

MIL-P-5954A(ASG)

6 APRIL 1953

Superseding
MIL-P-5954(USAF)
26 July 1950

MILITARY SPECIFICATION

PUMP UNIT, HYDRAULIC, ELECTRIC MOTOR DRIVEN FIXED DISPLACEMENT

This specification has been approved by the Department of the Air Force and by the Navy Bureau of Aeronautics.

1. SCOPE

1.1 This specification establishes the requirements for all types of fixed displacement electric motor-driven hydraulic pumps.

2. APPLICABLE SPECIFICATIONS, STANDARDS, DRAWINGS, AND PUBLICATIONS

2.1 The following specifications, standards, drawings, and publication, of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein:

SPECIFICATIONS

Federal

QQ-P-416
QQ-Z-325

Plating, Cadmium (Electrodeposited)
Zinc Plating (Electrodeposited)

Military

MIL-D-5028

Drawings and Data Lists; Preparation of
(For Engines, Accessories and Other
Auxiliary Equipment)

MIL-F-5504
MIL-H-5440

Filters, Hydraulic, Aircraft
Hydraulic Systems; Design, Installation
and Test of Aircraft, (General
Specification for)

MIL-I-6868
MIL-L-6880

Inspection Process, Magnetic Particle
Lubrication of Aircraft; General
Specification for

MIL-M-3171

Magnesium Alloy; Processes for Corrosion
Protection of

MIL-M-7911

Marking, Identification of Aeronautical
Equipment, Assemblies, and Parts

MIL-O-5606
MIL-P-5514

Oil; Hydraulic, Aircraft, Petroleum Base
Packings; Installation and Gland Design
of Aircraft Hydraulic and Pneumatic
(General Specification for)

MIL-P-5633

Packaging and Packing of Aircraft Material
in Steel Shipping Containers

MIL-P-6871
MIL-S-7742

Plating, Chromium
Screw Threads, Standard, Aeronautical

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Air Force-Navy Aeronautical

AN-QQ-A-696	Anodic-Films; Corrosion-Protective (For) Aluminum Alloys
AN-D-17	Drawings, Tool Lists, and Sample Tools for Aeronautical and Associated Equipment
AN-M-40	Motors; Aircraft Direct Current, 24 volt System

U. S. Air Force

32590	Motors; Aircraft, Alternating Current, 400 Cycle, Induction, General Specifi- cation for
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STANDARDS

MIL-STD-10	Surface Roughness Waviness and Lay
MIL-STD-129	Marking of Shipments

DRAWINGSAir Force-Navy Aeronautical Standard Drawings

AN814	Plug and Bleeder - Screw Thread
AN995	Wire - Lock
AN6290	Gasket - Straight Thread Tube Fitting, Boss
AND10050	Bosses - Standard Dimensions for Gasket Seal Straight Thread
AND10074	Boss Spacing - Hydraulic
AND10260	Flange - Type X Accessory Mounting
AND10261	Flange - Type XI Accessory Mounting
AND10262	Flange - Type XII Accessory Mounting
AND10398	Metals - Definition of Dissimilar
AND20000	Drive - Type X Engine Accessory
AND20001	Drive - Type XI Engine Accessory
AND20002	Drive - Type XII Engine Accessory

PUBLICATIONSAir Force-Navy Aeronautical Bulletin

No. 143	Specifications and Standards; Use of
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(Copies of specifications, standards, and drawings required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Components. - The electrical motor-driven hydraulic-pump unit shall consist of a pump and an electric motor connected together with a drive and flange assembly as specified herein.

3.2 Materials. - Materials shall conform to applicable specifications and shall be as specified herein. Materials which are not covered by applicable specifications, or which are not specifically described herein, shall be of the best quality, of the lightest practicable weight, and suitable for the purpose intended.

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3.2.1 Metals.- Metals, except metal which is in constant contact with hydraulic fluid during use or storage, shall be of a corrosion-resistant type or shall be suitably protected to resist corrosion during the normal service life of the component.

3.2.1.1 Dissimilar metals.- Unless suitably protected against electrolytic corrosion, dissimilar metals shall not be used in intimate contact with each other. Dissimilar metals are defined in Drawing AND10398.

3.2.1.2 Plastic parts.- The use of plastic parts shall be subject to the approval of the Services for the specific application involved.

3.2.4 Protective treatment.- When materials are used in the construction of the pump units that are subject to corrosion in salt air or other atmospheric conditions likely to occur during service usage, they shall be protected against such corrosion in a manner that will in no way prevent compliance with the performance requirements of this specification. The use of any protective coating that will crack, chip, or scale with age or extremes of atmospheric conditions shall be avoided.

3.2.5 Selection of materials.- Specifications and standards for all materials, parts, and Government certification and approval of processes and equipment, which are not specifically designated herein and which are necessary for the execution of this specification, shall be selected in accordance with ANA Bulletin No. 143, except as provided in the following paragraph.

3.2.5.1 Standard parts.- Standard parts (MS, AN, or JAN) shall be used wherever they are suitable for the purpose, and shall be identified on the drawing by their part numbers. Commercial utility parts such as screws, bolts, nuts, cotter pins, etc, may be used, provided they possess suitable properties and are replaceable by the standard parts (MS, AN, or JAN) without alteration, and provided the corresponding standard part numbers are referenced in the parts list and, if practicable, on the contractor's drawings. In the event there is no suitable corresponding standard part in effect on date of invitation for bids, commercial parts may be used provided they conform to all requirements of this specification.

3.3 Design and construction.-

3.3.1 General.- Detail requirements including dimensions, weight, size, and location of pump ports, rated pressure, rated capacity, input voltage, and other pertinent data shall be furnished by the manufacturer along with a preproduction sample, as provided in Section 4.

3.3.2 Drive.- The drive upon which the pump is mounted to the electric motor shall conform dimensionally to either Drawing AND20000, AND20001, or AND20002 engine accessory drive.

3.3.3 Temperature range.- The component shall be designed to operate satisfactorily throughout a temperature range of -65° to at least 160°F, or more, as specified in paragraph 4.3.1 (b) (5).

3.3.4 Duty cycle.- The duty cycle shall be as specified in paragraph 4.3.1 (b) (7).

3.3.5 Direct-current motors.- All direct-current 24-volt system electric motors, shall be in accordance with Specification AN-M-40, except as modified by the following paragraphs. (Where duplication occurs between tests in this specification and those in Specification AN-M-40, the tests in this specification shall suffice.)

3.3.6 Alternating-current electric motors.- All 400-cycle alternating-current electric motors shall be in accordance with Specification 32590 except as modified by the following paragraphs. (Where duplication occurs between tests in this specification and those in Specification 32590, the tests in this specification shall suffice.)

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3.3.7 Altitude.- Barometric pressures shall range from 30 inches of mercury absolute down to 3-1/2 inches of mercury absolute (approximately an altitude of 50,000 feet).

3.3.8 Efficiency.- The over-all efficiency of the pump-motor unit shall be at least 50 percent at rated conditions of operation.

3.3.9 Hydraulic-pump mounting flange.- The hydraulic-pump mounting flange shall be in accordance with Drawing AND10260, AND10261, or AND10262 (Accessory Mounting Flange), as applicable, to mate with the corresponding electric-motor accessory drive, unless an appreciable weight saving can be shown that is satisfactory to the procuring activity.

3.3.9.1 Gasket.- A mounting flange gasket, as specified on the applicable AND drive drawing, shall be incorporated between the pump and motor.

3.3.10 Shaft seal.- The hydraulic pump shall be provided with a suitable seal for the pump shaft. The shaft seal shall be of such design as to be capable of sealing both a positive and negative pressure as specified in Section 4.

3.3.11 Drains.- Drain holes and plugs, as specified on the applicable drawings, shall be provided for external drainage of the oil leakage around the pump shaft.

3.3.12 Lubrication.- The hydraulic pump itself shall be self-lubricating with no provision 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 lubrication shall be in accordance with Specification MIL-L-6880. The lubrication shall be such that it will result in satisfactory operation when the electric motor-driven hydraulic pump is permanently mounted in any position. Renewal of the lubricant shall not be required during the life of the unit.

3.3.12.1 Fluid.- Hydraulic fluid, as referenced herein, shall conform to Specification MIL-C-5606.

3.3.13 Balance.- The moving parts of the electric motor-driven hydraulic-pump unit shall be inherently balanced, and the pump unit shall not vibrate excessively under any conditions of operation.

3.3.14 Pressure pulsation.- The electric motor-driven pump unit shall be designed to deliver continuous flow of oil without excessive pressure impulses when the pump is operated under any of the conditions specified in Section 4.

3.3.15 Cooling air.- No external blast air shall be allowed.

3.3.16 Mounting position.- The pump operation shall not be impaired by mounting in any possible position.

3.3.17 Plugs.- All plugs, except permanently installed plugs which will not have to be removed during the life of the component, shall conform to Drawing AN814 and shall be sealed with gaskets conforming to Drawing AN6290. Permanently installed plugs may be pipe-threaded or of any form suitable for the purpose, and shall be so installed as to make removal impossible during the normal life of the unit.

3.3.18 Threads.- Except for permanently installed pipe-threaded plugs, and unless otherwise specified on the applicable drawing, only straight threads conforming to Specification MIL-S-7742, National Fine Thread Series, class 3 (NF3) shall be used.

3.3.19 Bosses.- All bosses for connecting fittings shall conform to Drawing AND10050. Boss spacing shall comply with Drawing AND10074. Ports shall be permanently marked to indicate proper connections to be made.

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3.3.20 Seals.- All packings, gaskets, and installations thereof shall conform to the requirements of Specification MIL-P-5514.

3.3.21 Safetying.- All threaded parts shall be positively locked or safetyed by safety-wiring, self-locking nuts, or other approved methods. Safety wire shall have a minimum diameter of 0.032 inch and shall conform to Drawing AN995.

3.3.22 Snap rings.- Snap rings, if used, shall be used in accordance with the requirements of Specification MIL-H-5440.

3.3.23 Lubricants.- Only hydraulic fluid conforming to Specification MIL-O-5606 shall be used to lubricate seals during installation and assembly of hydraulic components.

3.4 Interchangeability.- All parts having the same manufacturer's part number shall be directly and completely interchangeable with each other with respect to installation and performance. Changes in manufacturer's part numbers shall be governed by the drawing number requirements of Specification MIL-D-5028. Subassemblies, composed of selected mating components, must be interchangeable as assembled units, and shall be so indicated on the manufacturer's drawings. The individual components of such assembled units need not be interchangeable.

3.5 Weight.- Weight shall be maintained as low as possible, consistent with the requirements of this specification. The weight of the assembled component shall be specified in the manufacturer's assembly drawings.

3.6 Finish.-

3.6.1 Surface roughness.- Surface-roughness finishes shall be established and shall be specified in the manufacturer's drawings as outlined in Standard MIL-STD-10. The determination of surface finish shall be made by profilometer, comparator, brush analyzer, or other suitable comparison equipment with an accuracy of ± 5 microinches at the level being measured.

3.6.2 Steel or copper-alloy parts.- Unless otherwise authorized, all steel or copper-alloy parts, except those in constant contact with hydraulic fluid during use or storage shall be cadmium-plated in accordance with Specification QQ-P-416, type I, class B; zinc-plated in accordance with Specification QQ-Z-325; or chrome-plated in accordance with Specification MIL-P-6871. Cadmium or zinc plating may be used in contact with hydraulic fluid provided there is no rubbing or abrasion on the surfaces to which it is applied. Surfaces in sliding contact with each other may be chrome-plated.

3.6.3 Aluminum-alloy parts.- Unless otherwise authorized, all aluminum-alloy parts, except those in constant contact with hydraulic fluid during use or storage, shall be covered with an anodic film conforming to the requirements of Specification AN-QQ-A-696.

3.6.4 Magnesium-alloy parts.- Wherever practical, magnesium-alloy parts shall be treated in accordance with Specification MIL-M-3171 to provide protection against corrosion. Magnesium shall be used only when specifically approved by the procuring activity.

3.6.5 No finishes or paints, other than those specified above, or color markings specified herein or otherwise authorized by the Services, shall be applied to the components either externally or internally prior to installation in the airplane.

3.7 Radio noise filter.- A radio noise filter, meeting the requirements of Specification AN-M-40, shall be incorporated in all direct-current units.

3.8 Magnetic inspection.- All magnetizable, highly stressed parts shall be subjected to magnetic inspection in accordance with Specification MIL-I-6868. Where necessary, such inspection shall be specified on the manufacturer's drawing. Cracks or other injurious defects disclosed by magnetic inspection shall be cause for rejection.

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3.9 Performance.- The pump unit shall satisfy the performance requirements specified in Section 4 when subjected to the tests headed as follows:

- (a) Examination of product
- (b) Break-in run
- (c) Rated-voltage run
- (d) Proof-pressure run
- (e) Capacity and shaft-seal leakage
- (f) Low-temperature starting
- (g) Shaft-seal leakage
- (h) Capacity
- (i) Endurance
- (j) Recalibration
- (k) Operation
- (l) High temperature
- (m) Low-temperature capacity

3.10 Special tools.- The design shall be such that special or unusual tools will not be required for normal maintenance and inspection of the component. Special tools and commercial standard tools are defined in Specification AN-D-17.

3.11 Identification of product.-

3.11.1 Nameplate.- A nameplate, permanently and legibly filled in with the information listed below shall be securely attached to the pump unit. The information marked in the spaces provided shall be in accordance with Specification MIL-M-7911.

PUMP UNIT, HYDRAULIC, ELECTRIC MOTOR DRIVEN, FIXED DISPLACEMENT
 Rated pressure
 Duty cycle
 Rated voltage
 Rated amperage
 Specification MIL-P-5954A(ASG)
 Stock No.
 Manufacturer's Part No.
 Manufacturer's Serial No.
 Contract or Order No.
 Manufacturer's name or trade-mark
 US Property

Decalcomanias are not considered permanent marking for this purpose.

3.12 Workmanship.- All details on workmanship shall be in accordance with high-grade aircraft electric-motor and hydraulic-pump manufacturing practice.

3.12.1 Cleaning.- All parts shall be clean and free from dirt, sand, metal chips, and other foreign matter, while being assembled and after assembly.

4. SAMPLING, INSPECTION, AND TEST PROCEDURES

4.1 Classification of tests.- The inspection and testing of hydraulic pumps shall be classified as follows:

- (a) Preproduction tests: Preproduction tests are those tests accomplished on samples which are representative of the production of the item after the award of contract, to determine that the production meets the requirements of this specification.

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- (b) Inspection tests: Inspection tests are those tests accomplished on the pump units manufactured and submitted for acceptance under contract.

4.2 Test conditions.-

4.2.1 Cleaning.- All oil or grease or other corrosion-resistant compounds shall be removed from the interior and exterior parts of the hydraulic-pump unit and external parts of the electric motor.

4.2.2 Oil.- Unless otherwise specified, all tests shall be conducted using hydraulic oil conforming to Specification MIL-O-5606.

4.2.3 Measurements and apparatus.-

4.2.3.1 Inlet pressure.- The inlet pressure shall be measured with a calibrated manometer or equally accurate pressure gage, located as close to the inlet port as practicable. Inlet pressure shall be obtained by evacuating or pressurizing the pump reservoir.

4.2.3.2 Outlet pressure.- The outlet pressure shall be measured with a calibrated pressure gage, located as close to the discharge port as practicable.

4.2.3.3 Oil flow.- The oil flow shall be measured by any method which will give results to an accuracy of 2 percent.

4.2.3.4 Motor voltage.- The input voltage shall be measured at the terminals of the motor by means of a precision laboratory-type instrument accurate to 1 percent.

4.2.3.5 Motor current.- The motor current shall be measured by a precision laboratory-type instrument accurate to 1 percent.

4.2.3.6 Electric power.- The input power to an alternating-current motor shall be measured by a precision laboratory-type instrument accurate to 2 percent.

4.2.4 Oil temperature.- Unless otherwise specified, the oil-inlet temperature shall be $66^{\circ} \pm 3^{\circ}\text{C}$ ($150^{\circ} \pm 5^{\circ}\text{F}$).

4.2.5 Filtration.- For all tests, a filter may be installed except in the Break-in run where a filter is mandatory. The filter shall be in accordance with Specification MIL-F-5504.

4.2.6 Ambient conditions.- Unless otherwise specified, the ambient pressure shall be 25 to 30 inches of mercury absolute and the ambient temperature shall be 70° to 100°F . No external forced circulation of air shall be allowed other than that which is built into the pump-motor unit.

4.3 Preproduction tests.-

4.3.1 Sampling instructions.- One motor-pump unit of each manufacturer's number shall be subjected to preproduction testing by the manufacturer. An opportunity shall be given a Government Inspector to witness such tests. The unit shall be submitted to the cognizant Service with a complete test report of testing, in duplicate. This report shall contain original data sheets or photostatic copies thereof. The following detail requirements shall also be furnished by the airframe manufacturer to the cognizant Government activity:

- (a) Application: (Brief description)

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(b) Design:

- (1) Dimensions: The over-all dimensions, the size and location of pump ports, and the type and location of electrical connectors, shall be as shown on attached figure____. (Figure to be supplied by the airframe manufacturer.)
- (2) Weight: The maximum dry weight of the complete pump-motor assembly shall not exceed____pounds.
- (3) Rated pressure: The rated delivery pressure of the pump shall be____psi gage.
- (4) Rated capacity: The pump capacity shall be at least____gallons per minute at rated input-motor voltage, rated delivery pressure, 150° ±5°F fluid-inlet temperature, and 18 inches of mercury absolute inlet pressure.
- (5) Operating temperatures: The maximum inlet oil and ambient temperature shall be____.
- (6) Input voltage: The normal input voltage when measured at the motor-input terminals shall be____.
- (7) Duty cycle: The maximum duty cycle of the unit shall be as follows:

- (8) Explosion-proof: The unit_____(shall or shall not) be explosion-proof as defined in Specification AN-M-40.
- (9) Oilproof: The unit_____(shall or shall not) be required to be oilproof as defined in Specification AN-M-40.
- (10) Thermal protection: Thermal protection, as defined in Specification AN-M-40,_____(shall or shall not) be required.
- (11) Current: The maximum continuous running current at rated voltage, rated delivery pressure, and any condition of inlet pressure or temperature specified herein shall not exceed____amperes. The maximum starting current at the above determined conditions shall not exceed____amperes.

(c) Additional detail requirements: (If applicable)

All requests for preproduction approval shall be accompanied by one complete set of detail and assembly vandykes, or other reproducible drawings, and one set of reproductions of these drawings.

4.3.1.1 In the case of two series of motor-pump units which are intended to serve the same general function, approval of one unit of the series may, at the discretion of the Services, be applied to any other unit of the series if all of the internal working parts are identical in every detail with the corresponding internal working parts of the approved unit, and provided it meets such operational requirements as may be designated by the Services. For example, approval of this type would apply to all units which differ from previously approved ones only insofar as port size, port location, external body dimensions, and external body configuration are concerned.

4.3.1.2 Approval applies only to the design, materials, construction, and nominal dimensions of the unit tested. Such features shall be identified by the manufacturer's part number submitted in his test report. Any change in any of these features may require new Preproduction tests at the option of the qualifying activity. Such changes shall be identified by the assignment of new numbers to the manufacturer's drawings of the component or its component parts and shall receive Government approval prior to incorporation in production. At the option of the Government, minor changes in these features may be approved without an attendant change in the part number. The contractor shall submit to the procuring activity a list of all parts which make up the motor-pump unit giving drawing numbers with dated revisions at the time of submittal for tests. This list shall be revised and resubmitted when any changes are incorporated.

4.3.1.3 Drawings.- The assembly drawings shall show a cutaway section showing all details in their normal assembly position and shall carry part numbers of all details and subassemblies. The following data shall be furnished on or together with all assembly drawings:

- (a) Mounting dimensions
- (b) Port dimensions
- (c) Over-all dimensions
- (d) Rated capacity
- (e) Rated pressure
- (f) Duty cycle
- (g) Rated voltage
- (h) Rated current
- (i) Weight

4.3.2 Tests.- The Preproduction tests of electric motor-driven hydraulic-pump units shall consist of all the tests specified under Inspection tests and, in addition, the following tests.

4.3.2.1 Operation.- The capacity of the pump, electric-motor input power and current shall be determined at the conditions specified below. The capacity shall be as specified in the airframe manufacturer's detail requirements, paragraph 4.3.1(b) (4). During all of those runs, the shaft-seal leakage shall be measured. The unit shall operate satisfactorily under all the conditions specified, the rate of shaft-seal leakage shall not exceed 5 milliliters per hour, and the air leakage past the seal into the pump shall be negligible. The pump-inlet temperature shall be maintained at $66^{\circ} \pm 3^{\circ}\text{C}$ ($150^{\circ} \pm 5^{\circ}\text{F}$), unless otherwise specified.

4.3.2.1.1 Sea-level operation.- Runs shall be made at 90-, 100-, and 110-percent rated voltage, at zero (or lowest possible pressure), 25-, 50-, 75-, and 100-percent rated delivery pressure and 18 inches of mercury absolute pump inlet pressure. The pump shall operate satisfactorily during these runs.

4.3.2.1.2 Pressurized-tank operation.- The oil tank shall be so pressurized that the pump inlet pressure is 26.7 psi absolute and a pressure of 3.5 inches of mercury absolute will be maintained surrounding the pump-motor unit. The unit shall then be tested at 90-, 100-, and 110-percent rated voltage at zero (or lowest possible pressure) and rated pressure. The unit shall operate satisfactorily during these runs.

4.3.2.1.3 Altitude operation.- The oil-tank pressure shall be reduced until the pump-inlet pressure is 14 inches of mercury absolute and the surrounding pressure is 3.5 inches of mercury absolute. Runs shall be made at 90-, 100-, and 110-percent rated pressure. The unit shall operate satisfactorily during these runs.

4.3.2.2 High temperature.- The pump-motor unit, in a static condition, shall be subjected to an ambient temperature of 160° to 165°F , or as specified in paragraph 4.3.1(b) (5), for a period of 30 hours. The unit shall then be operated at this same ambient and inlet-oil temperature at rated voltage, rated delivery pressure, and 18

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inches of mercury absolute inlet pressure for one-half hour for a continuous duty pump, or for an intermittent duty pump for 12 duty cycles or the accumulation of one-half hour of operation, whichever is longer. The unit shall operate satisfactorily during this run.

4.3.2.3 Low-temperature capacity.- The electric motor-driven hydraulic-pump unit shall be cooled by some suitable means to a temperature of -51° to -57°C (-60° to -70°F) and shall be allowed to soak at this temperature for at least 72 hours. The capacity of the pump, electric-motor input power and current shall be determined at 100 \pm 1 percent rated voltage, rated pressure, -50° \pm 5 $^{\circ}\text{F}$ fluid-inlet temperature, 14 inches of mercury absolute fluid inlet pressure, -60° to -70°F atmospheric temperature, and 3.0 to 3.5 inches of mercury absolute atmospheric pressure. The capacity when measured 2 minutes after starting under these conditions shall be not lower than 70 percent of the rated capacity.

4.4 Inspection tests.- Inspection tests of the motor-pump units shall consist of individual tests, subject to the test conditions specified herein, and Sample Tests.

4.4.1 Individual tests.-

4.4.1.2 Examination of product.- Each unit shall be examined to determine conformance with the applicable drawings and all requirements of this specification in which there are no specific tests.

4.4.1.3 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 1 hour continuous run at 110-percent rated voltage for a continuous duty unit. For an intermittent duty unit, the break-in run shall consist of 12 duty cycles, or the accumulation of 1 hour of operation, whichever is longer. The pump and motor may be broken in separately.

4.4.1.4 Rated-voltage run.- Each unit shall be operated at rated voltage \pm 2 percent and 100 \pm 3 percent rated pressure as follows:

One-half hour, or the equivalent number of duty cycles, at 25 to 26.7 psi absolute inlet pressure.

One hour, or the equivalent number of duty cycles, at 18 to 16 inches of mercury absolute inlet pressure.

During the first one-half hour, the rate of leakage of oil out of the pump through the drive shaft seal shall be determined. During the last hour, the pump-outlet sight glass shall be observed to determine air leakage. The rate of shaft-seal oil leakage shall not exceed 5 milliliters per hour, and the air leakage into the pump shall be negligible.

4.4.1.5 Proof-pressure run.- The unit shall be operated for 1 minute at rated voltage \pm 2 percent, 18 to 30 inches of mercury absolute inlet pressure, 125-percent rated outlet pressure, and 52° \pm 14 $^{\circ}\text{C}$ (125° \pm 25 $^{\circ}\text{F}$) oil-inlet temperature. There shall be no oil leakage through the pump housing or cover, or at the gaskets or ports. The rate of drive shaft-seal leakage shall not exceed 1/8 milliliter of oil per minute. If desired, the 125-percent rated outlet pressure may be obtained with an external source of pressure and the pump in a static condition.

4.4.1.6 Capacity and shaft-seal leakage.- The capacity and shaft-seal leakage shall be determined at rated voltage \pm 2 percent, rated outlet pressure, 18 inches of mercury absolute inlet pressure. The rate of shaft-seal leakage shall not exceed 5 milliliters per hour.

4.4.1.6.1 Leakage under pressure.- The shaft-seal leakage shall not exceed 5 milliliters per hour when the above test is repeated with inlet pressure of 26.7 psi absolute.

4.4.1.6.2 Static leakage.- With the unit in a static condition, with an inlet pressure of 26.7 psi absolute maintained, and with the oil inlet temperature at 150° ±5°F at the start of the test, the drive shaft-seal leakage shall be observed for one-half hour and shall not exceed 5 drops per hour.

4.4.2 Sampling tests.- One unit from the first 50, an additional one from the next 450, and also one from every 5,000 or fraction thereof on the order after the first 500 units shall be selected at random and subjected to the Sampling tests. These tests shall be in addition to the Individual tests specified herein.

4.4.2.1 Low-temperature starting.- The electrical motor-driven hydraulic pump and fluid shall be cooled by some suitable means to a temperature of -51° to -57°C (-60° to -70°F). Immediately after a minimum time of 72 hours at this temperature, the unit shall be started (by applying 90-percent rated voltage ±2 percent across the terminals) and allowed to come to maximum speed 50 times. These starts shall be made with as low an inlet and outlet restriction as practicable. In addition 25 starts shall be made at 125-percent rated pressure (+300 -0 psi), pressure to be maintained by any suitable pressure-regulating valve. The capacity of the refrigerating equipment and the length of time between starts shall be such that the pump-body temperature and oil-reservoir temperatures shall be from -51° to -57°C (-60° to -70°F) at each of the 75 starts.

4.4.2.2 Shaft-seal leakage.- The shaft-seal leakage shall not exceed 5 milliliters per hour when the unit is operated under the conditions specified in the following paragraphs:

- 4.4.2.3 Capacity
- 4.4.2.4 Endurance
- 4.4.2.4.4 Recalibration

4.4.2.3 Capacity.- The capacity of the unit shall be measured at 66° ±3°C (150° ±5°F) oil-inlet temperature after at least 1 minute of operation under each of the following conditions:

TABLE I

Capacity test conditions

Pump voltage percent of rated	Pump-inlet pressure inches of mercury absolute	Pump delivery pressure in pounds per square inch +200, -0
90	18	100 percent rated
100	18	100 percent rated
110	18	100 percent rated

4.4.2.4 Endurance.- The unit shall satisfactorily complete 500 hours of operation as shown in table II with no failure of parts or excessive wear. The air velocity immediately surrounding the unit shall not exceed 2 feet per second. This velocity shall be determined with the motor in a static condition (not operating).

4.4.2.4.1 Delivery pressure.- For continuous duty units, the delivery pressure shall be cycled for 3 minutes at 100-percent rated pressure followed by 12 minutes at 25-percent rated pressure. The change in pressures shall occur in less than 1 second. For intermittent duty pumps, the pressure shall be cycled as defined by the duty cycle of the unit as specified in the requirements of the airframe manufacturer. (See (6) under paragraph 4.3.1.)

4.4.2.4.2 Starting.- During the Endurance test, continuous duty motors shall be stopped and started against 100-percent rated delivery pressure at least twice every 24 hours. The peak starting current shall be recorded at the start and finish of the Endurance test.

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TABLE II
Endurance test conditions

No. of hours 1/ operation	No. of cycles 2/ operation	Motor terminal voltage, percent of rated voltage ± 2 percent	Fluid inlet temperature		Pump-inlet pressure	Atmospheric temperature		Atmospheric pressure in. Hg abs	Normal altitude
			Deg F	Deg C		Deg F	Deg C		
125	1,500	90	165 ± 5	74 ± 3	12 psi gage	70 to 100	21 to 38	25-30	sea-level
150	1,800	100	165 ± 5	74 ± 3	14 in. hg abs	70 to 100	21 to 38	25-30	
125	1,500	110	165 ± 5	74 ± 3	12 psi gage	70 to 100	21 to 38	25-30	
25	300	90	-50 ± 5	45.5 ± 3	14 in. hg abs	-60 to -70	-51 to -57	3.0-3.5	50,000 ft
50	600	100	-50 ± 5	-45.5 ± 3	12 psi gage	-60 to -70	-51 to -57	3.0-3.5	
25	300	110	-50 ± 5	-45.5 ± 3	14 in. hg abs	-60 to -70	-51 to -57	3.0-3.5	

1/ For continuous duty units, use number of hours.

2/ For intermittent duty units, use number of cycles in column two, or number of hours elapsed time in column one, whichever is longer.

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4.4.2.4.3 Measurements shall be taken before and after the Endurance test and a wear analysis shall be made showing the wear on each rubbing part. If, during the endurance testing, a major part fails, the test shall be terminated. The replacement hydraulic unit shall have a redesigned part or one of different material corresponding to the failed part, except that if the failure was caused by faulty material or workmanship, the testing activity may authorize the installation of a part of the original design and material with the defect overcome. The Endurance test shall be considered complete when every major part has concurrently completed the Endurance test. Minor parts may be replaced and penalty runs conducted at the option of the testing activity.

4.4.2.4.4 Recalibration.- Following the Endurance test, the capacity and shaft-seal leakage shall be determined in accordance with paragraph 4.4.1.6, Capacity and shaft-seal leakage. The rate of shaft-seal leakage shall not exceed 5 milliliters per hour, and the unit capacity shall not have decreased more than 15 percent from the capacity prior to the Endurance test at the condition defined.

4.4.3 Rejection and retest.- When tests are specified on a quantity of hydraulic-pump units that are selected as representative of a certain lot, and one or more of this number fails to meet the requirements, additional units of the lot represented shall be tested immediately to determine the cause of failure. Individual performance tests shall not be interrupted, unless the defect is of such a nature that it will seriously affect the performance or safe use of the unit. Rejected units shall not be resubmitted for inspection without furnishing full particulars concerning previous rejection and measures taken to overcome the defects.

4.5 All parts, specimens, or assemblies destroyed in making tests required by this specification or drawings, to determine compliance with the specification or drawings, shall be in addition to the quantity specified in the contract or purchase order and shall be furnished without increasing the cost of the contract or order.

5. PREPARATION FOR DELIVERY

5.1 Application.- The requirements specified herein apply only to direct purchases by or direct shipments to the Government.

5.2 Packaging and packing.- Each unit shall be packaged and packed for shipment in accordance with Specification MIL-P-5633.

5.3 Marking of shipments.- Interior packages and exterior shipping containers shall be marked in accordance with Standard MIL-STD-129. The nomenclature shall be as follows: Pump Unit, Hydraulic, Electric Motor Driven, Fixed Displacement, (*Rated Pressure), (*Volts, Cycles, Phase, AC "or" Volts DC of Motor), Specification MIL-P-5954A(ASG), *Mfrs. Part No.

*Applicable data to be entered by the contractor.

5.3.1 In addition, the following marking shall be required.

IF IN STORAGE AFTER (date)** THE PUMP SHALL BE TESTED
AND INSPECTED BEFORE ISSUE.

**NOTE: This date shall be 18 months from date of inspection.

6. NOTES

6.1 Intended use.- The hydraulic-pump units covered by this specification are intended for use on aircraft for hydraulic operation of such mechanisms as landing gears, brakes, flaps, gun turrets, servo units, and bomb-bay doors.

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6.2 Drawing requirements.- The attention of contractors is invited to the fact that Government contracts for equipment, whether procured directly by the Government or through another contractor, require that all drawings submitted, must be in accordance with the requirements of Specification MIL-D-5028.

6.3 Ordering data.- Invitations for bids, contracts, and purchase orders should state the conditions for the following.

6.3.1 Preproduction tests.- It is expected that the contract or purchase order will specify that one fixed displacement electric motor-driven hydraulic-pump unit will be required as a preproduction sample and that this preproduction sample will be subjected to the Preproduction tests to determine compliance with the requirements of the specification. The invitation for bids and the contract should specify the point of inspection for these tests.

NOTICE: When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

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SPECIFICATION ANALYSIS SHEET		Form Approved Budget Bureau No. 119-R004	
INSTRUCTIONS			
This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity (as indicated on reverse hereof).			
SPECIFICATION			
ORGANIZATION (of submitter)		CITY AND STATE	
CONTRACT NO.	QUANTITY OF ITEMS PROCURED	DOLLAR AMOUNT \$	
MATERIAL PROCURED UNDER A			
<input type="checkbox"/> DIRECT GOVERNMENT CONTRACT <input type="checkbox"/> SUBCONTRACT			
1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?			
A. GIVE PARAGRAPH NUMBER AND WORDING.			
B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES.			
2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID			
3. IS THE SPECIFICATION RESTRICTIVE?			
<input type="checkbox"/> YES <input type="checkbox"/> NO IF "YES", IN WHAT WAY?			
4. REMARKS (Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)			
SUBMITTED BY (Printed or typed name and activity)			DATE