



AEROSPACE STANDARD

Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AS 714 A

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AIRCRAFT HYDRAULIC START MOTOR

1. SCOPE

This Aerospace Standard (AS) establishes the requirements for hydraulic start motors suitable for use in starting a gas turbine engine, and the methods to be used for demonstrating compliance with these requirements.

- 1.1 Model Specification: A model specification shall be prepared for each starter model utilizing this AS as a guide and supplying specific requirements where appropriate.

2. APPLICABLE DOCUMENTS

The following documents shall form a part of this AS to the extent specified herein. The applicable issue of each shall be that in effect on the date of this AS unless otherwise specified in the manufacturer's model specification. Supplementary specifications, standards, or the like, 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 manufacturer's model specification or as may be otherwise mutually agreed upon between the vendor and the purchaser.

- 2.1 Government Documents: Available from Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.1.1 Federal Specifications:

QQ-N-290 Nickel Plating
QQ-C-320 Chromium Plating (Electrodeposited)

2.1.2 Military Specifications:

MIL-M-3171	Magnesium Alloy, Processes for Corrosion Protection of
MIL-S-5002	Surface Treatments and Inorganic Coatings for Metal Surfaces of Weapons Systems
MIL-B-5087	Bonding, Electrical, and Lighting Protection, for Aerospace Systems
MIL-C-5541	Chemical Films for Aluminum and Aluminum Alloys
MIL-C-6021	Casting, Classification and Inspection of
MIL-W-6858	Welding, Resistance, Aluminum, Magnesium, Non-hardening Steels, or Alloys, Nickel Alloys, Heat-resisting Alloys, and Titanium Alloys, Spot and Seam
MIL-W-6873	Welding, Flash, Carbon and Alloy Steel
MIL-B-7883	Brazing of Steels, Copper, Copper Alloys, Nickel Alloys, Aluminum and Aluminum Alloys
MIL-M-7997	Motor, Aircraft Hydraulic, Constant Displacement General Specification for
MIL-I-8500	Interchangeability and Replaceability of Component Parts for Aircraft and Missile
MIL-W-8604	Welding of Aluminum Alloys, Process for
MIL-W-8611	Welding, Metal Arc and Gas, Steels and Corrosion and Heat Resistant Alloys, Process for
MIL-A-8625	Anodic Films; Corrosion -protective for Aluminum Alloys

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2.1.2 (Cont'd.)

MIL-F-8815	Filter and Filter Elements, Fluid Pressure, Hydraulic Line, 15 Micron Absolute, Type II Systems
MIL-S-8879	Screw Threads, Controlled Radius Root with Increased Minor Diameter, General Specification for
MIL-T-10727	Tin Plating

2.1.3 Military Standards:

MIL-STD-130	Identification Marking of U.S. Military Property
MIL-STD-143	Standards and Specifications, Order of Precedence for the Selection of
MIL-STD-453	Inspection, Radiographic
MIL-STD 794	Part and Equipment, Procedures for Packing and Packaging of
MIL-STD-810	Environmental Test Methods
MIL-STD-889	Metals, Dissimilar
MIL-STD-1523	Age Control of Age-sensitive Elastomeric Material
MIL-STD 1595	Aerospace Welder Performance Qualification Safety Wiring and Cotter Pinning, General Practice for
MS3336(AS)	Accessory Drives, Aircraft Engine, Reference Chart for
MS33649	Bosses, Fluid Connection - Internal Straight Thread

2.1.4 Military Handbooks:

AFSC DH 1-3	Design for Maintainability
AFSC DH 1-6	System Safety

2.2 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

ARP 243	Nomenclature, Aircraft Hydraulic and Pneumatic Systems
AIR 1160	Aircraft Engine and Accessory Drives and Flange Standards

3. REQUIREMENTS**3.1 Item Definition:** This section describes the general requirements for hydraulic starters, either fixed or variable displacement, suitable for operation in hydraulic systems.**3.1.1 Interface Definitions:****3.1.1.1 Hydraulic Fluid:** The starters shall meet the functional requirements using the hydraulic fluid defined in the model specification. Contamination level shall be based upon continuous filtration of the inlet fluid through a 15 micron absolute filter conforming to MIL-F-8815.**3.1.1.2 Rated Inlet Pressure:** The rated inlet pressure is defined as the maximum pressure required at the starter inlet port when operating at rated torque, rated outlet pressure and rated temperature. The rated inlet pressure shall be stated in the model specification.**3.1.1.3 Rated Outlet Pressure:** The rated outlet pressure is defined as the pressure at the starter outlet port against which the starter is designed to produce rated torque at rated inlet pressure and rated temperature. The rated outlet pressure shall be stated in the model specification.**3.1.1.4 Rated Temperature:** The rated temperature is defined as the maximum fluid temperature at the starter inlet port when operating at rated torque and rated pressures. The rated temperature shall be stated in the model specification.**3.1.1.5 Mounting Pad:** The mounting pad criteria shall be specified in the model specification.

3.1.1.6 Starter Drive: The starter shall incorporate a spline-shaft type connection as defined in the model specification. The hydraulic motor drive shall be in accordance with AIR 1160 or MS 3336 (AS).

3.2 Characteristics:

3.2.1 Performance Characteristics:

3.2.1.1 Hydraulic Pressure:

3.2.1.1.1 Operating Pressure: The component shall operate as specified throughout the temperature and the operating pressure range, and shall operate after exposure to peak pressure of 135% of the normal operating pressure or as specified in the model specification.

3.2.1.1.2 Non-Operating Proof and Burst Pressure: The compartment shall be designed for inlet proof and burst pressures of 150 and 250% of operating pressure within the fluid temperature range specified and within the applicable ambient temperature range. Outlet and case proof and burst pressures shall be stated in the model specification.

3.2.1.1.3 Leakage: There shall be no external leakage through static seals and structure throughout the operating pressure range or while subjected to proof pressure within the fluid temperature ranges specified herein. A slight wetting, insufficient to form a drop, shall not be considered leakage. Leakage from the drive shaft seal, under specified operating conditions, shall not exceed the values specified in 4.5.7.4.

3.2.1.2 Torque:

3.2.1.2.1 Rated Torque: The rated torque is defined as the minimum torque at the starter output shaft when operating at rated pressures, rated temperature, and rated speed. The rated torque shall be stated in the model specification together with the maximum continuous torque, the maximum peak transient torque and the minimum torque at minimum cut-off speed. A rated torque versus speed characteristic curve shall be included as per Fig. 1.

3.2.1.3 Flow:

3.2.1.3.1 Rated Flow: The rated flow is defined as the maximum fluid flow needed to meet the torque requirements at any starter output shaft speed from zero RPM to cutout speed. The rated flow shall be stated in the model specification together with the maximum flow during no-load operation.

3.2.1.4 Speed:

Rated Speed: The rated speed is defined as the maximum starter output shaft speed at which rated torque is produced and is usually related to engine light-off speed. The rated speed shall be stated in the model specification.

Cut-out Speed: The cut-out speed is defined as the starter output shaft speed at which the cut-out device will signal the termination of starter operation, for example, opening a normally closed electrical circuit. The minimum and maximum cut-out speeds shall be stated in the model specification.

Over-running Speed: The starter shall be capable of continuous over-running operation at the maximum over-running speed stated in the model specification.

3.2.1.5 Contamination: The starter shall meet the performance requirements herein when operated with hydraulic fluid filtered prior to use through a 15 micron absolute filter conforming to the requirement of MIL-F-8815.

3.2.1.6 Positioning: The starter operation shall be unaffected by the position in which the starter is mounted.

3.2.2 Physical Characteristics:

3.2.2.1 Polar Moment of Inertia: The effective mass polar moment of inertia of the starter rotating parts at the starter output shaft, shall be specified in the model specification.

3.2.2.2 Dimensions: The starter envelope shall be within the dimensions shown on the outline drawing of the model specification and the location of fluid ports and electrical connectors shall be as shown. The location of the center of gravity of the starter shall be indicated on the drawing.

3.2.2.3 Weight: The dry weight of the starter shall not exceed the value stated in the model specification.

3.2.2.4 Overhung Moment: The maximum overhung moment of the complete starter with fluid shall be specified in the model specification.

3.2.2.5 Drive Couplings: The starter shall incorporate a drive coupling with a shear section or torque limiting device sized so that the maximum static torque transmitted will not exceed the value stated in the model specification. The drive coupling shall be held in place by a positive retainer and shall be replaceable without disassembly of the starter.

3.2.2.6 Ports: Inlet and outlet ports shall conform to MS 33649. Seal drain ports shall conform to MS 33649-04. All ports shall be sized and located as shown on the manufacturer's installation drawing. The starter design shall eliminate the necessity for a case drain port. Allowable loads on the ports from attached lines shall be specified in the model specification.

3.2.2.7 Continuous Motoring: The starter shall be capable of continuous motoring operation for a minimum of 5 min. at any speed and torque within the limits of Fig. 1.

3.2.2.8 No-Load Operation: The starter shall be capable of operating for a minimum of 1 min. with the output shaft unloaded and the cut-out device inoperative when the hydraulic fluid is maintained at rated temperature and pressure.

3.2.2.9 Automatic Cut-out Device: The starter design shall incorporate an automatic cut-out device which will open a normally closed circuit within the cut-out speed range specified in the model specification. Motor cavitation during cutout conditions shall be prevented.

3.2.2.10 Electrical-Hydraulic Components:

3.2.2.10.1 Operating Characteristics: Electrically operated components shall be designed for minimum electrical power consumption, consistent with other requirements of this specification. Electrically actuated components that are designed to return automatically to the original position when deenergized shall do so with up to 150% of the maximum operating pressure applied to the component when no less than 10% of the normal operating voltage is present.

3.2.2.11 Shaft Seal: The starter design shall incorporate output shaft seal assemblies to prevent the leakage of hydraulic fluid into the drive pad cavity.

3.2.2.12 Magnetic Chip Detector: The starter shall include a magnetic chip detector.

3.2.2.13 Starter Controls: Variable displacement starters shall be equipped with suitable controls for providing a controlled change in displacement during the starting cycle.

3.2.2.14 Clutch Assembly: The starter design shall incorporate an overrunning clutch mechanism to provide engagement, disengagement and re-engagement of the output shaft independent of any external signal.

- 3.2.2.15 Disengagement and Re-engagement: Provision for disengagement and re-engagement of the starter shall be internal in the construction and shall be independent of external signal. Re-engagement of the starter after interruption during a starting cycle shall be accomplished without damage. There shall be no limitation, within the rated life, of the number of starts performed in succession.
- 3.2.2.16 Lubrication: It is preferred that the starters be self-lubricated with no provisions for lubrication other than the hydraulic fluid and or gear case lubricant. It is further desired that only the specified hydraulic fluid be used to lubricate seals during assembly and installation of the starters.
- 3.2.2.17 Balance: The starter shall be inherently balanced as specified in MIL-M-7997. The self-induced vibration of the motor drive interface shall not exceed 0.005-in. double amplitude or 3.5G, whichever is less, between 5 cps and 2,000 cps.
- 3.2.2.18 Drive Couplings: The starter design shall incorporate a replaceable drive coupling with a shear section or other torque limiting device sized to limit transmitted torque within the intended engine drive rating.
- 3.2.2.19 Rotation: Drive rotation for the starter shall be identified as viewed from the anti-drive end of the starter and shall be stated in the model specification.
- 3.2.2.20 Parts Containment: In the event of an internal failure of the starter all parts shall be contained within the starter housing and there shall be no loss of fluid from the starter due to failure.
- 3.2.2.21 Speed Limiter: The no-load runaway speed of the starter shall be limited to a safe value, either by inherent design characteristics or by the incorporation of speed limiting devices.
- 3.2.2.22 Fire Resistance: The starter shall be capable at minimum flow conditions of withstanding a 2,000°F ambient temperature for 5 min. with an initial fluid and case temperature of 275°F. The shaft seal and external leakage shall be in accordance with 3.2.2.11. The motor need not operate after exposure to this temperature.
- 3.2.2.23 Acceleration and Deceleration: The starter shall be capable of accelerating from zero to rated speed and decelerate from rated to zero speed in 0.02 sec. The acceleration/deceleration, however, shall not exceed 50,000 radians per sec. squared. The starter shall not be damaged by such operating conditions.
- 3.2.3 Reliability:
- 3.2.3.1 Storage Life: The storage life of the starter (except for age-sensitive items) shall be a minimum of 10 years and when packaged in accordance with MIL-STD-794.
- 3.2.3.2 Operating Life: The model specification shall specify the useable life of the starter, in terms of flight or engine operating hours.
- 3.2.3.3 Rated Endurance Life: The model specification shall state the required number of start cycles for which the unit must be designed.
- 3.2.4 Maintainability: