform Classification Committee, 202 Union Station, 516 West Jackson Boulevard, Chicago, Illinois 60606.)

NATIONAL CLASSIFICATION BOARD
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 General engine requirements. All requirements specified herein shall be met by either type engine except as otherwise specified.

3.1.1 Acceptance requirements. The engine, in addition to meeting all other requirements of this specification, must have met, at time of bid, one or more of the following requirements:

(a) The engine has been used in commercial service for a period of 2 years. The reliability of the engine shall be as specified (see 6.1). This statement shall include the mission, definition of failure, reliability level and confidence limits. This requirement shall be verified by documentation attested to by the user. It shall show that the engine has met or exceeded the reliability requirements. An engine having met this requirement shall also meet all provisions of this specification.
(b) Previously accepted by the Naval Ship Engineering Center (NAVSEC) as complying with the requirements of this specification for shipboard use at or above the normal rating (see 6.1). Engines meeting this requirement need be subjected only to tests required by 4.4.2.
(c) Previously accepted by NAVSEC as complying with this specification for shipboard use at a lesser rating. The engine in this case shall pass the test in 4.4.4 to be accepted as the proposed rating. The proposed rating shall be no more than 15 percent higher than the previously approved rating. The engine manufacturer shall submit documentation showing why the engine would be acceptable at the higher rating. The engine shall be subjected to tests required by 4.4.3 and 4.4.4.

3.1.2 New engines. When specified (see 6.1), engines not meeting any of the criteria in 3.1.1 may be accepted by passing tests specified.

3.1.3 Engines with significant design changes. Where engines previously accepted for Naval shipboard use have required design changes because of unsatisfactory use in service, the engine shall be considered a new engine and shall successfully complete the requirements of 3.1.1(a) in a configuration incorporating all changes.

3.2 Change control.

3.2.1 Model designation. The equipment manufacturer shall specify a model designation for each engine (including gears if supplied), generator set or other complete engine driven package to completely identify the unit for logistic purposes. Any changes or modifications, whether internal or external, that will affect the form, fit or functional interchangeability or will require different logistics support shall require a suffix to the basic model designation to indicate the change.

3.2.2 Bill of materials. The contractor shall supply to NAVSEC a parts list (see 6.1) which completely defines (for operation, maintenance and logistics) the engine model supplied. This shall be the parts list for the engine which has been accepted for Navy use in accordance with 3.1 and has successfully passed the other tests in this specification as may be required. It shall constitute the approved parts list for any subsequent engines of the same model to be delivered to the using service. This shall include a complete listing of parts broken down by components and showing part numbers and quantities as well as the lowest level of parts replacement recommended for each level of maintenance. The level of maintenance to be considered shall be determined in accordance with the definitions in 3.3.1. Changes to the approved engine model parts list shall be governed by the requirements specified in 3.2.3.

3.2.2.1 A model specification following the format and contents of MIL-E-8594 shall be submitted to NAVSEC for each engine model supplied (see 6.1). A rough copy shall be submitted for approval. The final copy shall be completely updated and all contractually approved changes incorporated.

3.2.3 Engineering (design and construction) changes.

3.2.3.1 Material substitution. Procedures for temporary material substitution shall be made in accordance with ANA Bulletin No. 182 with the approval of the procuring agency.

3.2.3.2 Part numbers. Part numbers shall not be coded to describe part characteristics.

3.2.3.3 Changes. No changes shall be made in the design or materials of parts listed in an approved parts list, except when such changes are approved in accordance with the provisions of a particular contract (ANA Bulletin No. 445) or as approved in writing by NAVSEC. Where the engine has previously been supplied for a different function/application, e.g. previously been supplied as a generator and now being supplied or proposed to be supplied as a propulsion engine or as a propulsion engine with a different drive, those parts necessarily changed may be changed without approval as long as the unit now carries its own unique identification. Once assigned its identification, then no changes can be made without proper evaluation and approval, regardless of whether form, fit or function is affected by the change.

3.2.3.4 Approval of changes. Approval of changes shall not relieve the contractor of full responsibility for the results of such changes on any engine characteristic.

3.2.4 Interchangeability. All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable with respect to installation and performance, except that matched parts or selective fits will be permitted where required. Such matched or selected fit parts shall be identified and a listing shall be provided the using service. A new part number shall be assigned, when a part or assembly is changed in such a manner that any of the following conditions occur:

Condition 1. Performance or durability is affected to such an extent that superseded items must be discarded for reasons of safety or malfunctioning.
Condition 2 - Parts, sub-assemblies, or complete articles are changed to such an extent that the superseded and superseding items are not directly and completely interchangeable with respect to installation and performance.
Condition 3 - When interchangeable, repairable assemblies contain non-interchangeable items, both the non-interchangeable items and the parent assemblies change identification.

3.2.4.1 When a part or assembly is changed in such a manner that none of the conditions specified in 3.2.4 occur, the part numbers shall not be changed. Under no conditions shall the number be changed when new usage is found for an existing part. When an item has been furnished to the Government, the applicable part number shall not be changed unless conditions outlined in 3.2.4 apply.

3.2.5 Installation changes. Changes to the engine features requiring changes in the shipboard installation made after approval of mockup or quality testing shall be submitted to NAVSEC for approval or in accordance with the particular contract (ANA Bulletin No. 445). Where applicable, mockups, prototypes, and training units shall be kept current with approval changes, unless specifically exempted, at least through the first production contract, unless otherwise authorized.

3.3 Rating and maintenance requirements.

3.3.1 Definitions. For the purposes of this specification, the following definitions are applicable

(a) Normal rating. The maximum power level at which the engine has passed the engine durability tests specified (see 4 4 1) and which can be produced at the end of the heavy maintenance period assuming compressor cleaning as required and normal shipboard maintenance have been accomplished as recommended.

(b) Other ratings. Special ratings that may be required for a particular craft or mission shall be as defined (see 6.1) as well as in testing information to demonstrate that rating.

(c) Shipboard maintenance. This shall include overall examination of the complete engine, plus replacement of any external components including igniters, thermocouple harness, fuel control, governor, etc. Internal replacement shall be limited to the combustion area. Hot section examinations may be performed including any replacements of combustion burner cans, fuel manifold and nozzles, first stage nozzle guide vanes and first stage rotating turbine blades as may be possible without further disassembly and do not require balancing of any rotating part.

(d) Heavy maintenance. This includes maintenance normally accomplished in a shop by a tender or base It includes complete sectionalization, cleaning, examination and replacement of complete compressor and turbine rotor sections with pre-balanced assemblies and replacement of engine accessories. Engine accessories include the fuel pump, fuel control, lube oil pumps, speed control governors and starting equipment.

(e) Overhaul. Overhaul is normally to be accomplished at the engine manufacturer's plant or at a commercial or military overhaul activity equipped with the recommended common shop tools and special tools and facilities. It shall include complete disassembly, examination, cleaning ard repair of the gas turbine engine and accessories.

(f) Heavy maintenance period. This is the period during which the engine is expected to run prior to removal for heavy maintenance or overhaul assuming normal recommended shipboard maintenance procedures have been followed, limiting pressures, temperatures and horsepower ratings have not been exceeded and lubricating and fuel oils specified in this specification have been used.

3.3.2 Standard operating conditions. All engine ratings shall be based on the following atmospheric conditions:

(a) Air temperature - 100°F.
(b) Atmospheric pressure - 29.92 inches of mercury absolute.
(c) Pressure at compressor intake duct flange
    (1) Total head: 4.0 inches of water below atmospheric.
(d) Pressure at turbine exhaust duct flange:
    (1) Static head: 6.0 inches of water above atmospheric.

3.3.3 Required engine performance shall be as specified (see 6.1) and shall include the normal power rating and specific fuel consumption at that rating, or at other power outputs.

3.4 General design.

3.4.1 Resistance to shock. Unless otherwise specified (see 6.1), the engine and any driven component including subbase and accessories shall meet the requirements of MIL-S-901. The engines shall be classified grade A, class III, type A, as defined in MIL-S-901.

3.4.2 Subbase. The engine and driven equipment shall be assembled together on a rigid subbase where required to maintain alignments. The subbase shall be designed to maintain alignment of components without permanent deformation when subjected to accelerations experienced when tested in accordance with MIL-S-901. Where a subbase is supplied by the shipbuilder, the contractor shall certify that the subbase is acceptable to the engine manufacturer. The subbase shall be of sufficient strength to prevent misalignment of the attached units when the subbase is rigidly supported at three extreme corners. No additional bracing or stiffening of the subbase shall be required for handling or installation. All components of the gas turbine shall be mounted on the subbase. No part of the gas turbine shall extend below the lower face of the subbase.

3.4.3 Alignment. Alignment between the engine and driven components of a unit shall be maintained by flanges, dowels keys, thrust plates, or fitted bolts. Attachments for mounting the engine shall be of a type that shall permit movement of the engine due to expansion. The contractor shall furnish to the installing activity detail recommendations concerning the proper method of mounting and aligning the engine and driven equipment. These recommendations shall have prior approval of the procuring agency.

3.4.4 Vibration. All parts of the engine shall be free of self-induced destructive vibration at all engine speeds, including steady-state and transient conditions throughout the complete operating range of the engine. The contractor shall be responsible for ensuring that no destructive vibrations are induced in the engine as required by types I and II of MIL-STD-167 and shall so certify in writing when engines are shipbuilder furnished that no destructive vibrations are induced in the engine by components of the specific system in which it will be installed such as propeller blades, other prime movers, shafting, controls, clutches, couplings, external auxiliaries and gearing. The engine manufacturer may specify production vibration limits in the transverse, torsional and longitudinal modes higher than those of MIL-STD-167 requirements if the test required by 4 4 1 is run at a vibration level with the amplitudes twice that of the stated production acceptance limit.

3.4.5 Rotation. Unless otherwise specified (see 6.1), the direction of rotation of the output shaft shall be counterclockwise when viewed from the output end of the engine package at the propeller shaft input.

3.4.6 Dimensions and weight. The maximum allowable dimensions and weight of the unit shall be as specified (see 6.1). The items to be included in the dimension and weight determination shall include the engine, the driven components, service fluids, attached piping, accessories and subbase.

3.4.7 Materials. All materials shall be resistant to or protected to resist salt water corrosion.

3.4.7.1 The use of magnesium and magnesium alloys is prohibited.

3.4.7.2 Unpainted surfaces of aluminum or aluminum alloys shall be treated to conform to the requirements of MIL-A-8625. Surfaces to be painted shall be treated to conform to the requirements of MIL-C-5541. Internal surfaces in contact with oil do not require this treatment.

3.4.7.3 Threaded or faying surfaces Where threaded surfaces or faying surfaces may require disassembly in service, an antiseize compound shall be used within the limitations of MIL-A-907. For the assembly of aluminum alloy parts, through bolting is preferred using cadmium or zinc plated steel bolts and nuts, this applies with particular emphasis to comparatively highly stressed assemblies or those subject to vibrating loads. Where the use of tap bolts or machine screws is necessary, these shall be threaded into steel inserts in the aluminum alloy. The steel inserts shall be secured in such a manner as to prevent their turning or backing out. No alloys of copper, such as brass or bronze, shall be acceptable for use in threaded contact with aluminum alloys. All threads shall comply with the requirements of Handbook H-28.

3.4.8 Inclination. The engine and accessory components, including piping systems shall be designed to operate satisfactorily, and without loss of oil or cooling water under the following conditions:

(a) Permanently trimmed up to 5 degrees on either end from the normal horizontal plane (31 degrees for amphibians).
(b) Permanently listed up to 15 degrees to either side of the vertical (31 degrees for amphibians).

(c) Momentary trim of 10 degrees up or down from the normal horizontal plane for 10 seconds.
(d) Momentary list up to 45 degrees to either side of the vertical for 10 seconds.

3.4.8.1 When the installation is other than horizontal, the angle of installation shall be as specified (see 6.1) and shall be added to the aforementioned limits.

3.4.9 Lifting means. Eyebolts, holes, or equivalent means shall be provided to permit lifting the complete engine, including driven component and attached accessories furnished by the engine builder, as a complete unit without jacking the engine

3.4.10 Resiliently mounted equipment. When specified (see 6.1), the equipment shall be resiliently mounted and the following information shall be submitted 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 the 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 unit about 3 mutually perpendicular axis with the origin and the unit center of gravity and the orientation of the axis indicated with respect to the equipment and ship.
(e) The 6 natural frequencies (in Hertz) of the unit
(f) The type mounting used in performance of the calculations For mountings other than approved Navy type, information relative to mount natural frequency, static load detection and transmissability shall be required.
(g) List of assumptions made in calculating natural frequencies.

3.4.11 Smoke. The reflectance number of the exhaust smoke, measured and defined as indicated in 4 4.5, shall be no less than 84 and in addition there shall be no white smoke visible under any operating condition

3.5 Detail design.

3.5.1 Piping systems. Piping shall be securely strapped and supported by the engine structure and, if necessary, isolated by flexible hose to prevent vibration and resist shock The use of tapered pipe thread connections is prohibited. Connections to piping of the ship boat or other craft shall be provided with flanges in accordance with MIL-F-20670. The other connections shall be by flareless connectors in accordance with MIL-F-21467 or welded and bolted flange connections.

3.5.1.1 Flexible devices employing movable joints or flexible hose are potential areas of failure. Rigid piping shall be used where possible and be designed to absorb vibration or deflection without employing these devices. Where this is not possible, the following shall apply.

(a) Teflon hose in accordance with MIL-H-25579 shall be used. Permanent flareless connectors in accordance with MIL-F-21467 are required.
(b) Fire protection sleeves in accordance with FAA T50-C42 and T50-53A shall be used on all flexible hose. The fire sleeve shall extend over the hose socket and shall be securely clamped.
(c) Flexible hose shall be mounted and clamped in a manner to eliminate the possibility of abrasion with adjoining components or structure under vibratory conditions.

3.5.2 Lubricating oil system. The lubricating oil system shall adequately lubricate the unit throughout the operating range. Provisions shall be incorporated to prevent oil from entering the air or gas stream. Bearing drains shall be of sufficient capacity to prevent excessive build up of oil pressures at the bearings. All pump suction lines shall be fitted with a strainer to exclude particles which may cause damage to the pump. The system shall preclude the possibility of metal particles from a single area failure being distributed to other areas causing secondary damage. The engine shall be capable of operating satisfactorily using lubricating oil in accordance with one of the following MIL-L-9000, MIL-L-2104, MIL-L-17672, or MIL-L-23699. Means shall be provided to limit the lube oil pump(s) discharge pressure Provisions shall be made for the measurement of oil pressure and temperature. The unit shall be provided with an accessible oil drain at the lowest point(s) in the system in order that the unit may be adequately drained when installed. Insofar as practicable, all oil drainage shall be collected at a single readily accessible

point The lube oil tank fill fitting shall be located such that the tank can be filled without the use of special tools. The fill cap shall be fastened to the unit by a chain or a similar captive method. An oil level gage or dipstick shall be provided and shall be located in an accessible position. An operating level mark on the oil level gage or dipstick is required. The breather system shall be so designed that oil in liquid form will not be lost through the breather when operating the unit under conditions specified herein. The lube oil tank shall permit complete internal cleaning through the use of access holes if the tank is built into the foundation or subbase or by removal and flushing if it can be considered removable. Hideout points for dirt shall be minimized in the systems by providing no undrainable traps and rounded rather than sharp corners.

3.5.2.1 Pre-operational and post-operational lubrication system shall be supplied when required for proper operation of the engine.

3.5.2.2 Lubricating oil filter cases for use with MIL-L-9000, MIL-L-2104 or MIL-L-17672 shall accept filter elements in accordance with F-[illegible]-351 and shall be duplex filters in all cases. Engines using oil in accordance with MIL-I-23699 shall be equipped with filter elements of either reusable or disposable type compatible with this oil. All filters shall be provided with a relief valve, either internal or external, to the filter case to by-pass oil around the filter and with a delta-P gage with a warning mark to indicate to the operator when the pressure drop across the filter is approaching by-pass limits. Lube oil filters and strainers shall be designed to prevent the accumulated contaminant from entering the system through the relief valve.

3.5.2.3 Lubricating oil cooler(s) shall be provided by the contractor. Unless otherwise specified (see 6.1), the cooling medium shall be either air, fresh water, sea water, fuel or other system lubricants. If fresh water, sea water, or fuel is used as the coolant, the coolant shall be at a lower pressure than the lube oil within the heat exchanger. If fresh water is to be the coolant, the contractor shall provide the complete fresh water system including expansion tank and heat exchanger for cooling the fresh water Air system engine driven fans shall be supplied by the contractor unless otherwise specified (see 6.1).

3.5.2.4 Engine or motor driven sea water pumps shall be furnished by the engine manufacturer if required (see 6.1) and shall be capable of lifting a specified head of water from a dry pipe. The pump(s) shall be installed so that water may be drained by gravity by means of a drain cock. Pumps shall be installed to prevent air binding of pump casing or provided with a continuous vent at the upper part of the casing. A bronze pump with monel shaft shall be used.

3.5.2.5 For HI shock applications, water cooled oil coolers shall conform to MIL-C-15730. If HI shock is not specified (see 6.1) the coolers may conform to MIL-C-21121. Coolers shall be of sufficient capacity to maintain lubricating oil temperatures within operating limits for standard conditions at all loads up to 110 percent load where operating with sea water inlet temperatures of 35° to 95°F. If synthetic oil is used, no material containing more than 5 percent copper except monel shall be used in the cooler lube system.

3.5.2.6 Sea water piping shall be made of 90-10 copper-nickel alloy in accordance with MIL-T-16420. Fittings and valves shall be of bronze.

3.5.3 Fuel system. All metallic lines shall be corrosion-resisting steel. All internal elements of the fuel system shall be resistant to corrosion by sea water. Design of the fuel nozzles and fuel manifold shall assure complete drainage upon shutdown to prevent internal carbon formation due to heat soak Design of the engine shall provide positive means of draining all unburned fuel from the combustor, turbine, exhaust collector or other collection areas. Shut-off valves shall close rapidly and completely. All shut-off valves, other than manually operated valves, shall be closed when de-energized. The use of snap rings, where their failure would present a fire hazard is prohibited. The fuel manifold, fuel nozzles, fuel valves and fuel control components shall be designed to permit change-out, without special tools or removing the engine from its foundation. The engine fuel filter shall be the coalescer type sized to accommodate a flow equal to 150 percent of the engine fuel flow at normal rating. The unit shall consist of a housing, coalescer and separator stages, sight gage, drain valve and suitable mounting arrangement and shall meet the performance and test requirements of MIL-F-8901. The coalescer element shall be in accordance with MIL-F-52308. The separator stage shall be teflon coated monel mesh screen and may be in the form of a separate element, canister or divider between the coalescer element and the unit outlet. The sight gage shall contain a brightly colored ball which will float on the fuel-water interface. The unit may be designed for horizontal or vertical mounting and shall be installed in the fuel piping between the engine mounted fuel pump and the governor or fuel control. The filter shall contain an internal relief valve and a differential

pressure warning signal (for example, a switch) which will activate at a lower pressure than that which would cause lifting of the relief valve. The filter shall prevent the accumulated contaminants from entering the system through the relief valve. The fuel piping shall be arranged to avoid any air pockets or undrained traps and have provision for venting air after any part or component changes. The fuel filter shall be of the duplex type. The engine shall be capable of starting and operating continuously throughout its load range when supplied with the following fuels and fuel conditions

(a) Fuels
  (1) MIL-F-16884
  (2) MIL-T-5624, JP-5
(b) Contamination
  (1) 200 parts per million (ppm) total water
  (2) 2.5 mg/L dirt after having passed through a nominal 10 micron filter.
(c) Operating limits
  (1) Fuel supply pressure. 0 to 20 pounds per square inch gage (psig)
  (2) Fuel temperature. 20° to 100°F
  (3) Air temperature: 20° to 120°F

3.5.4 Starting system. The type and performance of the starting system shall be as specified (see 6.1).

3.5.4.1 Inching motor. If required, an inching motor shall be provided by the contractor to prevent brinelling of anti-friction bearings. The contractor shall be responsible for determining this requirement.

3.5.4.1.1 A mechanical interlock or suitable over-run between the engine starting and engine turning mechanisms shall be provided to prevent both the accidental starting of the engine when the turning gear is engaged and to prevent engagement of the inching motor during the engine operation.

3.5.5 Electrical system. All electrical equipment shall be wired in a 2 wire ungrounded system. Grounding of turbine control and starting circuits shall be permitted during starting. Wiring shall be resistant to or protected against corrosion and unintentional grounding or associated equipment. When required (see 6.1), wiring and electrical equipment shall also be shielded from interactions with stray electromagnetic signals and shall be designed to avoid producing such radiations. Interference shielding shall be provided in accordance with MIL-I-16165.

3.5.6 Control system. The engine shall be provided with attached control levers for starting, stopping and speed regulation or as may be agreed upon with the boat or shipbuilder. Engines with the reverse gear included as part of the procurement shall have the reversing control located adjacent to or integral with the throttle control.

3.5.6.1 If reverse gears are provided, an indicator shall be provided to show whether the mechanism is set for ahead, neutral, or astern operation.

3.5.6.2 When a remote or power operated control system is required for controlling the engine (see 6.1), auxiliary hand operation shall be provided at the engine. The design shall include means to prevent simultaneous remote and hand operation. Hand or power operated control mechanisms shall permit convenient operation by one man.

3.5.7 Governing systems. The engine shall be equipped with one of the following types of governing systems:

(a) Unless otherwise specified (see 6.1), engines to drive a.c. generators for emergency or ships service power shall have a governing system 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 speed shall return to within 1 percent of the final steady state speed in not more than 5 seconds following a change in load. When operating at all loads up to and including rated load, the periodic or aperiodic oscillations of speed shall be not greater than plus or minus 1/2 of 1 percent of rated speed.
(b) Unless otherwise specified (see 6.1), propulsion engines shall be governed by sensing and regulating either the gas generator speed or the power turbine inlet pressure. Periodic or aperiodic variations of power at a fixed power turbine speed shall not exceed plus or minus 2 percent of set power up to 50 percent power nor exceed plus or minus 1 percent of set power from 50 to 100 percent power.

3.5.7.1 Unless otherwise specified (see 6.1), the governor shall have a droop characteristic which can be adjusted so that the speed droop (from no load to rated load) can be set at any value between 0 and 5 percent of rated speed. Generator sets shall be shipped with a 3.8 percent speed droop. The speed setting shall be adjustable within 5 percent above and 5 percent below rated speed at any load from no load to rated load. Generator set governors shall be provided with a speed control motor which shall be single phase, 60 cycle, 115 volt a.c. or a universal type (rated single phase 60 cycle, 115 volt a.c. and 115 volt d.c.) and shall be of a design approved by the command or agency concerned.

3.5.7.2 The engine shall have an overspeed protection device to prevent the output shaft speed from exceeding 107 percent of normal rating speed. Use of the overspeed shutdown device (see 3.5.10 2) to accomplish this is permissible.

3.5.8 Inlet and exhaust ducting connection. Connections for compressor inlet and turbine exhaust ducting shall be provided in accordance with the requirements of each installation as specified (see 6.1). However, it is the contractor's responsibility to provide connections for ease of removal, so that field service of the unit may be accomplished. Where no other screening provision is to be made, the unit shall be provided with a 1/4 by 1/4 inch mesh non-corrosive inlet screen (see 6.1), of sufficient strength for expected operating conditions. This screen, on its supplied mounting, must be free of any damaging engine induced vibrations and contain no obvious stress raisers such as flattened or calendared wire. Brazing of screen wire is prohibited.

3.5.9 Compressor cleaning. Compressor intake design shall be able to accommodate the type of compressor cleaning as determined by the contractor which shall be capable of removing oil and industrial fouling as well as salt. Maximum power output after cleaning shall be not less than 100 percent of normal rating at the same turbine inlet temperature. It shall not be necessary to remove any components such as fuel or lube oil lines, accessories, or inlet bell mouth during cleaning operation. When specified (see 6.1), cleaning shall be able to be done at normal operating conditions.

3.5.10 Safety devices (see 6.1).

3.5.10.1 Warning circuit. The engine shall be equipped with a warning circuit which will give the operator an audible and visual warning of unsafe conditions for at least the following items:

(a) Low lubricating oil pressure.
(b) High lubricating oil temperature.
(c) High turbine gas temperature.
(d) Lubricating oil filter element excessive differential pressure.
(e) Fuel filter element excessive differential pressure.
(f) Others recommended by the engine manufacturer and approved by NAVSEC.

Pressure or thermostatic switches or both shall be in accordance with MIL-S-16032.

3.5 10.2 Overspeed shutdown system. The engine shall be equipped with an automatic system which will prevent the engine from overspeeding to the point where the life of the rotating parts will be less than the full service life of the engine. The overspeed shutdown system shall perform the function under the maximum possible accelerating conditions of the engine. No other automatic shutdowns shall be permitted.

3.5.11 Instruments. The contractor shall provide the instrumentation that the engine manufacturer normally recommends to measure and indicate rotor speeds, fuel, lubricating oil, air and gas temperatures and pressures and vibration levels (see 6.1). The instrumentation shall provide the following information:

(a) Sufficient data to allow the operator to monitor operation to ensure safe and proper operation.
(b) An indication of the need to perform maintenance procedures recommended by the engine manufacturer shall be accomplished. Hour meters and start counters shall be required unless otherwise specified (see 6.1).
(c) Any data required for troubleshooting to a level recommended for shipboard maintenance.
(d) Enough data to indicate when the engine shall be removed from the ship for heavy maintenance.

3.5.11.1 Instruments shall be in accordance with the following

Instrument	Specification
Tachometers	MIL-T-16049
Pyrometers	MIL-P-16304
Indicators	MIL-I-17244
Thermometers	MIL-T-19646
Pressure indicators	MIL-I-18997

3.5.12 Gears, clutches, couplings and bearings. Integral gears, clutches, couplings and bearings shall be supplied in accordance with the manufacturer's commercial practice. Lubricating oil used in these components shall be the same as the lubricating oil used in the engine. Gears shall meet the durability and strength ratings in accordance with the applicable standards listed in the latest issue of the AGMA standards and Technical Publications index at a quality level of 12 or more.

3.5.12.1 Gears for generator sets shall be capable of withstanding the torque resulting from a short circuit across the generator terminals.

3.5.13 Guards and shields. Guards and shields shall be provided to the extent specified in 3.5.13.1 and 3.5.13.2 (see 6.1).

3.5.13.1 Guards. Guards shall be provided for protection of personnel from hazardous equipment such as exposed rotating shafts or pulleys, high voltage equipment, belts and chains. The guard shall be furnished by the contractor for installation by the installing activity.

3.5.13.2 Shields All hot surfaces shall be shielded or lagged so that no external surface exceeds a temperature of 450°F. All fuel and lubricating oil and other combustible fluid lines, fittings, sumps, etc., shall be located or shielded so that any leaks cannot drip or spray on any component which could present a fire hazard.

3.5.13.3 Containment. The engine shall be designed to contain any failure of blades, blade attachment devices, etc. Engines having any prior record of failure of main rotor discs shall be provided with shields to contain a maximum energy disc rupture, unless otherwise agreed to by NAVSEC. When specified (see 6.1), engines supplied shall be provided with a shield to contain a maximum energy rotor burst.

3.6 Marking.

3.6.1 Marking of engine components and parts. Engines, components and parts shall be marked for identification in accordance with MIL-STD-130. Repair parts shall be marked with the manufacturer's part number by casting, stamping or etching. Where it is not practical to mark repair parts by any of these methods, the parts shall be identified by tags or printed sheet on or in the package. Complete accessory components, such as pumps, coolers, governors, instruments, and starters shall be provided with identification plates attached showing manufacturer's name, model or part number of the components and capacity or rating when applicable.

3.6.2 Engine identification plate. An identification plate shall be mounted on each engine in a location where it can be easily read without danger to personnel. This plate shall conform to MIL-P-15024, type A, except that aluminum alloys are not permitted. The plate shall contain the following information.

(a) Contractor's name.
(b) Federal stock number.
(c) Rating and speed.
(d) Serial number.
(e) Dry weight.

3.6.3 Instruction plate. An instruction plate shall be provided indicating the starting procedures, normal and emergency shutdown procedures, and safety precautions.

3.7 Plan for maintenance.

3.7.1 Maintenance engineering analysis. The contractor shall conduct a critical engineering analysis of the engine or system to be supplied determining the type and rate of degradation of the various materials and parts involved in the design when operating

under the condition outlined in the plan for use (see 3.7 4). The contractor shall determine the most effective and efficient procedure for performing necessary maintenance and the logistics resources required to support the equipment supplied.

3.7.2 Recommendations. The contractor shall prepare a plan making specific recommendations for shipboard, tender and shore spare and repair parts including replaceable assembly tools (both standard and special), test and support equipment for shipboard maintenance and heavy maintenance (see 3 3.1 and 6.1). The plan shall summarize on a time schedule all maintenance actions (examination, tests, adjustments, replacement of parts and overhaul) which should be taken, all parts which should be replaced (and all other parts which should be available to allow replacement if inspection so indicates). The plan shall provide detailed maintenance procedures and logistic requirements at all maintenance levels to provide for the reconditioning or replacement of each item subject to continuous degradation before the degradation results in failure. The plan shall specify any required examination, storing and testing requirements on stocked parts, and periodic replacement where shelf-life is a factor. The plan shall take into account an allowance for increased time between heavy maintenance and overhaul requirements with experience to take advantage of the learning and confidence that comes with operating the equipment in service.

3.7.2.1 If a plan for maintenance for use of the item for a similar system requirement has been previously submitted, resubmittal shall not be required. Instead the contractor shall reference the previous approval letter and shall propose any changes considered appropriate because of the additional like items which will now enter the system. If a previous plan for maintenance for the item has been developed for a plan for use varying from that presently specified, appropriate adjustments shall be made (the plan for a propulsion unit may differ from that for an emergency generator set).

3.7.3 Repair parts. Repair parts shall be furnished in accordance with MIL-P-15137 (see 6.1 and 6.2).

3.7.3.1 The range and depth of fleet support repair parts and related consumables to be carried by the forces afloat shall provide a 90-day endurance, except that non-self sustaining ships (normally, ships of less than 1,000 tons displacement) shall have sufficient items to accomplish each assigned mission.

3.7.3.2 Wherever the potential usage of a part during combat will increase from peacetime requirements, the combat requirements shall be identified. When an extended period between expected replacement of an onboard repair part will exist (exceeds approximately 1 year), but when replacement during some 90-day period will be required within the heavy maintenance period, it shall be so indicated.

3.7.3.3 Subject to the requirements of 3.7.3.1 and 3.7.3.2, 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 ship).
  (1) Provide an effectiveness (filling of demands onboard) of 100 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).

3.7.4 Plan for use. Unless otherwise specified (see 6.1), the engine (in service) shall be operated in accordance with the test schedule shown in 4.4.1 under the condition specified in 3.3.2 using fuel in accordance with 4.3.2.1 with a salt water separator in the inlet. In addition, the following items shall apply:

(a) Type A engines. There shall be at least one engine start per operating hour. The engine shall be operated 1000 hours per year if it is a propulsion engine and 500 hours per year if it is a generator drive engine.

(b) Type B engines. There shall be at least one engine start per 8 operating hours. The engine shall be operated approximately 3000 hours per year if it is a propulsion engine and 4000 hours per year if it is a generator drive engine.

3.8 Drawings and installation criteria (see 6.1).

3.8.1 Drawings. Unless otherwise specified (see 6.1), drawings shall be submitted in accordance with type II of MIL-D-1000/2. Contents shall include categories B, D, G, and H and form 3 of MIL-D-1000. Category I drawings for Government emergency manufacture shall be supplied when specified (see 6.1).

3.8.1.1 Installation criteria may be supplied as category G drawings in accordance with MIL-D-1000 or may be supplied as a separate installation handbook or a combination of both.

3.8.2 Microfilm of drawings. A set of engine drawings shall consist of microfilm aperture cards of all installation and assembly drawings together with detail drawings of parts for each component, except accessories exempted herein. Drawings of items on Qualified Products Lists and standard hardware such as bolts, nuts, washers, cotter keys and similar items that are fully described in bills of material, and drawings of pieces used in fabrication of a welded part shall not be included in the microfilm. Microfilm shall be in accordance with MIL-M-38761 and MIL-M-38761/2.

3.8.2.1 A microfilm index of drawings, listing manufacturer's drawing numbers, name of drawing and microfilm frame number of each drawing, shall be submitted to NAVSEC for approval prior to actual microfilming Drawings shall be arranged as component groups headed by the assembly drawing. The index shall be preceded by a summary list of drawings showing installation drawings and component assemblies and list the applicable index sheets. Detail microfilm drawings are not required for non-repairable items, such as igniter plugs, thermocouples, filter elements, etc.

3.9 Service and parts manuals (see 6.1).

3.9.1 Technical manuals. Operating and maintenance manuals (see 3.3.1) shall be furnished in accordance with the requirements of MIL-M-15071, type I. In addition, a "Precise Access Block Diagram and Associated Text Page(s)" prepared in accordance with MIL-M-24100 shall be included in the manual for the engine systems.

3.9.2 Validation. The contractor shall be responsible for the validation of the information contained therein for all manuals supplied. In those cases where validation is performed at a subcontractor's plant, the prime contractor is responsible for the quality of the technical manual information and shall provide verifiable evidence of the adequacy at 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. The personnel performing the validation shall be on a technical level equivalent to the intended user of the technical manual. Manuals or any part of any manuals that have been validated for any other Government requirements need not be revalidated. 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) Destructure 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.

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

(a) Contractor's full identification (if other than prime, full identification of both shall be indicated).
(b) Contract number(s).
(c) Chapters and sections validated and the date each was accomplished.
(d) Name, signature, and authority of validating officer.

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 inspection system which the supplier is required to maintain, as provided in the inspection clause of the contract or order, shall be in accordance with MIL-I-45208 (see 6.1 and 6.2).

4.2 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 involving tests and contract drawings. The rigorous examination shall apply equally to service components and repair parts.

4.3 Test data and test conditions.

4.3.1 Test data. Test data, corrected as specified in 4.3.1.1 to the standard operating conditions specified in 3.3.2 shall be submitted to the command or agency concerned for approval. Test data shall be complete in all aspects to verify the requirements of this specification. All tests shall run at a mass average basis temperature at the turbine inlet entry to the first stage turbine nozzle equal to what would be experienced when operating at standard operating conditions. Turbine exhaust gas temperature may be used to approximate turbine inlet temperature, if the engine manufacturer provided the relationship between exhaust gas temperature and inlet gas temperature for all operating conditions.

4.3.1.1 Data correction. Data correction shall be as follows unless otherwise approved by NAVSEC:

$$HP_{(cor)} = \frac{HP\ (obs)}{\delta\sqrt{\theta}}$$

$$N_{(cor)} = \frac{N(obs)}{\sqrt{\theta}}$$

$$WA_{(cor)} = \frac{WA(obs)}{\delta}\sqrt{\theta}$$

$$WF_{(cor)} = \frac{WF\ (obs)}{\delta\sqrt{\theta}}$$

NOTE: WF correction does not apply to engines with regenerators or recuperators.

$$T_{(cor)} = \frac{T(obs)}{\theta}$$

$$SFC_{(cor)} = SFC(obs)\ \frac{LHV}{18400}$$

Where:

- HP - Horsepower
- N - Speed (revolutions per minute (rpm))
- WA - Air rate (lbs/sec)
- WF - Fuel rate (lbs/sec)
- T - Temperature ($^{\circ}R$)
- SFC - Specific fuel consumption (lbs/HP-hr)
- LHV - Low heating value of fuel used in testing (BTU/lb)
- (cor) - Corrected to 100°F. and 29.92 inches of mercury atmospheric temperature and pressure
- (obs) - Observed condition
- P - Atmospheric pressure (inches of mercury absolute)
- θ - $\frac{T(obs)}{560}$
- δ - $\frac{P(obs)}{29.92}$

4.3.2 Test conditions All components shall be cleaned of oil, grease, or preservative compounds prior to the start of any testing All accessories shall be mounted in their normal positions on the unit. Test assemblies or components shall be subjected to operating loads simulating those encountered under shipboard conditions. Sufficient instrumentation shall be provided to indicate the performance of the engine During the test of 4.4.1, only one engine shall be used and no parts replacement shall be made except as agreed upon by NAVSEC. Compressor cleaning and normal recommended shipboard preventive maintenance procedures, not including replacement of parts other than filter elements, may be accomplished during the test. A complete log of all preventive maintenance accomplished, all engine adjustments made, all compressor cleanings accomplished and all parts replaced and the circumstances involved shall be maintained and submitted to NAVSEC All tests shall be run with ratings corrected to standard conditions (see 3 3.2). During all running, the engine parameters shall stay within the limits established by the manufacturer prior to the test. At the completion of the engine test, the engine and components shall be completely disassembled. Examination shall indicate that all parts and components are suitable for further operation. If some doubt exists that some part(s) is suitable for future operation, the test shall be continued for an additional 50 hours. The engine tested shall be identical to the engines to be supplied except where agreed to by NAVSEC. Tests shall include no special fuel filters to protect the engine other than those provided by the engine builder.

4.3.2.1 Fuel. All testing shall be performed using diesel fuel in accordance with MIL-F-16884, but with the following additional limitations.

(a) Distillation, 90 percent point, °F. (min.) - 650.
(b) Sulfur, percent - 0.20 (min.) to 1.10 (max.).
(c) Luminometer number, see notes 1 and 2 (max.) - 30.
or
(d) Hydrogen content, see notes 1 and 3 (max.) - 13.
(e) Total water, ppm (min.) - 200.
(f) Dirt, see note 4, milligrams per liter (min.) - 2.5.

NOTES:
1. Contractor may use either luminometer number or hydrogen content limitation as he chooses.
2. Measured in accordance with ASTM D-1740.
3. Measured in accordance with ASTM D-1018.
4. Dirt shall be similar to a.c. Dust-Fine supplied by a.c. Spark Plug Division, General Motors Corp., Flint, Michigan, but shall have particle size distribution as shown in table I.

Table I - Particle size distribution.

Size microns	Weight (percent)
0 - 5	53
5 - 10	25
10 - 20	22

4.3.2.2 Lubricating oil. All testing shall be performed using one of the lubricating oils specified in 3.5.2.

4.3.2.3 Salt in air. Salt shall be introduced into the inlet air stream in accordance with table II during the acceptance test. NAVSEC, Philadelphia Division (NAVSECPHILADIV), is available to aid in developing the apparatus required to introduce the salt. A salt water separator, preferably of a type tested by NAVSECPHILADIV may be used between the point of introduction of the sea water and the engine inlet. Acceptance test of an engine with a particular type of separator shall require use of that same type separator in any application of the engine unless a waiver is granted by the procuring agency. The test set-up for introducing and measuring salt shall be submitted to NAVSECPHILADIV for approval.

Table II - Salt concentration.

Operating time, percent of total	50	45	3	2
Total salt concentration ppm (by weight)	0.003	0.007	0.016	0.03
Droplet size range percent of total ppm:				
Above 13 micron	25	45	45	50
4 to 13 micron	25	30	30	25
Less than 4 micron	50	25	25	25

4.3.2.4 Salt solution shall be as follows:

$MgCl_2.6H_2O$	11.0 grams
$CaCl_2$ (anhydrous)	1 2 grams
Na_2SO_4	4.0 grams
NaCl	25.0 grams
H_2O	To make 1 liter of solution

NOTE: Natural sea water may be used if approved by contracting agency.

4.4 Engine tests. Unless otherwise specified herein, all tests apply to both type A and B engines.

4.4.1 Engine durability test. A specific test cycle may be required to meet mission requirements for a particular application (see 6.1). Otherwise, the cycle to be run shall be as specified in 4.4.1 1 through 4 4.1.5.

4.4.1.1 Type A engines. The engine shall be tested for a period of 1,000 operating hours (1,000 cycles) on the schedule specified in table III.

Table III - Test cycle, type A engines.

Time (Minutes)	Power (percent)
2	Idle
10	100
5	20
3	Idle
10	60
20	100
10	90
60	0 (not operating)

4.4.1.2 Type B engines. The engine shall be tested for a period of 3,000 operating hours (3,000 cycles) on the schedule specified in table IV. This cycle applies for both propulsion and generator drive engines except as noted.

Table IV - Test cycle, type B engines.

Step	Time (Minutes)	Power percent
1	5	Idle
2	20	30
3	15	50
4	60	100
5	20	90
6	20	80
7	30	100
8	20	60
9	20	Idle
10	30	100
11	40	90
12	30	100
13	60	20
14	30	50
1/ 15	1	Idle
1/ 16	11	100
1/ 17	1	Idle
1/ 18	1	90

Table IV - Test cycle, type B engines (cont'd.)

Step	Time (Minutes)	Power percent
1/19	1	Idle
1/20	1	100
1/21	1	Idle
1/22	1	50
1/23	1	90
1/24	1	Idle
1/25	10	50
1/26	5	20
1/27	5	30
28	60	0 (not operating)

1/ Steps 15 through 27 apply to propulsion engines only. For generator drive engines, steps 15 through 27 shall be excluded and the engine operated for 40 minutes 50 percent power instead.

4.4.1.3 Engine speed. For generator drive engines, the output shaft speed shall follow the relationship of horsepower equals a constant times speed cubes ($HP = K:N^3$) with 100 percent speed coinciding. The test shall be conducted with a droop setting of 3.8 percent during the test unless otherwise specified (see 6.1). All load changes shall be as rapid as is feasible. In no event shall load change exceed 1 minute, and for steps 15 through 27 (see table IV) the change shall be limited only by engine capability.

4.4.1.4 Single shaft engines proposed for propulsion use with a controllable pitch propeller, a modulating clutch or coupling, electric drive or other means that will allow the use of an engine that must run at a single speed or with a narrow speed range shall be allowed to run at whatever speed is recommended by the engine builder. In this case the complete unit, including engine and propeller clutch, etc., shall be tested as a system and still follow the required load schedule.

4.4.1.5 Test acceptance criteria. The test shall be considered complete after the engine has run the required test and the following conditions are met:

(a) Performance degradation has not exceeded 3 percent.
(b) No shutdown has occurred because of engine malfunction or part failure which cannot be corrected within 2 hours from the time of shutdown using only onboard repair parts and consumables. In any event, 2 forced shutdowns because of malfunction or part failure involving the same part or component or any forced shutdown requiring access to internal engine components shall be cause for test failure.
(c) No internal component of the engine (i.e., parts requiring engine disassembly) has been replaced, repaired or adjusted during the test.
(d) No external component has been replaced or repaired other than as may be required by engine malfunction (see (b)). Expendable parts (i.e., filters, igniters, etc.) are excluded but are limited to those items agreed to by NAVSEC prior to start of test.
(e) Vibration level is within the requirements of MIL-STD-167. If the engine builder has chosen a production vibration limit in excess of MIL-STD-167 allowed by 3.4.4, the vibration level at the start of the test must have equalled or exceeded twice the specified manufacturer's limit in amplitude and at the end of the test not exceed 3 times the manufacturer's limit nor exceed the condemning field operation limits. These limits shall be specified prior to start of testing.

4.4.2 Special tests. The following tests, as applicable, shall be conducted prior to or after award of contract. Where possible, they may be conducted in conjunction with the acceptance test. Consideration shall be given by NAVSEC to waiving one or more of these tests for a particular contract or order if satisfactory evidence can be presented showing that a previous test on the same engine model has accomplished the purpose of the test:

Test	Reference paragraph
Starting	4 4.2.1
Safety	4.4.2.2
Overspeed	4.4.2.3
Salt fog	4.4.2.4
Cold starting	4.4.2.5
Shock	4.4.2.6
Inclined operation	4.4.2.7

4.4.2.1 Starting test The engine shall be started by the method and apparatus intended for installation onboard ship, boat or other craft. From standstill condition at least 20 starts shall be made, and the engine brought to idling speed before shutting down. Two or more false starts during the starting test shall require a rerun of the starting test. The average time to start the engine shall be determined. Where air starting is provided, the amount of air required to complete 10 starts shall be determined. Where electric starting is provided, a time-ampere-voltage oscillograph recording shall be taken of at least 5 starts to show the power requirements and the time required for each start.

4.4.2.1.1 In order to check restartability after shutdown, the engine shall be shutdown from the full power, steady state condition and restarted 2 times each as follows

(a) Start immediately
(b) Start after 10 minutes.
(c) Start after 30 minutes.

4.4.2.1.2 Emergency starting test. If an emergency starting capability is required (see 6.1), the test herein shall be performed. A series of 4 emergency start sequences shall be performed. Each sequence shall include an aborted start (no fuel flow to prevent ignition) which shall be continued until reaching either maximum starter rpm or normal starter cutout speed (if an automatic cutout is provided) or until the operating cycle of the starter is exceeded. Each aborted start shall be followed by an emergency start attempt External power shall not be supplied to the engine starter or starter storage devices during any portion of each of the 4 sequences of one aborted start and one emergency start. If an emergency start attempt is unsuccessful in bringing the generator set on the line in 10 seconds the whole emergency starting procedure shall be repeated.

4.4.2.2 Safety test. All warning devices shall be tested at least 10 times. Failure to actuate the warning device shall be cause for rejection.

4.4.2.3 Overspeed tests.

4.4.2.3.1 Single shaft engine. The single shaft engine shall be operated with no load at 105 percent normal rating speed for a period of 15 minutes.

4.4.2.3.2 Engines with free power turbine

4.4.2.3.2.1 Gas generator The gas generator shall be operated at 102 percent normal rating speed for a period of 15 minutes.

4.4.2.3.2.2 Power turbine. The power turbine shall be operated at 110 percent normal rating speed for a period of 15 minutes.

4.4.2.3.3 Test acceptance criteria. The test shall be considered complete if no damage occurs to the engine and if the vibration level does not exceed the limits of 3.4.4.

4.4.2.4 Salt fog test. In order to determine the conformance with 3.5.5 the engine shall be subjected to a salt fog test in accordance with method 509 of MIL-STD-810.

4.4.2.5 Cold starting test. When specified (see 6 1), the engine shall be subjected to the following cold starting test·

(a) After special provisions have been made for cold starting, the engine and batteries for starting shall be placed in an atmosphere at minus 30°F. for a period of 10 hours.
(b) The engine shall be started at least 10 times by the normal method of starting. A rerun of the test shall be required if any of the starts is a hot start or is aborted.

4.4.2.6 Shock tests. Unless otherwise specified (see 6 1), shock tests shall be conducted as specified in MIL-S-901 for grade A, class III equipment.

4.4.2.7 Inclined operation test. The inclination test on the completely assembled unit shall be made under the conditions of time at load specified in 4.4.2.7.1 in each of the following positions

(a) Shaft inclined, forward end down 5 degrees.
(b) Shaft inclined, forward end up 5 degrees
(c) Shaft horizontal, base inclined to right 15 degrees.
(d) Shaft horizontal, base inclined to left 15 degrees.

4.4.2.7.1 Prior to start of tests, the lubricating oil sump shall be filled to the maximum operating level with the unit in a level position No oil shall be added during the tests, and the level shall be checked and recorded on log sheets prior to start of test and between each tilt. The engine shall be run at speeds determined in accordance with 4.4.1.3 and at the following powers

(a) 5 minutes - no load
(b) 5 minutes - 1/2 load
(c) 5 minutes - rated load
(d) 5 intermittent load cycles, each cycle consisting of rated load for 30 seconds and no load for 30 seconds

Following the load tests, the overspeed trip shall be checked at least 3 times in each tilt position and recorded. During the progress of all tests, it shall be ascertained that the mechanical balance is as good as it was in the horizontal position, that there is no pounding or grinding of bearings, that the lubrication is satisfactory, and that there is no leakage of lubricant from the engine or gear. Variation in overspeed trip speed by more than 2 percent shall be cause for rejection.

4.4.3 Duplicate engine routine tests. Production engines, which are duplicates of the engine which has been tested and satisfactorily passed the tests specified in 4.4.1 and 4.4.2 shall be subjected to a 10 hour test, for type A engines and a 24 hour test for type B engines in accordance with cycles of 4.4.1.1 and 4.4.1.2 respectively and shall be subjected to the safety test specified in 4.4.2.2 prior to final acceptance.

4.4.4 Uprating test. Engines having previously been accepted for Navy shipboard use at a particular rating may be accepted for a higher rating, not to exceed 115 percent of the previously accepted rating by running a 150 hour test for type A engines and a 500 hour test for type B engines in accordance with the test cycle of 4.4.1 and burning fuel in accordance with 4.3.2.1. During this test 100 percent power shall be 110 percent of the newly proposed rating. Test conditions specified in 4 3.2 and acceptance criteria of 4.4.1.5 shall apply.

4.4.5 Smoke. During all testing, at intervals of no more than 50 operating hours, the reflectance number of the exhaust smoke shall be measured at idle, 20, 50, 80 and 100 percent power levels using the following method.

(a) Smoke limit - The maximum amount of smoke acceptable at any power setting is that amount which produces a filter paper stain of reflectance number 84 or more when the smoke is sampled and the stain is evaluated as given below.
(b) Description of smoke measurement method - a test smoke stain is obtained on a piece of standard filter paper by passing a given amount of smoke through a given area of filter paper. The sample volume and filter paper area shall be chosen such that their ratio (sample volume/filter area) corresponds to that specified in (c). The shade of the stain is analyzed with a suitable photometer.
(c) Apparatus
  (1) Sampling device - A sampling device provided a total volume of 307 $inch^3$ of sample (14.7 psia, 70°F) for each square inch effective filter paper surface area. A Von Brand smoke meter or equivalent shall be used. The sampling device and connections shall be of such construction that the total travel of sample from stack to filter paper shall not exceed 10 feet.
  (2) Sampling location - The exhaust smoke sample shall be taken with a sampling probe located in the engine exhaust stack at a distance of at least 4 A/P (A = cross sectional area of stack, P = perimeter of stack) from the nearest exhaust stack change in cross section. The sampling probe shall be an impact type, that is located with the sampling tip facing into and parallel to the sampled stream.

(d) Analysis of samples - Samples shall be analyzed with a suitable photometer as follows
  (1) Set the photometer to read 100 percent while directing its beam on an area of clean filter paper adjacent to the smoke stain. The filter paper being read shall be backed by an additional piece of clean filter paper.
  (2) Read the stain shade by directing the beam of the photometer on the stain, with the filter paper being read backed by a piece of clean filter paper (see (d)(1)). No part of the photometer beam shall fall outside the area of the stain. The percent reflection number read on the photometer shall be called the reflectance number. A number of 84 or above is acceptable.

(e) Filter paper - Filter paper shall be the type designated by the name "Genuine Whatman Filter Paper No 4", made by the W&R Balston, Ltd or equal and available from chemical supply outlets.

(f) Suitable photometer - The photometer shall be an electrically operated type employing a photoelectric cell and a green tristimulous filter. A Photovolt Photoelectric Reflection Meter Model 610 with search unit 610-Y or equivalent can be used.

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

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements For the extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2 see 6.3.)

5 1 Preservation and packaging Preservation and packaging shall be level A or C as specified (see 6.1).

5.1.1 Level A.

5.1.1.1 Basic engine unit. The basic engine unit including driven equipment shall be cleaned and preserved as follows

(a) The gas turbine engine shall be cleaned and preserved in accordance with MIL-L-5607 Upon completion of preservation of the lubricating and fuel oil systems, the throw-away elements shall be replaced with new elements.

(b) Reduction gear, accessory gears and couplings shall be cleaned and preserved in accordance with MIL-P-17286.

(c) Coolers shall be cleaned and preserved in accordance with MIL-C-15730. All external unpainted ferrous surfaces shall be coated with a preservative conforming to type P-1 or type P-19 of MIL-P-116

(d) Water pumps shall be cleaned and preserved as follows
  (1) Pumps shall be cleaned in accordance with process C-1 of MIL-P-116. All internal surfaces coming into contact with water shall be flushed or fog sprayed with a preservative conforming to type P-3 of MIL-P-116, or with chemical boil-out cannot be used for preservative removal or where removal by hot water or steam is desired, grade 5 of MIL-C-16173 shall be used. All external unpainted ferrous surfaces shall be coated with a preservative conforming to type P-1 or type P-19 of MIL-P-116

(e) Packaging (see 5 2 4(b)). Engine units shall be individually unit protected in accordance with MIL-P-116, method II, and as follows
  (1) Method IIa - A reusable container conforming to MIL-C-9959 shall be used.
  (2) Method IId - Metal, reusable containers shall be as specified in 5 2.1.1 if required.

5.1.1.2 Repair parts and tools. Mechanical repair parts and tools shall be preserved and packaged in accordance with MIL-P-17286 or MIL-R-196 as applicable. Electrical repair parts shall be preserved and packaged in accordance with MIL-E-17555. Unless used in sets or pairs or as otherwise specified in the contract or order, repair parts and tools shall be individually preserved and packaged When specified (see 6.1), onboard repair parts and tools shall be packed in repair parts storage 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 listing repair parts and tools accompanying the equipment or procured as a set or kit. The list shall be placed in the index list support located on the interior side of the cover of the repair parts box or suitably 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. Repair parts and tools shall be cushioned in accordance with the applicable commodity specifications as referenced in 5.2.4.

5.1.2 Level C. Preservation and packaging of gas turbine units, accessories or repair parts shall afford protection against corrosion, deterioration 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, B or C, as specified (see 6 1).

5.2.1 Basic engine unit.

5.2.1.1 Levels A and B (see 5 2.4(b)). Each unit shall be packed in a plywood sheathed crate conforming to type II, class 2, style A or B, of MIL-C-104. Each unit shall be anchored, 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 examination part for use in viewing the humidity indicator mounted in the barrier material. Alternately, when specified (see 6.1), engine units shall be packed in metal, reusable containers in accordance with MIL-E-5607.

5.2.1.2 Level C. Packing shall be accomplished in a manner which will insure acceptance by common carrier at the lowest rate and will afford protection against physical or mechanical damage during direct shipment from the supply source to the first using activity for early installation in accordance with Uniform Freight or National Motor 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, B or C, as specified (see 6.1) in accordance with the applicable commodity specification or MIL-E-17555 or MIL-P-17286 as applicable. Rough handling test as specified in MIL-E-17555 is not required. Unless otherwise specified (see 6.1), detached components, repair parts and tools shall be packed separately and shipped concurrently with the basic equipment, set or system.

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 and repair parts shall be in accordance with MIL-STD-1186 and the applicable commodity or container specification and appendix thereto. In addition, the following shall be mandatory for cushioning material 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 packaging or level A and B packing applications such as cushioning, filler dunnage, etc., is prohibited. Unless approved by the procuring agency (see 6.1), use of polystyrene "loose-fill" for packaging and packing under 5.1.2, 5.2.1.2, and 5.2.2 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 packages and containers (interior and exterior) shall be marked or labeled as follows.

CAUTION

Contents cushioned, etc , with polystyrene "loose-fill" material, Remove and discard "loose-fill" before shipboard storage. If required, recushion with cellulosic material, bound fiber, fiberboard, transparent cellulose material, etc.

5.3 Marking.

5.3.1 Standard markings. In addition to any special marking or instructions required herein or as specified (see 6.1), interior 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 (see 5 1.1.1(e)). 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 the following 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) "REUSABLE INTERIOR AND EXTERIOR CONTAINER"
(d) Handling and structural markings as applicable (see MIL-STD-129 and appendix to MIL-C-104).

5.4 Special instructions.

5.4.1 Unpacking instructions. The instructions shall contain, as a minimum, the information required herein The contractor may supplement as necessary to insure freedom of damage during unpacking

"To unpack, remove the top and sides, leaving the unit resting on shipping container base. Open barrier, remove all cushioning, ets Remove the packing bolts holding the unit to the container base and lift unit " In unpacking, the following preçautions shall be observed to prevent possible damage:

(a) Observe arrows marked on container. Three point to the cover which can be removed most easily.
(b) Remove nails with nail-puller only.
(c) Remove screws with screwdriver.
(d) Never pound or hammer the container.
(e) Keep all levers, crowbars, etc., away from container interior.

These instructions shall be placed in a sealed, waterproof envelope, sealed and 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.

5.4.2 Technical manuals.

5.4.2.1 Boxed or crated equipment. Technical manuals and log books, which accompany shipments shall be placed in the pocket provided on the outside of the reusable container. The pocket housing the manuals shall be marked "MANUALS ENCLOSED".

5.4.2.2 Equipment in metal containers. Technical manuals accompanying equipment in metal containers shall be packaged and packed as specified by the applicable container specification.

5.4.2.3 Bulk shipments. Technical manuals when shipped in bulk quantities shall not be individually wrapped, but shall be packed in accordance with the requirements of the applicable manual specification (see 3 9).

6. NOTES

6.1 Ordering data. Procurement documents should specify the following:

(a) Title, number and date of this specification.
(b) Type required (see 1.2).
(c) Reliability of engine (see 3.1.1(a)).
(d) Normal rating required (see 3.1.1(b) and 3.3.3).
(e) Acceptance of new engines (see 3.1.2).
(f) Bill of materials (see 3.2.2).
(g) Model specification (see 3 2.2 1).
(h) Special ratings (see 3.3 1(b)).
(i) Waiver of shock requirements (see 3.4.1 and 3 5.2.5).

(j) If direction of rotation is to be other than counterclockwise (see 3.4.5).
(k) Dimensions and weight (see 3.4 6).
(l) Angle of installation if other than horizontal (see 3 4.8.1).
(m) If equipment is to be resiliently mounted (see 3 4.10).
(n) Cooling medium (see 3 5.2 3)
(o) If air system engine driven fans are to be supplied by contractor (see 3.5.2.3).
(p) If engine or motor driven sea water pumps are required (see 3.5.2.4).
(q) Type and performance of starting system (see 3.5 4).
(r) If wiring and electrical equipment is to be shielded (see 3.5.5).
(s) If remote or power operated control system is required (see 3.5.6.2).
(t) Generator drive governors (see 3.5.7(a)).
(u) Propulsion engine governors (see 3.5.7(b)).
(v) Governor droop characteristic (see 3.5.7.1).
(w) Connections for compressor inlet and turbine exhaust ducting (see 3.5.8).
(x) Inlet screen (see 3.5.8).
(y) If cleaning is to be done at normal operating conditions (see 3.5.9).
(z) Safety devices (see 3.5.10).
(aa) Instrumentation (see 3.5.11).
(bb) If hour meters and start counters are not required (see 3.5.11(b)).
(cc) Guards and shields (see 3.5.13).
(dd) If engine is to be supplied with a shield to contain a maximum energy rotor burst (see 3 5 13.3).
(ee) Plan for maintenance (see 3.7.2).
(ff) Repair parts (see 3.7.3).
(gg) Plan for use (see 3.7 4).
(hh) Drawings and installation criteria (see 3.8).
(ii) If drawings are to be other than as specified in 3.8.1.
(jj) If category I drawings are to be supplied (see 3.8.1).
(kk) Service and parts manual (see 3.9).
(ll) Quality assurance requirements (see 4.1.1).
(mm) If a specific test cycle for a particular application is required (see 4.4.1).
(nn) If droop setting is to be other than that specified in 4.4 1.3
(oo) If emergency starting capability is required (see 4.4.2.1 2).
(pp) If engine is to be subjected to cold starting test (see 4.4.2.5).
(qq) If shock tests are not to be conducted in accordance with MIL-S-901 (see 4.4.2.6).
(rr) Level of preservation and packaging required (see 5.1).
(ss) Type of repair parts storage boxes required (see 5.1.1.2)
(tt) Level of packing required (see 5.2).
(uu) If engine units are to be packed in metal, reusable containers (see 5.2.1.1).
(vv) Level of packing required for detached instruments, accessories, repair parts and tools (see 5.2.2).
(ww) If components, repair parts and tools are to be packed other than as specified in 5.2.2.
(xx) When use of polystyrene "loose-fill" material is approved (see 5.2 4(b)).
(yy) Special marking required (see 5.3.1).

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

(a) MIL-P-15137 (see 3.7.3).
(b) MIL-I-45208 (see 4.1.1).

6.3 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.

6.4 CHANGES FROM PREVIOUS ISSUE. THE OUTSIDE MARGINS OF THIS DOCUMENT HAVE BEEN MARKED "#" TO INDICATE WHERE CHANGES (DELETIONS, ADDITIONS, ETC.) FROM THE PREVIOUS ISSUE HAVE BEEN MADE. THIS HAS BEEN 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 AS WRITTEN IRRESPECTIVE OF THE MARGINAL NOTATIONS AND RELATIONSHIP TO THE LAST PREVIOUS ISSUE.

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1. DOCUMENT NUMBER	2 DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION	4 TYPE OF ORGANIZATION *(Mark one)*
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	☐ 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)*

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