

AIRCRAFT CONSTANT DISPLACEMENT HYDRAULIC MOTOR

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1. SCOPE:

- 1.1 Scope - This specification establishes the common requirements for constant displacement hydraulic motors, suitable for use in aircraft and missiles, and the methods to be used for demonstrating compliance with these requirements.
- 1.2 Model Specification - A motor model specification shall be prepared for each distinct motor model by either the contractor who intends to purchase and install that model, or the motor manufacturer, and submitted to the purchaser for approval. The model specification should conform to Appendix I of this specification.

2. APPLICABLE SPECIFICATIONS, OTHER PUBLICATIONS, AND DRAWINGS:

- 2.1 The following documents shall form a part of this specification to the extent specified herein. The applicable issue of each shall be that in effect on the date of this Aeronautical Standard unless otherwise specified in the Model Specification. Supplementary specifications, standards, etc., which by reference in any of the following publications are indicated to be part thereof, shall not be considered as effective except as specifically stated in the Model Specification, or as may be otherwise mutually agreed upon between the vendor and purchaser.

2.1.1 Specifications:

Federal

QQ-N-290
QQ-P-416
QQ-S-365
QQ-Z-325

Nickel Plating
Plating, Cadmium (Electrodeposited)
Silver Plating (Electrodeposited)
Zinc Plating (Electrodeposited)

Military

MIL-A-8625
MIL-C-5501
MIL-C-5541
MIL-C-6021
MIL-C-26074
MIL-D-5028

Anodic-Films; Corrosion-Protective
(For) Aluminum Alloys
Closure, Aircraft, Tubing Protective
Chemical Films for Aluminum and
Aluminum Alloys
Casting, Classification and Inspection of
Coating - Nickel - Phosphorous,
Electroless Nickel, Requirements for
Drawings and Data Lists; Preparation of
(For Engines, Accessories, and other
Auxiliary Equipment)

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Documents

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MIL-D-8513	Drawings and Data Lists; Preparation of (For Special Support Equipment)
MIL-E-5272	Environmental Testing, Aeronautical and Associated Equipment (General Specification)
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft and Ordnance
MIL-M-3171	Magnesium Alloy, Processes for Corrosion, Protection of
MIL-M-7911	Marking, Identification of Aeronautical Equipment, Assemblies and Parts
MIL-O-6083	Hydraulic Fluid, Petroleum Base, Preservative
MIL-P-6064	Packaging of Lightweight Aircraft Accessories
MIL-P-6871	Plating, Chromium
MIL-P-6906	Plates; Information and Identification
MIL-S-7742	Screw-Threads, Standard, Aeronautical
MIL-T-10727	(Ord) Tin Plating

2.1.2 Standards:Military

MIL-STD-10	Surface Roughness, Waviness and Lay
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Marking of U.S. Military Property
MS-20995	Wire, Lock
MS-33514	Fitting End - Standard Dimensions for Flareless Tube Connection and Gasket Seal
MS-33515	Fitting End - Standard Dimensions for Bulkhead Flareless Tube Connections
MS-33540	Safety Wiring, General Practices for
MS-33656	Fitting End - Standard Dimensions for Flared Tube Connections and Gasket Seal
MS-33657	Fitting End - Standard Dimensions for Bulkhead Flared Tube Connections
ARP-243	Nomenclature, Aircraft Hydraulic and Pneumatic Systems
ARP-575	Filter Patch Testing



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2.1.3 Drawings:Air Force - Navy Aeronautical Standard Drawings

AN814	Plug and Bleeder - Screw Thread
AND10050	Bosses - Standard Dimensions for Gasket Seal Straight Thread
AND10064	Fittings - Installation of Flared Tube, Straight Threaded Connectors
AND10074	Boss Spacing - Hydraulic
AND10260	Flange Type X Accessory Mounting
AND10261	Flange Type XI Accessory Mounting
AND10262	Flange Type XII Accessory Mounting

3. REQUIREMENTS:3.1 Performance Requirements:3.1.1 Functional Requirements:

3.1.1.1 Hydraulic Fluid - The specific hydraulic fluid used to drive the motor shall be fully defined in the Model Specification.

3.1.1.2 Rated Torque - The rated torque is defined as the minimum torque that the motor shall produce continuously while operating with the specified fluid at rated temperature, specified operating differential pressure, and rated speed. Rated torque shall be expressed in pound inches (lb. in.) and shall be specified in the Model Specification.

3.1.1.3 Rated Inlet Pressure - The rated inlet pressure shall be defined as the maximum hydraulic system pressure for which the motor is designed to operate continuously at rated temperature and rated speed. It shall be expressed as pounds per square inch gage (psig).

3.1.1.3.1 The rated inlet pressure shall be either 1500, 3000, 4000, or 5000 psig and shall be specified in the Model Specification.

3.1.1.4 Rated Differential Pressure - The rated differential pressure shall be defined as the measured differential pressure between the inlet and outlet connections to the motor. This differential pressure represents the force available to the hydraulic motor for conversion into torque.

For design purposes the maximum anticipated pressure at the outlet connection shall be stated in the Model Specification. Rated differential pressure shall be expressed in terms of pounds per square inch (psi) and shall be specified in the Model Specification.

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3.1.1.5 Rated Speed - The rated speed of a motor shall be the maximum speed at which the motor is designed to operate continuously at rated temperature and rated differential pressure. The rated speed shall be measured and stated as RPM of the motor output shaft and shall be specified in the Model Specification.

3.1.1.6 Rated Temperature - The rated temperature of a motor is defined as the maximum continuous fluid temperature at the inlet port of the motor. It is expressed in degrees fahrenheit (°F).

3.1.1.6.1 The rated temperature shall be specified in the Model Specification and shall be one of the values listed in Table I.

TABLE I

<u>Hydraulic System</u>	<u>Rated Temperature of Motor And Maximum System Temperature</u>
Type I	160° F
Type II	275° F
Type III	450° F

3.1.1.6.2 The minimum continuous fluid temperature at the motor inlet port is not related to the rated temperature by this specification. A minimum continuous fluid temperature may be specified in the Model Specification.

3.1.1.7 Maximum Displacement - The maximum displacement of a motor is defined as the maximum theoretical volume of hydraulic fluid consumed in one revolution of its drive shaft neglecting leakage, fluid compressibility and part deflections. It shall be expressed as cubic inches per revolution (cu. ins./rev.).

3.1.1.7.1 The maximum displacement of any motor model shall be determined by calculation from the geometry and dimensions of the motor. The dimensions of the cylinder bore and stroke shall be taken at their normal values as stated on the pertinent drawings. The effects of allowable manufacturing tolerances, of deflections of the motor structure, of compressibility of the hydraulic fluid, of internal leakage, and of temperature shall be excluded from the calculation, because the maximum displacement is intended to be an index of the size of the motor rather than of its performance.

3.1.1.8 Consumption - The consumption of a motor is defined as the measured fluid flow input of the motor under the conditions of rated temperature, rated speed and rated differential pressure and type of fluid specified in the Model Specification. It shall be expressed in U.S. gallons per minute (gpm), and shall not exceed the value specified in the Model Specification.

3.1.1.9 Efficiency - The efficiency of a motor is defined as the ratio of output power to input power when the motor is operated at rated temperature, rated speed and rated inlet and differential pressures while using the specified hydraulic fluid. In the determination of input power by calculation from flow rate and pressure differential; the net pressure difference between inlet and outlet ports of the motor shall be used, the flow rate shall be determined by measuring the combined drained flows and discharge.

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- 3.1.1.9.1 The efficiency as outlined above is the overall motor efficiency and as such includes volumetric efficiency. Volumetric efficiency will not be called out separately in this specification. Efficiency shall be stated as a percentage and its minimum value shall be specified in the Model Specification.
- 3.1.1.10 Case Pressure - Case pressure shall be defined as the fluid pressure present on the interior of the motor housing in the area of the motor where internal leakage occurs.
- 3.1.1.10.1 Unless otherwise specified in the Model Specification, all motors shall be designed to operate continuously with a maximum pressure of 500 psi at the case drain port.
- 3.1.1.11 Balance - The moving parts of the hydraulic motor shall be balanced, and the motor shall not vibrate under conditions of operation at all speeds up to and including the maximum speed specified in the Model Specification.
- 3.1.1.12 Moment of Inertia - The moment of inertia of the rotating portion of the hydraulic motor shall be defined as the sum of the products of the mass of each elementary particle multiplied by the square of the distance of that particle from the axis of rotation. It shall be designated in pound inches squared (lb. in.²) and may be specified in the Model Specification when pertinent.
- 3.1.1.13 Torque Pulsations - The motor shall be designed to deliver continuous torque without excessive torque pulsation impulses when the motor is operated under any of the conditions specified in Section 4 of this specification. The maximum allowable variation in torque shall be as specified in the Model Specification.
- 3.1.1.14 Overspeed - The motor shall not be damaged when driven by its output load at intermittent speeds up to 150% of rated rpm. This condition can occur if the motor cavitates during dynamic braking.
- 3.1.1.14.1 If controls are required to prevent overspeed of the motor, this requirement shall be specified in the Model Specification.
- 3.1.1.15 Dynamic Braking - Hydraulic Motors shall be capable of withstanding up to 100% of rated pressure at the outlet port while full rated pressure is applied to the inlet port during deceleration of an inertia load from rated speed to zero rpm. This capacity is required for either direction of rotation.
- 3.1.1.16 Life - The life of hydraulic motors may be stated in the following ways:
- 3.1.1.16.1 Calendar Life - The minimum total calendar time during which no maintenance is required.
- 3.1.1.16.2 Storage Life - Time of storage condition (Conditions of environment should be specified) may be given as a percentage of calendar life.
- 3.1.1.16.3 Standby Life - Life of the unit installed in a system which is ready for operation but not operating.

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- 3.1.1.16.4 Service Life - The accumulation of operating time under service conditions, without overhaul.
- 3.1.1.16.5 The service life shall be specified in the Model Specification, and whenever applicable, any or all of the above other lives shall also be specified.
- 3.1.1.17 Rated Endurance - The rated endurance of a motor is defined as the total number of hours of operation to be included in the endurance phase of its pre-production test.
- 3.1.1.17.1 The value of the rated endurance shall be specified in the Model Specification and shall not be less than 750 hours for models having rated temperatures up to 275°F and not less than 100 hours for models having rated temperatures higher than 275°F.
- 3.1.2 Environmental Requirements: The environmental requirements for the motor shall define the environments of temperature, ambient pressure, vibration, acceleration, acoustic noise, shock and atmospheric conditions, and other environmental conditions that might be required, and shall be specified in the Model Specification. These requirements may be specified for conditions of service, test, transit and storage. In general, motors shall be designed to operate without impairment of function or change in adjustment under environmental conditions as specified below. Except as specifically directed herein, testing to demonstrate compliance with these requirements shall not be mandatory.
- 3.1.2.1 Altitude - Attitude - Motor performance shall be unaffected by change in altitude, or attitude.
- 3.1.2.2 Temperature - For the purposes of design, and of this specification, it shall be assumed that the ambient temperature surrounding the motor shall be such that no heat is transferred to or from the motor except by normal circulation of the working fluid. The ambient temperature shall be defined as the maximum temperature in degrees fahrenheit (°F) existing in an area adjacent to the motor. When it is considered to be a pertinent parameter, ambient temperature may be specified in the Model Specification.
- 3.1.2.3 Vibration - It shall be a design objective that the motors shall be capable of withstanding all normal vibrations excited by the driven device and linear vibrations in a spectrum as defined in Figure 1, MIL-E-5272. Other specific vibration requirements may be outlined in the Model Specification.
- 3.1.2.4 Accelerations - All motors shall be designed to withstand sustained accelerations of 10 g applied in any direction.
- 3.1.2.5 Atmospheric Conditions - All motors shall be designed to withstand continuous exposure, in the configuration as installed and either operating or non-operating, to salt spray as encountered in marine or coastal areas and to sand and dust as encountered in desert areas.
- 3.1.2.6 Thermal Shock - The motor design shall be such that the motor will withstand a thermal shock of 200°F differential temperature when imposed by operating fluid at rated speed conditions.

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- 3.1.3 Reliability Requirements - The reliability requirement consistent with the state-of-the-art at the time the Model Specification is written shall be specified in the Model Specification.
- 3.2 Design and Construction:
- 3.2.1 Installation Requirements:
- 3.2.1.1 Dimensions - Dimensions pertinent to the installation of motors in aircraft shall be shown on the manufacturer's installation drawing.
- 3.2.1.2 Weight - The dry weight of the completely assembled motor shall not exceed the value specified in the Model Specification. The internal volume of the case fluid of the motor shall be specified.
- 3.2.1.3 Direction of Rotation - Unless otherwise specified, the direction of rotation and the location of the inlet and outlet ports shall be clearly and permanently marked (Ref. ARP-243) on an exposed surface of the motor housing. Motors for reversible operation shall be marked as specified on the Installation Drawing.
- 3.2.1.3.1 The direction of rotation shall be as specified in the Model Specification.
- 3.2.1.4 Shaft Seal - The hydraulic motor shall be provided with a suitable seal for the motor shaft which will prevent fluid flow in either direction as specified in the Model Specification.
- 3.2.1.5 Mounting - All motors shall incorporate a standard mounting flange, which shall be in accordance with either AND10260, AND10261, or AND10262 as specified in the Model Specification. Motor operation shall not be impaired by mounting the motor in any possible position.
- 3.2.1.5.1 The oil holes and oil flow, specified on drawings AND10260, AND10261, and AND10262, shall not be applicable.
- 3.2.1.6 Drains - The motor body shall be provided with case drain and seepage drain connections and plugs as specified on the applicable Installation Drawing. The case drain port shall be identified on each motor by clear and permanent markings (Ref. ARP-243). By agreement between the motor manufacturer and the purchaser, only certain of the shaft seal drain bosses shall be tapped for external connection. In such cases, the boss or bosses to be so tapped shall be specifically designated on the Installation Drawing of the motor which accompanies the Model Specification.
- 3.2.1.7 Ports - Port sizes and port configuration shall be as specified in the Model Specification.

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3.2.1.7.1 The structural design of the ports and of the affected sections of the motor housing shall be such as to withstand the application of a torque 2.5 times the maximum value for steel tubing specified by AND10064, resulting from the attachment or removal of fittings on hoses when installing or removing motors during field maintenance, without permanent distortion or impairment of function.

3.2.1.8 Motor Drive - The motor shall have an output drive which conforms to the applicable drawing as specified in the Model Specification. The drive shall be made from appropriate materials to resist fatigue from vibration and reverse stresses set up by torsional vibration of the driven shaft.

3.2.2 Detail Requirements:

3.2.2.1 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 motor manufacturer's material specifications may be used provided the specifications are acceptable to the purchaser and contain provision for adequate tests. The use of the motor manufacturer's specifications will not constitute waiver of other applicable specifications.

3.2.2.1.1 Selection of Materials - Specifications and standards for all materials and parts, which are necessary for the execution of this specification, shall be selected as provided in the following paragraphs.

3.2.2.1.2 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 Paragraph 3.2.2.1.3.

3.2.2.1.2.1 Type I System Motors - Except for internal surfaces in constant contact with hydraulic fluid, ferrous alloys shall have a chromium content of not less than twelve (12) percent or shall be suitably protected against corrosion as specified under Paragraph 3.2.2.1.3. O-ring grooves for external seals shall not be considered as internal surfaces in constant contact with hydraulic fluid.

3.2.2.1.2.2 Type II and Type III System Motors - Cadmium and zinc platings shall not be used for internal parts or on internal surfaces in contact with hydraulic fluid or exposed to its vapors. Where performance or reliability of the motor will be jeopardized by the use of materials and processes as defined in Paragraphs 3.2.2.1.2 and 3.2.2.1.3, alternate materials and/or processes may be used subject to the approval of the purchaser. Such materials and/or processes shall be selected so as to provide the maximum degree of corrosion resistance consistent with the performance requirements.

3.2.2.1.2.3 Magnesium Alloys - The use of magnesium and its alloys shall be subject to the prior approval of the purchaser.