INCH-POUND

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MILITARY SPECIFICATION

PUMP UNITS, HYDRAULIC, ELECTRIC MOTOR DRIVEN, VARIABLE DELIVERY, GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification establishes the common requirements for variable delivery electric motor driven, hydraulic pump units, suitable for use in aircraft hydraulic systems.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

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

SPECIFICATIONS

FEDERAL

QQ-C-320	-	Chromium Plating (Electrodeposited).
QQ-N-290	-	Nickel Plating (Electrodeposited).
QQ-S-365	-	Silver Plating, Electrodeposited: General Requirements for.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Oklahoma City Air Logistics Center/MMEOR, Tinker AFB, OK 73145-5990 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC F4961 FSC 1650

MILITARY

MIL-P-116 - Preservation, Methods of.
MIL-B-5087 - Bonding, Electrical, and Lightning Protection, for Aerospace Systems.
MIL-H-5440 - Hydraulic Systems, Aircraft, Types I and II, Design and Installation Requirements for.
MIL-C-5541 - Chemical Conversion Coatings on Aluminum and Aluminum Alloys.
MIL-M-7793 - Meter, Time Totalizing.
MIL-M-7969 - Motors, Alternating Current, 400-Cycle, 115/200-Volt System, Aircraft, General Specification for.
MIL-M-8609 - Motors, Direct-Current, 28-Volt System, Aircraft, General Specification for.
MIL-A-8625 - Anodic Coatings, for Aluminum and Aluminum Alloys.
MIL-H-8775 - Hydraulic System Components, Aircraft and Missiles, General Specification for.
MIL-F-8815 - Filter and Filter Elements, Fluid Pressure, Hydraulic Line, 15 Micron Absolute and Micron Absolute, Type II Systems.
MIL-H-8890 - Hydraulic Components, Type III, (-65 Deg. to +450 Deg. F), General Specification for.
MIL-H-8891 - Hydraulic Systems, Manned Flight Vehicles, Type III Design, Installation & Data Requirements for, General Specification for.
MIL-T-10727 - Tin Plating, Electrodeposited or Hot-Dipped, for Ferrous and Nonferrous Metals.
MIL-P-15024 - Plates, Tags and Bands for Identification of Equipment.
MIL-P-19692 - Pumps, Hydraulic, Variable Delivery, General Specification for.
MIL-C-26074 - Coatings, Electroless Nickel, Requirements for.
MIL-I-81219 - Indicator, Elapsed Time, Electrochemical.
MIL-R-83248 - Rubber, Fluorocarbon Elastomer, High Temperature Fluid and Compression Set Resistant.

STANDARDS

MILITARY

MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-130 - Identification Marking of US Military Property.
MIL-STD-195 - Marking of Connections for Electric Assemblies.
MIL-STD-202 - Test Methods for Electrical Component Parts.
MIL-STD-276 - Impregnation of Porous Nonferrous Metal Castings.
MIL-STD-461 - Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Distribution.
MIL-STD-781 - Reliability Test Exponential Distribution.
MIL-STD-810 - Environmental Test Methods and Engineering Guidance.
MIL-STD-838 - Lubrication of Military Equipment.
MIL-STD-889 - Dissimilar Metals.

MIL-STD-2073 - DOD Material Procedures for Development and Application of Packaging Requirements.
MS21344 - Fitting-Installation of Flared Tube, Threaded Connectors, Design Standard for.
MS27595 - Retainer, Packing Back-up, Tetrafluoroethylene, Straight Thread Tube Fitting Boss.
MS28774 - Retainer, Packing Back-up, Single Turn, Tetrafluoroethylene.
MS28775 - Packing, Preformed, Hydraulic, plus 250°F (+135°C) (O-Ring).
MS28782 - Retainer, Packing, Back-up Teflon.
MS28783 - Ring, Gasket, Back-up Teflon.
MS33540 - Safety Wiring and Cotter Pinning, General Practices for.
MS33649 - Boss, Fluid Connection, Internal Straight Thread.

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

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 3951 - Packaging, Commercial

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1137.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated design specifications, specification sheets, or MS standards), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Precedence. The requirements of MIL-H-8775 or MIL-H-8890, and a design specification (see 6.7) to be prepared by the airframe contractor or unit manufacturer, as applicable, apply as requirements of this specification with the exceptions and additions specified herein. In case of conflict between the requirements of this specification and those of the design specification that meet or exceed requirements of this specification, requirements of the design specification shall take precedence. These units shall be designed for installation in hydraulic systems as defined in MIL-H-5440 or MIL-H-8891, as applicable.

3.2 Component parts. The electric motor driven pump unit shall consist of a hydraulic pump and an electric motor coupled together as a unit.

3.3 First article. When specified (see 6.4), a sample shall be subjected to first article inspection (see 6.5) in accordance with 4.3.

3.4 Design and construction.

3.4.1 Hydraulic pump. The hydraulic pump shall be designed to meet the applicable requirements of MIL-P-19692, except as may be modified herein. (Where duplication or conflict occurs between inspections in this specification and those in MIL-P-19692, the inspections in this specification shall apply.)

3.4.2 Electric motor. The electric motor shall be designed to meet the applicable requirements of MIL-M-7969 or MIL-M-8609, whichever is appropriate for the application. When required, elapsed time indicators shall conform to MIL-I-81219 or MIL-M-7793, as applicable.

3.4.2.1 Direct current motors. All 28 volt direct current electric motors shall be designed to meet the applicable requirements of MIL-M-8609, except as modified herein. (Where duplication or conflict occurs between this specification and those in MIL-M-8609, this specification shall apply.)

3.4.2.1.1 EMI filter. If required by the design specification, a filter to reduce electromagnetic interference conforming to MIL-STD-461 shall be incorporated.

3.4.2.2 Alternating current motors. All 400 hertz alternating current electric motors shall be designed to meet the applicable requirements of MIL-M-7969, except as modified herein. (Where duplication or conflict occurs between this specification and those in MIL-M-7969, this specification shall apply.)

3.4.3 Hydraulic ports. Port configuration shall be in accordance with MIL-P-19692 unless otherwise specified in the design specification.

3.4.4 Electrical connections. External termination of the motor wiring shall be in accordance with MIL-STD-195, unless otherwise shown on the applicable standard or design specification. The motor mounting provisions shall provide a low impedance path for radio interference currents, but shall not be used to complete motor electrical circuits in lieu of a lead. Wherever practicable, positive connections which do not depend upon insulation in compression shall be used. Suitable shielding shall be provided for remote filtering if specified in the design specification.

3.4.5 Leakage. External leakage from the unit of sufficient magnitude to form a drop shall not be permitted except at the drive shaft seal, where the rates of leakage under specified operating conditions shall not exceed the values specified in 4.4.2.4.

3.4.6 Lubrication. The hydraulic pump itself shall be self lubricating with no provisions other than the circulating oil. Where lubrication is required in the electric motor, or any gear cases, or other parts not in contact with hydraulic fluid, the lubricant shall be in accordance with MIL-STD-838 or as specified in the design specification. Such lubrication shall result in satisfactory operation when the pump is permanently mounted in any position.

3.4.7 Fluid resistance. The unit shall be designed and constructed to operate in an environment in which casual system fluid due to leakage and handling is present, and as required in 4.3.2.1.3 and in the design specification.

3.4.8 Drainage. The motor housing should be constructed to facilitate drainage of casual fluid; surface pockets which may entrap fluids should be avoided. The use of an oil slinger to keep fluid from the motor shaft may be warranted by the unit orientation.

3.4.9 Protection. Motor enclosure to be totally enclosed, utilizing fan cooled, nonventilated, jacketed, or wet rotor construction.

3.4.10 Safetying. All threaded parts shall be positively locked or safetied by safety wiring, self locking nuts, or other approved methods. Safety wire shall have a minimum diameter of 0.032 inch (0.8mm) and shall conform to MS33540. Lead type safety wire sealing shall not be used.

3.4.11 Reliability. The unit shall be designed to meet the reliability requirements specified in the design specification.

3.4.12 Maintainability. The unit shall be designed to meet the maintainability requirements specified in the design specification.

3.4.12.1 Maintainability features.

a. All wear surfaces shall be replaceable or repairable.

b. Disconnects, mounting and wiring provisions shall be designed to prevent erroneous connections.

c. Components which are not functionally interchangeable shall not be physically interchangeable.

d. The design shall permit line replacement of the unit or module thereof, using standard tools only.

e. The design shall be such that special or unique equipment is minimized for shop repair, overhaul, and checkout.

3.4.13 Noise level. The unit shall be designed to meet the airborne noise requirements specified in the design specification. When no noise requirements are specified, the unit shall be designed to attain minimum noise levels possible in keeping with good design practices.

3.5 Installation requirements.

3.5.1 Dimensions. Dimensions pertinent to the installation of units shall be specified on the manufacturer's installation drawing.

3.5.2 Weight. The wet and dry weight of the completely assembled unit shall not exceed the value specified in the design specification.

3.5.3 Mounting. Dimensions and any other pertinent design factors of the unit mounting pad or feet shall be specified in the design specification.

3.5.4 Orientation. Unit operation shall be unaffected by the position in which the unit is mounted.

3.6 Detail requirements.

3.6.1 Material. Materials and processes used in the manufacture of these products shall be of high quality, suitable for the purpose and shall conform to applicable government specifications. Materials conforming to the unit manufacturer's material specifications may be used provided the specifications are acceptable to the acquisition activity and contain provisions for adequate tests. The use of the unit manufacturer's specifications will not constitute waiver of other applicable specifications.

3.6.1.1 Metals. All metals shall be compatible with the fluid and intended temperature, functional, service, and storage conditions to which the components will be exposed. The metals shall possess adequate corrosion resisting characteristics, or shall be suitably protected in accordance with 3.6.1.2.

3.6.1.2 Corrosion protection. Metals which do not inherently possess adequate corrosion resisting characteristics shall be suitably protected, in accordance with the following subparagraphs, to resist corrosion which may result from such conditions as dissimilar metal combinations, moisture, salt fog, and high temperature deterioration as applicable. Dissimilar metals are defined in MIL-STD-889.

3.6.1.2.1 Ferrous and copper alloys. Ferrous alloys requiring corrosion preventive treatment, and all copper alloys, shall be suitably protected using the electrodeposited metallic coating selected from Table I. Tin, cadmium, and zinc plating shall not be used for internal parts or on internal surfaces in contact with hydraulic fluid or exposed to its vapors and not where subject to abrasion. O-ring grooves for external seals shall not be considered as internal surfaces in constant contact with hydraulic fluid. Where not indicated, class and type are at the option of the manufacturer. Such materials or processes shall be selected so as to provide the maximum degree of corrosion resistance consistent with the performance requirements.

TABLE I. Metallic coatings.

Cadmium plating	QQ-P-416, type II, class 2
Zinc plating	QQ-Z-325, type II, class 2
Chromium plating	QQ-C-320
Nickel plating	QQ-N-290
Silver plating	QQ-S-365
Tin plating	MIL-T-10727, type I
Electroless nickel	MIL-C-26074

Other metallic coatings, the use of which has been demonstrated to be satisfactory to the purchaser, such as electrodeposited 85 percent tin, 15 percent cadmium alloy may be used.

3.6.1.2.2 Aluminum alloys. Unless otherwise authorized, all aluminum alloys shall be anodized in accordance with MIL-A-8625, except that in the absence of abrasive conditions they may be coated with chemical film in accordance with MIL-C-5541. The exceptions noted will be subject to the approval of the acquisition activity.

3.6.1.2.3 Magnesium. Magnesium shall not be used.

3.6.1.3 Castings. Castings shall be of high quality, clean, sound, and free from cracks, blow holes, and excessive porosity and other defects. Defects not materially affecting the suitability of the castings may be repaired at the foundry or during machining by peening, impregnation, welding, or other methods acceptable to the acquisition activity. Inspection and repair of castings shall be governed by quality control techniques and standards satisfactory to the acquisition activity. When impregnation castings are used, they shall be in accordance with impregnation procedures and inspection requirements of MIL-STD-276.

3.6.1.4 Recycled and claimed materials. Recycled and reclaimed materials shall be used to the maximum extent possible without jeopardizing the end use of the item.

3.6.2 Seals. Pump static and dynamic seals shall be in accordance with MIL-P-19692.

3.6.3 Nameplate. A nameplate conforming to MIL-P-15024 and the applicable MIL-P-15024 specification sheet as required by the design specification and containing the following information legibly filled in shall be securely attached to the unit. The information marked in the spaces provided shall be in accordance with MIL-STD-130.

Pump Unit, Hydraulic, Electric-Motor-Driven, Variable Delivery
Rated Pressure
Rated Delivery
Rated Voltage (AC or DC)
Rated Amperage
Specification
Manufacturer's Part Number
Manufacturer's Serial Number
Manufacturer's Name or Trademark
Federal Stock Number
Contract Number
US

Any nameplate data required in addition to the above shall be specified in the design specification.

3.7 Functional requirements.

3.7.1 Hydraulic fluid. The hydraulic fluid that the unit is designed to handle shall be specified in the design specification.

3.7.2 Rated discharge pressure. The rated discharge pressure shall be the maximum pressure against which the pump unit is required to operate continuously at rated temperature and rated voltage. The pump shall maintain rated discharge pressure at zero flow condition. The value and tolerance range of the rated pressure shall be stated in the design specification.

3.7.3 Maximum full flow pressure. The maximum full flow pressure shall be the maximum discharge pressure at which the pump control will not be acting to reduce pump unit delivery at rated temperature, voltage, and inlet pressure. The design specification shall specify the value and limits for maximum full flow pressure operation.

3.7.4 Rated inlet pressure. The rated inlet pressure of the unit shall be the indicated pressure at the inlet port of the pump when it is operating at rated voltage, maximum full flow pressure and rated temperature. Inlet portion of system shall be in accordance with MIL-P-19692. The value of rated inlet absolute pressure, expressed in psi (kilopascals, kPa), shall be established in the design specification.

3.7.5 Case drain port pressure and flow. Unless a different value is specified in the design specification, the pump shall be designed in accordance with MIL-P-19692.

3.7.6 Rated temperature. The rated fluid temperature of the unit shall be in accordance with MIL-P-19692.

3.7.7 Rated voltage. The rated voltage shall be specified in the design specification.

3.7.8 Current Draw.

3.7.8.1 Rated current draw. The rated current draw of the unit shall be the measured input current to the motor under steady state running conditions of rated voltage, rated temperature, maximum full flow pressure, and rated inlet pressure. It shall be stated in the design specification.

3.7.8.2 Starting current draw. The starting current draw of the unit shall be the peak measured input current to the motor when the unit is started. Rated voltage, rated temperature, maximum full flow pressure, and rated inlet pressure conditions shall apply unless specified otherwise in the design specification. Maximum starting current shall be stated in the design specification.

3.7.9 Rated delivery. The rated delivery of the unit shall be the measured output of the pump under conditions of rated temperature, rated voltage, and maximum full flow pressure, using the hydraulic fluid specified in the design specification at rated inlet pressure. It shall be expressed in U.S. gallons per minute (GPM), liters per minutes (L/min), and its value specified in the design specification.

3.7.10 Proof pressure. The pump shall be capable of performing satisfactorily for one minute at 125 percent of rated discharge pressure. Inlet and case pressure shall be 450 to 500 psi (3100 to 3500 kPa) or 150 percent of rated pressure as specified in the design specification.

3.7.11 Rated endurance. The value of the rated endurance expressed in hours shall be specified in the design specification.

3.7.12 Cooling air. The unit shall not require external blast air cooling unless stated in the design specification.

3.8 Electrical requirements.

3.8.1 Electromagnetic interference. The motor shall be designed to minimize the generation of radio interference, and when required by the design specification or standard, the motor shall be equipped with a radio interference filter and shall meet the requirements of MIL-STD-461 as specified in the design specification.

3.8.2 Electrical bonding. When required, electrical bonding requirements of the unit shall be as specified in MIL-B-5087 or as specified in the design specification.

3.8.3 Insulation resistance. The motor shall be designed to meet the requirements of 4.4.2.5 or other requirements as stated in the design specification.

3.8.4 Dielectric strength. The motor shall be designed to meet the requirements of 4.4.2.6 or other requirements as stated in the design specification.

3.8.5 Thermal protection. When specified by the applicable motor standard or design specification, a protective means shall be supplied. One of the following methods and types of protection is to be specified.

3.8.5.1 Thermal protection method.

3.8.5.1.1 Method I. Protection shall be provided by a nonautomatic reset means to prevent smoke or toxic fumes from being generated by a motor under locked rotor or operating conditions. The protective device must be manually resettable or replaceable after partial disassembly of the motor.

3.8.5.1.2 Method II. Protection shall be provided to permit a motor to develop maximum output or locked rotor torque to the point of failure without being a fire hazard. The protective system must not be automatically reset and both motor and protector system are considered expended after one operation.

3.8.5.1.3 Method III. Protection shall be provided to permit average rated torque capability under all operable environmental power and load conditions and attain a substantial portion of the rated life of the motor under overload conditions which cause cycling of the thermal protective device. The motor and protector shall provide a minimum of 25 hours of intermittent or continuous locked rotor protection at rated voltage (and frequency for AC motors).

3.8.5.2 Thermal protection type.

3.8.5.2.1 Direct acting. A protector within or on the motor enclosure shall interrupt the motor power supply and shall be of sufficient rating to interrupt the maximum locked rotor current and perform in accordance with the appropriate thermal protection method specified herein (see 3.8.5.1). The

protector must be rated to provide a minimum of 5,000 interruptions of the maximum current, or 25 hours of intermittent or continuous locked rotor protection at rated voltage (and frequency for AC motors).

3.8.5.2.2 Indirect acting. A protector shall be provided with a minimum inductive contact rating of two amperes at 28 volts DC to operate relays and signal devices. The protector shall perform in accordance with appropriate thermal protection method specified herein (see 3.8.5.1) and shall have a minimum life of 5,000 operations.

3.9 Performance.

3.9.1 Current/power. The performance requirements shall be stated in the design specification. The minimum performance may be stated in maximum input current (input power) at rated fluid delivery of the unit.

3.9.2 Efficiency. Where the design specification states a required minimum efficiency, it shall be the ratio of output power to input power when the unit is operated at rated voltage and maximum full flow pressure. It shall be stated as percentage. To calculate output power, only the net difference between inlet pressure and outlet pressure shall be used.

3.9.3 Heat rejection. The maximum rate of heat rejection at specified conditions shall be stated in the design specification and determined by the procedure of 4.3.2.1.10. The value shall be considered equal to the difference between the input and output power of the unit at those conditions. Unit heat rejection reflects inefficiencies of the pump and motor combined. The heat rejection of the pump alone will provide a truer value of heat introduced into the hydraulic system fluid.

3.9.4 Pressure pulsations. Pressure pulsations shall be the oscillations of the pump discharge pressure in accordance with MIL-P-19692. The amplitude of pressure pulsations shall be determined by the test procedure of 4.3.2.1.11.2.

3.9.5 Variable delivery control. The pump shall incorporate a delivery control means in accordance with MIL-P-19692.

3.9.5.1 Response time. The response time of the pump shall be in accordance with MIL-P-19692. The unit shall be operated at rated voltage, and in a circuit as defined in 4.3.2.1.11.1.3 for response tests.

3.9.5.2 Stability. The stability of the pump shall be the freedom from an oscillation or "hunting" of the delivery control mechanism that can be traced to the pump delivery control means. The oscillographic trace of discharge pressure versus time shall be employed as the criterion of stability. All units, under any operating condition within the limits established in the design specification, after being disturbed from steady state operation by a change in flow demand or a change in input voltage shall recover steady state operation (other than permissible pressure pulsations as specified in 3.9.4) in not more than one second after the initial response to that change in flow demand.

3.9.5.3 Maximum transient pressure. The maximum transient pressure shall be as specified in MIL-P-19692 with unit operating as specified in 4.3.2.1.11.1.4.

3.9.6 Balance. The moving parts of the unit shall be inherently balanced and shall not vibrate in such a manner as to cause failure of any part in the pump or motor when operated at the maximum specified voltage and frequency.

3.9.7 Adjustment. Means shall be provided to adjust the pump delivery control mechanism as specified in MIL-P-19692.

3.9.8 Emergency two phase operation. When required by the applicable military specification or by the design specifications, units incorporating grounded neutral, three phase, Y-connected motors shall operate with one of the input power lines removed. Performance under one or more of the following conditions shall be established in the design specification:

a. Unit shall be capable of delivering specified reduced power output continuously.

b. Unit shall be capable of delivering a specified horsepower output for a specified number of operational cycles.

c. Other.

3.10 Environmental requirements.

3.10.1 Vibration. Units shall be capable of withstanding vibrations transmitted to the unit under all conditions of operation.

3.10.2 Acceleration. All units shall be designed to withstand sustained acceleration of 10g applied in any direction unless otherwise defined in the design specification.

3.10.3 Shock. All units shall be designed to withstand shock impulses transmitted from the airframe under all conditions of operation. Shock levels shall be defined in the design specification.

3.10.4 Atmospheric conditions. All units shall be designed to withstand continuous exposure, in the configuration as installed, and either operating or non-operating, to salt fog as encountered in marine or coastal areas, to dust and fine sand as encountered in desert areas, and to humidity ranging up to 100 percent.

3.10.5 Altitude. The unit shall be capable of operating to the altitude specified in the design specification. Provided that inlet pressure is maintained to at least the rated value as per 3.7.4, unit performance shall not be affected by change of altitude.

3.10.6 Fungus. The unit shall continue to operate properly when exposed to fungus growth as encountered in tropical climates.

3.10.7 Explosion proof (aeronautical). When specified by the design specification, the motor shall be explosion proof, as specified in 4.3.2.1.20.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of

all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of inspections. For the purpose of demonstrating compliance of the units with this specification, MIL-H-8775 or MIL-H-8890, as applicable, and the design specification, the inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.3).

b. Quality conformance inspection (see 4.4).

c. Qualification reliability inspections (see 4.5).

4.3 First article inspection. First article inspection, for the purpose of demonstrating conformance of the unit design to the requirements of this specification, MIL-H-8775, or MIL-H-8990, as applicable and with the design specification, to ensure their suitability for use in specific installations, and also to verify the manufacturer's ability to produce the item, shall consist of the design integrity tests specified in 4.3.2.

4.3.1 Design approval procedure.

4.3.1.1 Design specification. When specified in the contract or order, the airframe contractor or unit manufacturer shall prepare a design specification for each unit for which design approval is desired (see 6.4 and 6.7).

4.3.1.2 Similarity. In cases where the unit for which design approval is desired incorporates the same or operationally similar working parts as a unit which has previously received design approval, by a government acquisition activity, and service requirements for the previous utilization for which the unit was qualified were equivalent to or greater than service requirements for the units intended utilization, all or a portion of the design approval inspections may be waived; and, when specified in the contract or order, a report substantiated by drawings showing similarity to the approved article prepared in lieu of actual inspections (see 6.4).

4.3.1.3 First article inspection report. When specified in the contract or order, a report of the inspections performed and the results of the inspection shall be prepared (see 6.4).

4.3.1.4 Separate inspection of components. The design integrity inspections outlined in 4.3.2 include several which are, or may be, applicable to only the hydraulic pump or the electric motor. The separate inspection of components to avoid undue, unnecessary, or a duplication of inspections to which a component may have been previously subjected, is allowable. When specified in the contract or order, a design integrity inspection plan shall be prepared by the manufacturer to outline the method of inspection (see 6.4).

4.3.2 Design integrity inspections. The design integrity inspections shall consist of the following, performed in the suggested order listed on one sample unit, or the same inspection test performed on two sample units (A and B) on a selected basis, as defined by the following:

a. First article conformance (4.3.2.1.2) - Samples A and B
b. Fluid resistance (4.3.2.1.3) - Sample A
c. Low temperature (4.3.2.1.4) - Sample B
d. Starting current (4.3.2.1.5) - Samples A and B
e. Calibration (4.3.2.1.6) - Samples A and B
f. Proof pressure (4.3.2.1.7) - Samples A and B
g. Electromagnetic interference (4.3.2.1.8) - Sample B
h. Thermal protection (4.3.2.1.9) - Sample B
i. Heat rejection (4.3.2.1.10) - Sample B
j. Pressure pulsations (4.3.2.1.11.2) - Sample B
k. Response time (4.3.2.1.11.1.3) - Sample B
l. Maximum pressure (4.3.2.1.11.1.4) - Sample B
m. Vibration (4.3.2.1.12) - Sample B
n. Endurance (4.3.2.1.13) - Sample A
o. Shock (4.3.2.1.14) - Sample B
p. Salt fog (4.3.2.1.15) - Sample B
q. Dust (fine sand) resistance (4.3.2.1.16) - Sample B
r. Humidity (4.3.2.1.17) - Sample B
s. Altitude (4.3.2.1.18) - Sample A
t. Fungus (4.3.2.1.19) - Sample B
u. Explosion proof (4.3.2.1.20) - Sample B
v. Cavitation (4.3.2.1.21) - Sample B
w. Additional inspections, if any, required by the model specification - Sample A or B as defined by the model specification.

4.3.2.1 Design integrity inspection methods. The hydraulic fluid used in all design integrity inspections shall be that specified in the design specification. Unless otherwise specified, required steady state inspection operating conditions shall be maintained within the following limits:

Pump inlet pressure within ± two percent
Pump inlet temperature:

-70° to +110°F, within ± 5°F (-55° to +45°C, within ± 3°C)
+110° to +225°F, within ± 10°F (+45° to +110°C, within ± 6°C)
+225° to +350°F, within ± 15°F (+110 to +175°C, within ± 9°C)

Motor voltage within ± 2 percent
Pump discharge pressure within ± 2 percent
Pump flow within ± 2 percent

Accuracy of the instrumentation shall be consistent with the requirements of each individual inspection, and the degree of accuracy considered achieved shall be attested to.

4.3.2.1.1 Method of selection. The unit or units chosen for the design integrity inspections must be representative of those units to be produced in subsequent production.

4.3.2.1.2 First article conformance inspection. The quality conformance inspection which is included in the design approval inspection program shall be run exactly as specified in 4.4.2, except that pressure control inspections shall be extended to check the discharge pressure at cutoff and pump stability for the complete fluid temperature and voltage range of the unit.

4.3.2.1.3 Fluid resistance. Units incorporating fluid resistant motors and other electrical components shall be mounted in a manner simulating that in the actual application, and inspected under the following conditions:

a. The oil specified by the design specification or standard shall be allowed to drip on and flow over the unit at the rate of 1/2 pint (1/4 liter) per hour.

b. Unless otherwise specified by the design specification or standard, the oil temperature shall be between 135° and 150°F (55° and 65°C).

c. At no load with motor adjusted to give approximately rated speed, continuous duty motors and components shall be operated for 48 hours, and intermittent duty motor and components shall be operated for six duty cycles, following each 12 hours of exposure, for four periods of operation.

d. After this inspection the unit shall be cleaned and dried externally, and the motor shall then withstand a dielectric inspection voltage of 220V RMS for DC motors and 600V RMS for AC motors at commercial frequency of approximately 60 Hz, for one minute, successively impressed between each circuit and all other circuits and metal parts grounded together. The unit shall then pass the performance verification inspection specified in 4.3.2.1.13.5 at room ambient temperature.

4.3.2.1.4 Low temperature inspection. All temperature requirements apply equally to the unit body, hydraulic fluid, and ambient environment. After at least 18 hours at the minimum inlet temperature specified in the design specification, or at -65° ± 5°F (-55° ± 3°C), in the absence of such stipulation in the design specification. The unit shall be started and accelerated to speed in not more than two seconds, unless otherwise specified in the design specification. Twenty runs shall be made with the outlet pressure as low as practicable and the inlet pressure as specified in the design specification. When operating speed has been reached, it shall be maintained for at least 10 seconds; observations shall indicate whether the pump displaces fluid through the hydraulic system. Then five starts and runs shall be made, during which the

pump discharge line terminates in a relief valve set to pass fluid at maximum full flow pressure. In addition, five starts shall be made with the pump discharge line completely closed so that the unit will operate at rated discharge pressure. Throughout these inspections, after each run the unit and fluid shall be allowed to stand idle long enough for them to be restored to the above soaking temperature before starting the next run. The inspection circuit shall contain a volume simulating operating conditions in the aircraft system or as specified in the design specification.

4.3.2.1.5 Starting current. The unit shall be started with rated frequency (AC motors), and 75°F (25°C) ambient temperature. The inspection circuit shall be adjusted for maximum full flow pressure unless specified otherwise in the design specification. The starting current, as measured by an oscillograph or other suitable instrument, shall not exceed the value specified in the design specification. The measured starting current shall be corrected to rated voltage in proportion to any voltage reduction. The characteristics of the electric power supply and circuitry, i.e. capacitance, resistance, impedance, battery decay, etc. shall be as specified in the design specification. The inspection circuit shall simulate the specified circuit to the extent required to assure true representation of performance.

4.3.2.1.6 Calibration inspection. Values of flow rate and input current shall be determined at 90, 100, 110 percent of rated voltage. At each of these inputs, four sets of flow and current records shall be made at approximately the following pressures: 25, 50, 75, and 100 percent of maximum full flow pressure and at five equally spaced increments of flow between maximum full flow pressure and rated discharge pressure. Unless otherwise specified in the design specifications, calibrations will be made at the inlet condition specified in 3.7.4. Flow measurements may be made in the line downstream of the load valve but must be corrected for fluid compressibility at the option of the design specification.

4.3.2.1.7 Proof pressure inspection. The proof pressure inspection as outlined in 4.4.2.2 for quality conformance inspection shall be performed, except the inspections shall be repeated 10 times. At the conclusion of the proof pressure inspections, the pump delivery mechanism shall be restored to its normal adjustment or configuration.

4.3.2.1.8 Electromagnetic interference. The unit shall be inspected for interference in accordance with MIL-STD-461 as outlined in the design specification. Conducted and radiated measurements shall be within limits specified in MIL-STD-461.

4.3.2.1.9 Thermal protection.

4.3.2.1.9.1 Tests for method I of direct acting thermal protection.

4.3.2.1.9.1.1 Mounting. Unless otherwise specified in the design specification or standard, the motor mounting method shall thermally isolate the motor to prevent conduction to or from adjacent metallic structures.

4.3.2.1.9.1.2 Running overload inspection. The motor and thermal protector combination shall provide 115 percent of rated torque for one hour at maximum ambient, rated voltage without a nuisance trip, for continuous duty motors. The motor is then to be overloaded until the protector trips and no smoke or toxic

fumes shall occur. Intermittent duty motors shall be operated at room ambient and rated load until the protector trips. No smoke or toxic fumes shall occur. If no protector trip occurs prior to stabilization of frame temperature, the inspections shall be repeated in the maximum specified ambient.

4.3.2.1.9.1.3 Locked rotor inspection. With rotor locked at room ambient and rated voltage applied to the motor terminals, motor and thermal protector combination shall withstand one locked rotor protector interruption without the occurrence of smoke or toxic fumes.

4.3.2.1.9.2 Inspections for method II of direct acting thermal protection.

4.3.2.1.9.2.1 Mounting. Unless otherwise specified by the design specification or standard, the motor mounting method shall thermally isolate the motor to prevent conduction to or from adjacent metallic structures.

4.3.2.1.9.2.2 Running overload inspection. The motor shall be operated at 150 percent of rated torque in the maximum specified ambient at rated voltage until the power input has been completely interrupted by the protective system. During the test, no flame shall be visible and no external part of the motor, prior or subsequent to operation of the protective system, shall exceed 390°F (200°C) unless otherwise specified in the design specification or standard. If power interruption does not occur at 150 percent of rated torque within two hours, a load torque greater than 150 percent of rated torque may be utilized.

4.3.2.1.9.2.3 Locked rotor inspection. The motor rotor shall be locked while at room ambient and rated voltage applied to the motor terminals until the input power is completely interrupted by the motor protective system. During the inspection, no flame shall be visible and no external part of the motor, prior or subsequent to operation of the protective system, shall exceed 390°F (200°C) unless otherwise specified in the design specification or standard. When an explosion proof inspection requirement is specified, the above inspection shall be conducted in the explosive atmosphere specified in the design specification or standard. No explosion, external to the motor, shall occur.

4.3.2.1.9.3 Inspection for method III of thermal protection.

4.3.2.1.9.3.1 Running overload inspection. After conclusion of the explosion proof inspection, if specified, the motor and thermal protector combination shall provide 115 percent of rated torque for one hour at maximum ambient without a nuisance trip for continuous duty motors. The load shall then be increased to 150 percent of rated torque and the protector must trip within five minutes and not reset within a period equal to twice the time required to trip at 150 percent of rated torque. Cyclical inspections, by means of the thermal protector, shall be continued for 15 hours with the load set at 150 percent of rated torque.

4.3.2.1.9.3.2 Locked rotor inspection. After conclusion of the running overload test, the motor shall be submitted to locked rotor operation at rated voltage for 25 hours at room ambient. Following this inspection the motor shall pass a load inspection as specified in the design specification to verify required performance levels.

4.3.2.1.9.4 Indirect acting thermal protection inspections.

4.3.2.1.9.4.1 Motor and signal element. The motor and protector signal element shall be subjected to the inspections of 4.3.2.1.9.2 or 4.3.2.1.9.3, as appropriate, according to the method of protection specified and motor duty.

4.3.2.1.10 Heat rejection determination. To determine the rate of heat rejection, the unit shall be run at rated voltage and at rated discharge pressure, maximum full flow pressure, and at least two additional flow points between those values. Should it be desired to determine the rate of heat rejection at operating conditions other than these, the additional requirements shall be defined in the design specification. The maximum acceptable value in British thermal units per minute, BTU/MIN (kilojoules per min., kj/min.) of heat rejection rate at specified operating conditions shall be as specified in the design specification.

4.3.2.1.11 Maximum pressure, response time, and pressure pulsations. The pressure-time function of the unit and its hydraulic circuit during transient and steady state periods of operation shall be recorded as specified in MIL-P-19692.

4.3.2.1.11.1 System impedance.

4.3.2.1.11.1.1 Response time. The system impedance of the inspection circuit when determining unit response shall be in accordance with MIL-P-19692 when the unit is operated at rated voltage.

4.3.2.1.11.1.2 All other inspections. The system impedance of the inspection circuit when determining maximum pressure, pressure pulsation, stability, and the remaining design integrity tests shall be as specified in MIL-P-19692.

4.3.2.1.11.1.3 Response time. Response times shall be as specified in MIL-P-19692 with the inspection circuit specified in 4.3.2.1.11.1.1. Runs shall be made at rated input voltage or as specified in the design specification.

4.3.2.1.11.1.4 Maximum pressure inspection. The maximum pressure shall be as specified in MIL-P-19692 with the unit operating in the inspection circuit specified in 4.3.2.1.11.1.2. The inspection shall be run at rated voltage or as specified in the design specification.

4.3.2.1.11.2 Pressure pulsations. The inspection circuit specified in 4.3.2.1.11.1.2 shall be equipped with a dynamic pressure transducer of zero volume and sensitive to 20 to 100 kilo-Hertz. With unit at rated discharge pressure and rated input voltage, an oscillographic record shall be made of the pulsation pattern. In addition, runs shall be made at the minimum and maximum input voltages at maximum full flow pressure and at 25, 50, and 75 percent of full flow at each voltage. Values of pressure pulsation shall not exceed the limits specified in 3.9.4.

4.3.2.1.12 Vibration inspections.

4.3.2.1.12.1 Inspection unit mounting orientation. The inspection unit shall be mounted on a vibration generating mechanism successively in each of at least three positions. All of the inspections specified shall be performed in

each of the mounting positions. One of these mounting positions shall be such that the direction of vibratory motion shall be parallel to the shaft axis of the unit. Another mounting position, if and when practicable, shall be such that the direction of vibratory motion shall be parallel to the axis of the pump compensating mechanism.

4.3.2.1.12.2 Resonant frequency vibration. Resonant frequencies shall be searched according to the double amplitude and frequency charts of MIL-STD-810. Applicable procedures and inspection values shall be specified in the design specification.

4.3.2.1.12.3 Cyclic frequency vibration. Upon completion of the resonant frequency vibration, a cycling vibration shall be imposed in accordance with MIL-STD-810. Applicable procedures and inspection values shall be as specified in the design specification.

4.3.2.1.12.4 Other vibration inspections. Other vibration inspections to be performed when a particular installation imposes severe environmental conditions peculiar to its system requirements shall be as specified in the design specification.

4.3.2.1.12.5 Unit operation. Throughout the above vibration inspections the unit shall be operated in the inspection circuit of 4.3.2.1.11.1.2. The unit shall be operated at rated input voltage or as specified in the design specification. Oil inlet temperature shall be maintained at 140°F (60°C) regardless of the rated temperature of the unit being inspected, and ambient temperatures shall be maintained at room ambient conditions. The pump discharge pressure (zero flow) to be a discharge pressure corresponding to approximately 50 percent of rated delivery. These pressure cycles shall be abruptly accomplished by electrically controlled hydraulic valves at a rate of five cycles per minute. Transition from one condition of flow to the other condition of flow must be accomplished in a valve time of less than 0.50 seconds.

4.3.2.1.13 Endurance inspection. The sample unit shall be operated for 750 hours, or for the time specified in the design specification, to the endurance inspection schedule of Table II. The unit shall be operated at repeating cycles of full and partial flow as listed in the table. Continuous duty units shall be stopped and started every 24 hours. Intermittent duty units shall be operated to the duty cycle specified in the design specification and Table II shall be modified accordingly. Modification of duty cycle or any other inspection condition in the form of additions, deletions, or alterations shall be incorporated by specifying such changes in the design specification.

4.3.2.1.13.1 Fluid. The hydraulic fluid used in the endurance inspection shall be that specified in the design specification. The endurance inspection system shall be charged at the start of the endurance inspection and no fluid shall be added before completion except:

a. The amount of fluid unavoidably removed from the system during the specified filter checks and air ingestion inspections may be replaced.

b. In the event of failure of the inspection system external to the unit, resulting in loss of fluid or contamination not pertinent to unit endurance, the entire fluid supply may be replaced.

c. To maintain fluid within the physical and chemical property limits established by the procuring agency.

A record shall be made of the time and the quantity of fluid added in each case and entered in the log of the inspection.

4.3.2.1.13.2 Filtration for endurance inspection. The hydraulic fluid to be charged into the endurance inspection system shall be passed through a five micron absolute filter before entering the inspection system. Filters in accordance with MIL-F-8815, either five micron absolute or 15 micron absolute as specified in the design specification, shall be installed in the pump inlet, outlet, and case drain or cooling port lines throughout the endurance test. For Type III systems the filters shall be in general accordance with MIL-F-8815 and suitable for the temperature specified in the design specification.

4.3.2.1.13.3 Filter check. At intervals of 50 ± 8 hours, during the endurance inspection, clean filter elements shall be installed in all three filters, and the endurance schedule resumed for two hours, at the end of which these filter elements shall be removed and replaced with clean filter elements. The filter elements removed after two hours running shall be checked in accordance with 4.3.2.1.13.3.1.

4.3.2.1.13.3.1 Patch preparation. The fluid in each filter bowl shall be collected in clean containers. Rinse both the filter bowl and element with a minimum of 15 cubic centimeters (cc) of a suitable fluid solvent and add to the applicable container. The total resulting fluid shall be passed through a 47 millimeter (mm) disc, #40 Watman paper. Wash the disc free of fluid with a minimum of 15 cc of fluid solvent. After drying, the resultant filter patch shall be coated with clear lacquer and permanently attached to the log sheet of the inspection. All fluid solvent shall be filtered through a 0.45 micron pore size membrane prior to use during the foregoing procedure.

4.3.2.1.13.4 Calibration. Before starting the endurance test, and again upon completion of the inspection, the unit shall be calibrated, using the procedure specified in 4.3.2.1.6. The results of these calibrations shall be plotted on one chart to show the effect of the endurance inspection on the performance of the unit.

4.3.2.1.13.5 Performance verification. At the beginning of each phase of operation, the unit shall be operated at rated voltage, rated temperature, and rated inlet pressure. Measurement of output and case flow shall be performed at rated full flow pressure.

4.3.2.1.13.6 Start-stop cycles. Start-stop cycles shall be performed before and after the endurance inspection. The system shall be as specified in 4.3.2.1.11.1.2. Fluid temperatures may range from ambient to rated, but actual values shall be recorded.

4.3.2.1.13.6.1 Full load cycles. The unit shall be accelerated to rated speed within two seconds or time specified in design specification with the load orifice adjusted to 95 percent of maximum full flow pressure for the first half of the cycles, and 110 percent of rated pressure for the last half of the cycles. The unit shall be allowed to coast to a stop immediately after reaching rated speed.

TABLE II Endurance test schedule

Operating time (hours) 1/	Motor volt % rated ±2%	Pump inlet press absolute PSI (kPa) 2/	Fluid inlet Temp°F (°C) 3/	Atmos press absolute	Atmos temp°F (°C)		1st Period Min	% full flow	% of rated disch press	1st Period Min	2nd Period % full flow	2nd Period % of rated disch press	Pump case press gage PSI 6/	(kPa)
5	90			3.0-3.5 in. Hg (75-90) (mm Hg)	-20 (-30)	7/	14	100	4/	1	0	100	100	(7)
5	90			15 psi (100 kPa)	0 (-20)		14	100	4/	1	0	100	100	(7)
65	90			15 psi (100 kPa)	50 (10)		5	75	5/	5	100	4/	100	(7)
200	100			3.0-3.5 in. Hg (75-90) (mm Hg)	-60 (-50)	7/	5	50	5/	5	100	4/	100	(7)
200	100			15 psi (100 kPa)	120 (50)		14	100	4/	1	0	100	100	(7)
200	100			3.0-3.5 in. Hg (75-90) (mm Hg)	0 (-20)		15	100	4/	5	0	100	100	(7)
5	110			3.0-3.5 in. Hg (75-90) (mm Hg)	-20 (-30)	7/	14	100	4/	1	0	100	100	(7)
5	110			15 psi (100 kPa)	0 (-20)		14	100	4/	1	0	100	100	(7)
65	110			15 psi (100 kPa)	50 (10)		5	75	5/	5	100	4/	100	(7)

1/ - A time tolerance of 1 percent is permissible for case of test implementation. The total duration of all phases covered by this table shall be 750 hours as a minimum.
2/ - The inlet pressure shall be defined in the design specification.
3/ - One or more phases, totaling not less than 25 percent of rated endurance shall be run at rated temperature. The remaining 75 percent of the rated endurance shall be run at 80 percent of the rated temperature based on °F unless otherwise specified in the design specification. The apportionment of endurance test time between rated inlet temperature and the lower temperature(s) shall, where feasible, be based on a realistic appraisal of the mission profile of the aircraft in which the unit is to be installed.
4/ - Ninety-five percent of maximum full-flow pressure.
5/ - Pressure indicated shall be adjusted to provide stipulated flow.
6/ - Case drain port pressure shall be set by means of a fixed restriction at maximum drain flow condition. Pressures to be as stated except not less tab 30 PSI (200 kPa) above inlet.
7/ - Allow ambient air temperature to increase to 0°F (-20°C) after start-up.

4.3.2.1.13.6.2 No flow cycles. Follow the same procedure as specified in 4.3.2.1.13.6.1, except the discharge line shall be blocked during starts and stops, and in between cycles the discharge pressure shall be reduced to approximately 100 psi (700 kPa). Two no flow start stop cycles shall be performed for each phase. Half of the cycles shall be performed prior to the start of endurance inspection and the remaining half shall be performed following the inspection.

4.3.2.1.13.7 Air ingestion. The ingestion of air by the hydraulic system, for example as a result of the replacement of components during line maintenance, shall be simulated in accordance with MIL-P-19692.

4.3.2.1.13.8 Tear down inspection. After completion of the endurance inspection the unit shall be disassembled and all parts visually inspected, or inspected as specified in the design specification.

4.3.2.1.14 Shock inspections. Shock inspections, when required by the design specification, shall be imposed in accordance with MIL-STD-810. Applicable procedures and inspection values shall be as specified in the design specification.

4.3.2.1.15 Salt fog. The unit shall be subjected to the 48 hour salt fog inspection Method 509.1, Procedure I of MIL-STD-810. During this inspection, the unit shall be operated as follows:

a. Continuous duty units shall be operated at no load with voltage adjusted to give approximately rated speed for 10 periods of 15 minutes duration with a minimum nonoperating period of 45 minutes between running periods.

b. Intermittent duty units shall be operated at no load with voltage adjusted to give approximately rated speed for 10 duty cycles (a maximum of 15 minutes running time per cycle) with a minimum nonoperating period of 45 minutes between running periods.

c. Following the inspection, the motor shall be washed, dried for 48 hours, and shall then pass the quality conformance calibration inspection (4.4.2.3).

4.3.2.1.16 Dust (fine sand). The unit shall be subjected to sand and dust inspection Method 510.1, Procedure I, Part I of MIL-STD-810. The unit shall be located in the inspection chamber in any position. The inspection cycle shall be composed of 30 minute operative (no load) and 90 minute inoperative periods. Following this inspection, the unit shall pass the quality conformance calibration inspection (4.4.2.3).

4.3.2.1.17 Humidity. The unit shall be subjected to humidity inspection Method 507.1, Procedure I, of MIL-STD-810. Immediately following the unit shall pass the quality conformance calibration inspection (4.4.2.3.).

4.3.2.1.18 Altitude inspection. Unit ability to operate at altitude shall be demonstrated in the endurance inspection (4.3.2.1.13) unless a specific altitude inspection is required in the design specification. The design

specification may omit altitude inspection requirements if the unit incorporates a motor design not affected by vacuum conditions, an example being liquid cooled motors.

4.3.2.1.19 Fungus. The unit shall be subjected to fungus resistance inspections Method 508.1 Procedure I, of MIL-STD-810. Service covers and inspection plates shall be removed prior to the treatment with the spore suspension and then reinstalled after the spores have been introduced within the unit proper. Immediately following the inspection, the unit shall pass the quality conformance calibration inspection (4.4.2.3).

4.3.2.1.20 Explosion proof (aeronautical). Explosion proof units shall be subjected to explosion proof inspections Method 511.1, Procedure II, of MIL-STD-810. These inspections shall be made using two different explosive mixtures, one mixture resulting in maximum pressure and the other in maximum duration of flame. Inspections shall be conducted at sea level only, and five explosions shall be accomplished for each mixture. The explosive mixture may be circulated within the chamber and motor at sea level pressure in lieu of 10,000 feet (3000m) as specified for inspections under Procedure I of MIL-STD-810. Motors below two inches (50 mm) diameter may be inspected in accordance with Procedure I in lieu of Procedure II.

4.3.2.1.21 Cavitation inspection. The unit shall be operated at rated voltage, rated inlet temperature, and maximum full flow pressure. The fluid pressure at the pump inlet port shall be adjusted to 120 percent of rated inlet pressure. The rate of flow and delivery pressure shall be measured as inlet pressure is reduced in steps small enough to clearly establish the onset of cavitation and its effect on output.

4.3.2.1.22 Failure of parts. If, during the design integrity inspection program, the inspection is terminated because of a part failure, the unit shall be replaced or repaired using a redesigned part(s) or, in the case of faulty material or workmanship, the acquisition activity may authorize the installation of a part of the original design and the defect overcome. The program shall be considered complete when all parts within the unit have completed without failure the requirements of the program as specified in the applicable design specification.

Should unit tests be continued from point of failure with repaired or replaced part(s), subsequent failure of parts that have successfully completed total endurance requirements will not be considered cause of rejection.

4.4 Quality conformance inspection. Quality conformance inspection shall consist of a routine visual and dimensional examination and inspection program to determine conformance of the units of a given model to the dimensional, workmanship, and performance requirements of this specification, MIL-H-8775, or MIL-H-8890, as applicable, and the pertinent design specification. Each unit submitted for delivery under acquisition contract shall be subjected to the quality conformance inspection specified herein. Acceptance or approval of material during manufacture shall, in no case, be construed as guarantee of the acceptance of the finished product.

4.4.1 Examinations.

4.4.1.1 Examination of product. The unit shall be examined to determine conformance with the applicable standards and all requirements of this specification, MIL-H-8775 or MIL-H-8890, as applicable, and of the pertinent design specification, for which there are no specific inspections.

4.4.1.2 Inspection of packaging. Except when commercial packaging is specified, the sampling and inspection of the preservation and interior package marking shall be in accordance with groups A and B quality conformance inspection requirements of MIL-P-116. The sampling and inspection of the packing for shipment and storage shall be in accordance with the quality assurance provisions of the applicable container specification shown in Section 5. The inspection of marking for shipment and storage shall be in accordance with MIL-STD-129. The inspection of commercial packaging shall be as specified in the contract (see 6.3).

4.4.2 Inspection methods. The quality conformance inspection outlines the inspections for the assembled unit. In those instances wherein a component, i.e., motor or pump, has been subjected to a specific inspection previously as a separate component the inspection may be waived for that component to avoid duplication. When specified in the contract or order, the manufacturer shall prepare a quality conformance inspection procedure (see 6.4.). The break in and calibration inspections shall be performed on the assembled unit.

4.4.2.1 Break in run. The break in run shall be made with any desired pressure in the pump inlet and outlet lines and shall consist of one hour minimum continuous run at 90 to 110 percent of rated voltage.

4.4.2.2 Proof pressure run. The pressure control of the pump shall be adjusted for 125 percent of rated discharge pressure. Inlet and case drain pressure shall be 450 to 500 psi (3100 to 3500 kPa) or 150 percent of rated pressures. The unit shall be operated at 125 percent rated discharge pressure (zero flow), rated voltage ±2 percent, and optional fluid temperature for one minute. There shall be no external leakage sufficient to form a drop, except the shaft seal may leak at a rate not to exceed five milliliters (ml) per hour. There shall be no evidence of malfunction.

4.4.2.3 Calibration. The unit shall be operated at rated voltage, inlet pressure, inlet temperature, discharge pressure, and case pressure as specified in the design specification. The input and delivery of the unit shall be measured and recorded. The measured values for current and case flow shall be within the specified limits. The discharge pressure shall be reduced to maximum full flow pressure and the input current and delivery of the unit measured and recorded. The measured values for current, discharge flow, and case flow shall be within the limits specified in the design specification. Flow may be measured in the low pressure side of the discharge line at the option of the design specification, provided adequate compensation is made for compressibility in stating the delivery.

4.4.2.4 External leakage.

a. No external leakage, other than at shaft seal, of sufficient magnitude to form a drop shall be permitted.

b. Shaft seal leakage during quality conformance inspections:

(1) Static leakage shall not exceed one drop in 30 minutes at rated pressure conditions.

(2) Dynamic leakage shall not exceed one drop in 5 minutes during a one-hour period.

4.4.2.5 Insulation resistance. The motor shall be subjected to inspection per requirements of MIL-STD-202, Method 302, Condition B. A voltage potential of 500 VDC at 75°F (25°C) shall be applied between windings and between each winding and frame. Electrification time and minimum insulation resistance to be specified in the design specification. During this inspection all capacitors, elapsed time indicators, EMI filters, and other items not designed to meet the insulation inspection requirements shall be disconnected.

4.4.2.6 Dielectric strength. While the motor is hot as the result of operation it shall be subjected to and withstand the following voltages at a frequency of approximately 60 Hertz, applied between windings, and between each winding and frame, for the specified time. All winding permanently connected together are to be considered one winding. During this inspection, all capacitors, elapsed time indicators, EMI filters, and other items not designed to meet the specified dielectric inspection shall be disconnected.

AC Units 1250V (RMS); DC Units 500V (RMS) for one minute

OR

AC Units 1500V (RMS); DC Units 600V (RMS) for one second

No voltage breakdown shall occur as a result of this inspection.

4.4.2.7 Thermal protection. Motors furnished with thermal protective means shall be given a functional inspection by a suitable method, after the device has been installed in the motor, to check proper installation and operation of the protector.

4.5 Qualification reliability inspection. The purpose of this inspection is to demonstrate that the equipment design will meet specified performance and reliability requirements. This inspection shall be performed when required by the acquisition activity (see 6.2.1).

4.5.1 Test plan. The reliability qualification inspection shall be conducted in accordance with MIL-STD-781, Inspection Plan VC.

4.5.2 Accept-reject criteria. The accept-reject criteria shall be as shown graphically for inspection plan VC of MIL-STD-781. The decision risk for this plan is 10 percent and the discrimination ratio is 3.0:1. Inspection shall be continued until the total unit hour together with total count of relevant failures permit either an accept or reject decision. The inspection will be completed when the total unit inspection hours in multiples of lower test MTBF, 0_1 plotted against total failures, falls in an accept or reject area of the graph. 0_1 is 667 hours unless otherwise specified by the acquisition activity.

4.5.3 Test samples. The minimum number of inspection samples selected at random from the first 25 production units shall be five unless otherwise specified by the acquisition activity.

4.5.3.1 Overhaul period of samples. In case of failure of samples during inspections no unit can be overhauled with less than 180 hours of on line operation. In the event that infant failures reduce the number of samples in the program to less than five, new units may be selected at random from production beyond the initial 25.

4.5.4 General outline of inspections. Inspection may be performed simultaneously or in series on each of the five samples. Each unit shall be subjected to a sufficient number of 20 hour spectrums to demonstrate compliance to paragraph 4.5.2, unless otherwise specified by the acquisition activity. The 20 hour inspection spectrum is shown in Table III.

4.5.5 Failures during inspections. A failure shall be deemed to have occurred when it is first noted that a unit no longer conforms to the requirements of the design specification. In the event of a failure attributable to a remedial design or quality control deficiency, inspection on all five units shall be discontinued until the units have been reinspected or modified to correct the deficiency. Complete analysis and corrective action taken on all failures shall be recorded.

4.5.5.1 Replacement of failed units. Failed units shall be replaced with new or overhauled units and the inspections continued until acceptance under the criteria of paragraph 4.5.2. Where a unit fails in under 180 hours of on line inspection, no overhaul is permitted and the unit shall be replaced by a new unit randomly selected from production units.

TABLE III. Inspection hours and conditions.

Log of inspection hours	Inspection conditions
0 - - - - - - 20	
o - o o - o	Load cycles, first three and last three hours
o - o	10% to 20% flow demand fourth through fifteenth hour
o - o	0% flow demand sixteenth and seventeenth hour
o - - - - o o - o o - o	Rated input voltage, all inspection 80% rated fluid temperature, first three and last three hours
o - - - - o	100% rated fluid temperature, fourth through seventeenth hour
o	Start-stop cycle, one each hour
o - - - - - - o	Patch inspection; collection continuous through 20 hour period. Optional.

Monitor input voltage, pump pressure, flow, and external leakage at least once each hour period throughout the inspection. Record pump case drain flow.

4.5.6 Inspection conditions and schedules.

4.5.6.1 General. The conditions, as specified for the normal endurance inspections of this specification, shall apply for the reliability inspections with respect to type and quantity of hydraulic fluid, filtration, system impedance, and tolerance limits on fluid temperature, inlet, case, and discharge pressures, outlet flow, and input voltage. The spectrum shown in table III shall be followed.

4.5.6.2 Input voltage. Unless otherwise specified, the unit shall be operated at rated input voltage for all inspections.

4.5.6.3 Fluid temperature. Each 20 hour inspection period shall include 14 hours of operation with the pump inlet fluid temperature at 100 percent of rated temperature (fourth through seventeenth) and six hours of inspection with fluid temperature at 80 percent of rated value (first three and last three hours).

4.5.6.4 Case drain pressure and flow. Before the start of cycle inspections, the pump case drain flow shall be measured and recorded while the unit is operating at rated voltage, rated discharge pressure, and rated inlet fluid temperature and while the case drain pressure is maintained at 20 PSI (140 kPa) above inlet pressure or as specified in the design specification. Case drain pressure shall be regulated to a value of 40 to 50 psi (275 to 350 kPa) or

as specified in the design specification above inlet pressure, during unit operation at the start of the inspections at no load flow and 100 percent rated inlet temperature. This pressure will be set with an orifice type restriction. The restriction shall not be removed nor changed throughout the inspections but shall be modified by a bypass adjustment during case drain flow monitoring at the start of each 20 hour segment.

4.5.6.5 Inlet pressure. Inlet pressure shall be maintained as specified in the design specification.

4.5.6.6 Inspection pressures. Inspection pressures shall be as specified in the design specification and measured and recorded at the start of each 20 hour segment.

4.5.6.7 System bleeding. The system shall be thoroughly bled of air for all inspections. After each component or filter change the system shall be bled and fluid losses replenished.

4.5.6.8 Filter patch inspections. Patch inspections samples shall be collected continuously through the 20 hour inspection segment or as required by the acquisition agency.

4.5.6.9 High flow load cycles. Each of the six hour high flow load cycle periods (first three and last three hours) shall include 360 full inspection cycles consisting of five seconds at rated discharge pressure and five seconds at full flow pressure. Load changes shall be affected with solenoid valves with operating times of 0.05 seconds or less.

4.5.6.10 Low flow load cycles. During 12 hours (fourth through sixteenth) of the 20 hour segment, the unit shall be cycled continuously from 10 percent to 20 percent rated full flow with five seconds at 10 percent and five seconds at 20 percent.

4.5.6.11 Start-stop cycles. At the start of each hour inspection the unit shall be brought up to rated speed in a two second acceleration period or time specified in the design specification against a blocked line. The system pressure shall be reduced to approximately 100 psi (700 kPa) prior to each start. Units shall be allowed to coast to a stop against a blocked system immediately after reaching rated speed. Deceleration time shall be recorded. Fluid temperature may range from ambient to normal test levels, but shall be recorded during the fast starts. At the option of the acquisition agency, the start-stop cycle variables may be changed as desired.

4.5.6.12 External leakage. Both static and dynamic shaft seal leakage shall be monitored throughout the entire inspection. External leakage, other than shaft seal leakage, sufficient to form a drop shall be considered a failure.

4.5.6.13 Performance verification. At the beginning of each 20 hour segment the units shall be operated at rated voltage, rated temperature, and rated inlet pressure. Measurements of output and case flow shall be performed at rated full flow pressure.

4.5.6.14 Cold starts and rapid warm up. At the beginning of the endurance inspections, three cold start cycles are to be performed on each sample unit.

The fluid in the pump suction line and reservoir shall be stabilized at -65°F (-55°C) or to a temperature specified in the design specification. After the cold soak, the unit shall be brought up to rated speed and rated discharge pressure. Immediately on reaching rated speed, the unit shall be load cycled in accordance with 4.5.6.9 for 10 minutes. Static and dynamic shaft seal leakage shall be recorded and the pump checked for external leakage.

5. PACKAGING

5.1 Preservation. Preservation shall be level A, C, or industrial as specified. (See 6.3)

5.1.1 Level A. Unless otherwise specified by the procuring activity, each pump shall be individually preserved and packaged according to MIL-STD-2073. The method of preservation shall conform to submethod II-A of MIL-P-116.

5.1.2 Level C. Each pump shall be preserved and packaged in a manner which will afford adequate protection against corrosion, deterioration, and physical damage during shipments from supply source to the first receiving activity for immediate use.

5.1.3 Industrial. The industrial preservation of pump shall be in accordance with ASTM D3951.

5.2 Packing. Packing shall be level A, B, C, or Industrial as specified (see 6.3).

5.2.1 Level(s) A, B, or C. The level of packing shall be specified by the procuring activity. The level of packing shall be accomplished in accordance with the requirements outlined in MIL-STD-2073.

5.2.2 Industrial. The packaged pump shall be packed in accordance with ASTM D3951.

5.2.3 Marking. In addition to any special marking required by the contract or order, marking shall be in accordance with MIL-STD-129.

5.4 Inspection. The inspection of these packaging requirements shall be in accordance with 4.4.1.2.

6. NOTES

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

6.1 General. The notes contained in MIL-H-8775 or MIL-H-8890, as applicable, form a part of this specification.

6.2 Intended use. The units are intended for use on turbine engine driven aircraft for hydraulic operation of such mechanisms as powered flight control systems, landing gears, brakes, flaps, gun turrets, servo units, bomb bay doors, and automatic pilots. The units are primarily intended to be driven by the airplane electric power supply and to supply fluid to systems in accordance with MIL-H-5440 or MIL-H-8991, as applicable. When used in other type aircraft or

vehicles differing or additional inspections and separate approval may be required by the acquisition activity.

6.2.1 Reliability inspection. The reliability inspection plan, presented in 4.5 is for a unit in a fighter aircraft. The load cycles are derived from fighter aircraft mission profiles shown in MIL-STD-781, plus a 50 percent factor. The load cycles for a transport/cargo aircraft, by comparison, would be less severe than for a fighter, but the total operating hours per mission would be much greater for transport/cargo aircraft. Therefore, the required MTBF for a transport/cargo hydraulic pump should be much greater than for a fighter hydraulic pump.

6.2.1.1 Alternative reliability inspection plan. An alternate reliability inspection plan, such as VIC of MIL-STD-781, may be considered instead of Inspection Plan VC, if approved by the acquisition activity.

6.3 Acquisition requirements. Acquisition documents should specify:

a. Title, number, and date of this specification.
b. Type of system in which the unit is to be used (see 1.1).
c. Manufacturer's part number.
d. Selection of applicable levels of preservation and packing (see Section 5).
e. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).

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

Reference Paragraph	DID Number	DID Title	Suggested tailoring
4.3.1.1	DI-E-3132	Configuration Item Product Function Specification	
4.3.1.2	DI-GDRQ-80943	Design Similarity Report	
4.3.1.3	DI-T-2072	Reports, Test	
4.3.1.4	DI-GDRQ-80944	Design Integrity Inspection Plan	
4.4.2	DI-T-3714A	Acceptance Test Procedures	

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

6.5 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerers whether the item(s) should be a preproduction sample, a first article sample, a first

production item, a sample selected from the first production items, a standard production item from the contractor's current inventory (see 3.3), and the number of items to be tested as specified in 4.4.1. The contracting officer should also include specified instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.6 Qualifications. When the design specification requires qualification, awards will be made only for products which are, at the time set for opening of bids, qualified for inclusion in Qualified Products List (QPL) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by the design specification. The activity responsible for the Qualified Products List is the design specification preparing activity and information pertaining to qualifications of products may be obtained from that activity.

6.7 Definitions.

Design specification	-	as referred to in this document is either the manufacturers specification or source control drawing.
EMI	-	electronic magnetic interference
MTBF	-	mean time before failing

6.8 Subject term (key word) listing.

thermal protector
inlet pressure
pump housing
seals
aircraft pumps

6.9 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians:
Army - AV
Navy - AS
Air Force - 99

Review Activity:
Navy - MC
Air Force - 82

Preparing Activity:
Air Force - 71

Project Number
1650-0403

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

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

DD FORM 82 MAR 1426 PREVIOUS EDITION IS OBSOLETE.