



AEROSPACE STANDARD

AS5994**REV. A**Issued 2000-11
Stabilized 2013-10

Superseding AS5994

Pump Units, Hydraulic, Electric Motor Driven, Variable Delivery

RATIONALE

The power sources committee voted during the May 2013 meeting to stabilize this document since AS595 and AS19692 contained the required information on commercial and military pumps. For electric motors, SAE specifications have not been kept up to date and all the motor specifications referenced in this spec are out of date with no replacements. It was determined that information used in this specification is stable and therefore stabilization of the document was recommended.

STABILIZED NOTICE

This document has been declared "Stabilized" by the SAE A-6C6 Power Sources Committee and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

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NOTICE

This document has been taken directly from U.S. Military Specification MIL-P-5994D, Notice 1 and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards. The initial release of this document is intended to replace MIL-P-5994D, Notice 1. Any part numbers established by the original specification remain unchanged.

The original Military Specification was adopted as an SAE standard under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of government specifications and standards. TSB rules provide for (a) the publication of portions of unrevised government specifications and standards without consensus voting at the SAE Committee level, and (b) the use of the existing government specification or standard format.

Under Department of Defense policies and procedures, any qualification requirements and associated qualified products lists are mandatory for DOD contracts. Any requirement relating to qualified products lists (QPL's) has not been adopted by SAE and is not part of this SAE technical document.

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.

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.

2.1.1 (Continued):

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 3591 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.

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.

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

- 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 subjected 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.