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**Aircraft Hydraulic Starter/Pumps**

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## 1. SCOPE

1.1 Scope - This specification established (1) the common requirements for hydraulic units capable of functioning as starters and as pumps suitable for use in aircraft and missiles and (2) the methods to be used for demonstrating compliance with these requirements.

1.2 Model Specification - A Model Specification, conforming to Appendix I of this specification, shall be prepared for each starter/pump model by either the purchaser or the starter/pump manufacturer. Where conflicts exist, the requirements of the Model Specification shall govern.

## 2. APPLICABLE DOCUMENTS

2.1 The following documents shall form a part of this standard to the extent specified herein. The applicable issue of each shall be that in effect on the date of this Aerospace Standard unless otherwise specified in the manufacturer's Model Specifications. 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.

### 2.1.1 Aerospace Material Specifications (AMS)

AMS 2400	Plating - Cadmium
AMS 2402	Plating - Zinc
AMS 2403 or 2424	Plating - Nickel
AMS 2406	Plating - Chromium Hard
AMS 2408	Plating - Tin
AMS 2410 or 2412	Plating - Silver
AMS 2470	Anodic Treatment - Aluminum Base Alloys
AMS 2473 or 2474	Chemical Treatment - Aluminum Base Alloys
AMS 2475	Protective Treatments - Magnesium Base Alloys

### 2.1.2 Industry Standards

USA B46.1	Surface Texture
AS 478	Identification Marking Methods
AS 567	General Practices for Use of Lockwire, Key Washers and Cotter Pins

### 2.1.3 Military Specifications

MIL-P-116	Preservation, Methods of
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MIL-C-5501	Caps and Plugs, Protective, Dust and Moisture Seal
MIL-H-6083	Hydraulic Fluid, Petroleum Base, Preservative
MIL-P-6906	Plates, Information and Identification
MIL-S-7742	Screw Threads, Standard, Aeronautical
MIL-H-8775	Hydraulic Systems Components, Aircraft General Specification for
MIL-F-8815	Filters and Filter Elements, Fluid Pressure, Hydraulic, Line; 15 Micron Absolute Type II Systems
MIL-C-11796	Corrosion Preventative, Petrolatum, Hot Application
MIL-P-19692	Pumps, Hydraulic, Variable Delivery, General Specifications for
MIL-H-5440	Hydraulic Systems, Aircraft, Types I and II Design, Installation, and Data Requirement for

### 2.1.4 Military Standards

MIL-STD-100	Engineering Drawing Practices
MS33586	Metals, Definition of Dissimilar
MIL-STD-129	Marking of Shipments
MS33649	Bosses, Fluid Connection, Internal Straight Thread

### 2.1.5 Publications - (Air Force-Navy Aeronautical Bulletins)

No. 445	Changes, Engineering, to Aircraft Engines, Propellers, and Aeronautical Equipment in Production and Service
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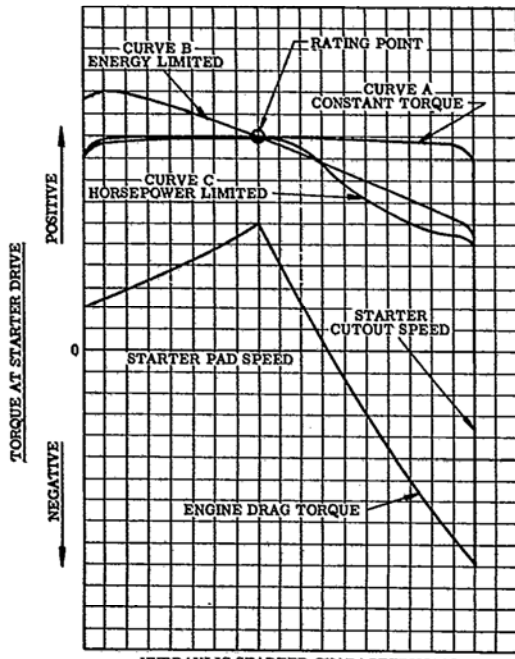
## 3. REQUIREMENTS

3.1 General Requirements - This section describes the general requirements for hydraulic starter/pumps, either fixed or variable displacement, suitable for operation in hydraulic systems conforming to the requirements of MIL-H-5440, or as otherwise specified by the Model Specification. The starter/pumps shall include any combination of the components listed below needed

to satisfactorily meet the requirements of the AS and the Model Specification.

3.1.1 Starter/Pump Assembly - The starter/pump design shall incorporate a hydraulic rotating assembly suitable for converting fluid energy into mechanical energy in the form of rotary motion and converting rotary motion into fluid energy.

3.1.2 Control Assembly - Variable displacement starter/pumps shall be equipped with suitable controls for providing an automatically controlled change in displacement during the starting cycle, the pumping cycle, or



HYDRAULIC STARTER CHARACTERISTICS  
FIGURE 1

both. The starting cycle shall be in accordance with Curve "B" or "C" of Fig. 1. The pumping cycle shall be in accordance with the rated output flow and pressure as a PUMP.

3.1.3 Gear Assembly - For applications requiring a speed ratio between the hydraulic assembly and the output shaft, the necessary gear assembly shall be incorporated within the construction of the starter/pump.

3.1.4 Shaft Seal - The starter/Pump design shall incorporate an output shaft seal assembly to prevent the leakage of hydraulic fluid or gear case lubricant from the starter/pump or the entry of engine lubricant into the starter. The shaft seal shall be replaceable without additional disassembly of the starter/pump.

3.1.5 Parts Containment - In the event of an internal failure of the starter/pump, all parts shall be contained within the starter/pump housing and there shall be no loss of fluid from the starter/pump due to the failure, and the starter/pump shall remain attached to the mounting pad of the engine accessory drive.

### 3.2 Performance Characteristics

3.2.1 Starter Performance - The following paragraphs, together with Fig. 1, describe the typical starter performance characteristics of hydraulic starter/pumps when they are operated from different types of hydraulic power sources.

3.2.1.1 Fixed Displacement - Fixed displacement starters, except for variations in efficiency, produce an output torque essentially proportional to input hydraulic pressure. Typical performance is shown in Fig. 1. Curves "A" and "B" represent performance during operation in conjunction with constant pressure (constant torque) and energy limited (decreasing pressure) hydraulic power systems respectively.

3.2.1.2 Variable Displacement - Variable displacement starters, when operated from a constant pressure horsepower limited source, produce essentially constant torque during the initial portion of the starting cycle until reaching rated flow. For the balance of the starting cycle, output torque decreases along an approximately constant horsepower line. Typical performance is shown as Curve "C" of Fig. 1.

3.2.2 Pump Performance - Variable delivery pumps deliver flow at essentially constant pressure from rated flow to cut-off.

### 3.3 Design Requirements

3.3.1 Starter/Pump Functional Requirements - The starter/pumps shall be designed and constructed to satisfy the performance requirements specified below when operating under the rated hydraulic conditions as defined.

3.3.1.1 Hydraulic Fluid - The starter/pumps shall meet the functional requirements using the hydraulic fluid defined in the Model Specification.

3.3.1.2 Rated Temperature - The rated temperature is defined as the maximum fluid temperature at the starter/pump inlet port. The rated temperature shall be stated in the Model Specification and shall be one of the values listed in Table I.

TABLE I

Hydraulic System	Rated Temperature
Type I	160 F
Type II	275 F
Type III	450 F

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

3.3.1.3 Rated Case Pressure - The rated case pressure is defined as the maximum pressure to be allowed in the case and shall be specified in the Model Specification.

3.3.1.4 Rated Speed - The starter/pump will have two rated speeds, one as a starter and one as a pump.