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AEROSPACE RECOMMENDED PRACTICE

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ACCUMULATOR, HYDRAULIC, CYLINDRICAL AIRCRAFT

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1. SCOPE:

This aerospace document establishes the requirements for aircraft hydraulic accumulators with piston type separators for use in aircraft hydraulic systems at rated pressures ranging up to 8000 per square inch (psi) (55 160 KPa), including details pertinent to the design, fabrication, and performance of the accumulator. The temperature range of the accumulator is -65°F (-54°C) to 275°F (+135°C) or as specified by the procurement specification.

1.1 Classification:

Hydraulic pressure accumulators shall be of the following classes:

a. Class 1000 - Hydraulic system, maximum rated pressure 1000 psi (7000 KPa)

b. Class 2000 - Hydraulic system, maximum rated pressure 2000 psi (14 000 KPa)

c. Class 3000 - Hydraulic system, maximum rated pressure 3000 psi (21 000 KPa)

d. Class 4000 - Hydraulic system, maximum rated pressure 4000 psi (28 000 KPa)

e. Class 5000 - Hydraulic system, maximum rated pressure 5000 psi (35 000 KPa)

f. Class 6000 - Hydraulic system, maximum rated pressure 6000 psi (42 000 KPa)

g. Class 7000 - Hydraulic system, maximum rated pressure 7000 psi (49 000 KPa)

h. Class 8000 - Hydraulic system, maximum rated pressure 8000 psi (56 000 KPa)

2. REFERENCES:

2.1 Applicable Documents:

The following documents form part of this ARP to the extent specified herein. The latest issue of SAE documents shall apply. The applicable issue of other documents shall be as specified in the procurement specification.

2.1.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AS1241	Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft
ARP1288	Placarding of Aircraft Hydraulic Equipment to Identify Required Fluid Suitability
ARP1383	Impulse Testing of Hydraulic Actuators, Valves, Pressure Containers and Similar Fluid System Components
MA2012	Port Connection Internal, Straight Thread, (Metric)
AS4059	Aerospace Cleanliness Classification for Hydraulic Fluids
AIR4150	(Draft) Inspection of In-Service Airborne Accumulators

2.1.2 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

2.1.2.1 Military Specifications:

MIL-P-116	Preservation, Methods of
MIL-H-5440	Hydraulic System, Aircraft, Design and Installation, Requirements for
MIL-A-5498	Accumulators, Hydraulic, Cylindrical, 3000 psi, Aircraft
MIL-C-5501	Caps and Plugs, Protective Dust and Moisture Seal
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance
MIL-I-6868	Inspection Process, Magnetic Particle
MIL-H-8775	Hydraulic System Components, Aircraft and Missiles, General Specification for
MIL-P-27401	Propellant Pressurizing Agent, Nitrogen
MIL-H-83282	Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Aircraft

2.1.2.2 Military Standards:

MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Marking of U.S. Military Property
MIL-STD-810	Environmental Test Methods and Engineering Guidelines
MIL-STD-1949	Inspection, Magnetic Particle
MIL-STD-6866	Inspection, Penetrant Method of
MS-33649	Boss, Fluid Connection - Internal Straight Thread

2.1.3 National Aerospace Standard:

Available from the Aerospace Industries Association of America, Inc., 1250 Eye Street, NW, Washington, DC 20005.

NAS 1638 Cleanliness Requirements of Parts Used in Aerospace Systems

2.2 Definitions:

The following terms used in this document are defined as follows:

2.2.1 VOLUMETRIC EFFICIENCY: The capability of the accumulator to expel the hydraulic fluid volume with which it has been filled (see Equation 1):

Volumetric efficiency = (Expulsion Volume/Filling Volume) X 100 (Eq.1)

2.2.2 PRECHARGE: The gas sealed within the accumulator and separated from the hydraulic fluid.

2.2.3 SEPARATOR: A part of the accumulator (the piston) that separates the gas and the hydraulic fluid.

2.2.4 VESSEL: That portion of the accumulator which contains the hydraulic fluid and gas.

2.2.5 RATED PRESSURE: Rated pressure is the maximum operating pressure as defined by the classification in 1.1.

2.2.6 EXTERNAL GAS LEAKAGE: External leakage is leakage of precharge gas from within the vessel as evidenced by free gas bubbles when the accumulator is immersed in a test fluid.

3. TECHNICAL REQUIREMENTS:

3.1 General:

Unless otherwise specified, the requirements of MIL-A-5498, MIL-H-5440, and Section 3 of Specification MIL-H-8775, which are applicable to accumulators, shall be considered a part of this specification.

3.2 Qualification Tests:

The accumulators furnished under this specification shall be a product that has been tested and has passed the qualification tests specified in Section 4.

3.3 Design and Fabrication:

3.3.1 General: Accumulators shall be designed and constructed to contain gas and hydraulic fluid under pressure. The accumulator shall be provided with a fluid port and a gas port.

3.3.2 Dimensions and Mounting Provisions: Dimensions and mounting provisions shall conform to the requirements specified in the procurement specification or MIL-A-5498, Figure 3.

3.3.3 Ports:

3.3.3.1 Fluid Port: A fluid port per MS 33649-8 (or MA2012) shall be provided, unless otherwise specified by the procurement specification. The fluid port shall be designed to give a minimum restriction to fluid flow.

3.3.3.2 Gas Port: A gas port per MS 33649-5 (or MA2012) shall be provided, unless otherwise specified in the procurement specification.

3.3.4 Weight: The unit weight shall be a minimum consistent with the performance requirements of this document and the procurement specification.

3.3.5 Fluid: The accumulator shall be designed to operate with the fluid specified in the procurement specification.

3.3.6 Seals: The seals contained within the accumulator shall be designed to be compatible with the operating fluid per 3.3.5.

3.3.7 Volumetric Efficiency: The volumetric efficiency shall be such that the fluid expelled shall be in excess of 95%.

3.4 Performance:

The accumulator shall be capable of the performance requirements specified, unless otherwise specified by the procurement specification.

3.4.1 Pressures: The accumulators shall be designed and constructed to the requirements for maximum rated pressures as specified in 1.1.

3.4.1.1 Precharge Pressure: The procurement specification shall specify the required precharge of the accumulator. The accumulator shall be precharged with inert gas only, per MIL-P-27401, or equivalent.

3.4.1.2 Vessel Proof Pressure: The vessel proof pressure shall be two times the maximum rated pressure.

3.4.1.3 Vessel Burst Pressure: The vessel burst pressure shall be four times the maximum rated pressure or as specified in the procurement specification and shall be designed to withstand this pressure at the maximum rated temperature of the accumulator.

3.4.2 Separator: The separator (hydraulic fluid/gas) shall be designed to operate with maximum precharge pressure per the procurement specification. Means shall be provided to prevent a seal between the piston and the part(s) it contacts when the piston is bottomed on the fluid end.

3.4.2.1 Proof Pressure: The separator shall be designed to withstand a differential pressure of 1.5 times the maximum rated pressure on the gas side and the fluid side.

3.4.2.2 Separator Friction: The hydraulic fluid pressure at which the separator begins to move shall not be greater than 100 psig (700 KPa) above the precharge pressure per 3.4.1.1.

3.4.3 Storage: The accumulator shall be constructed of materials that shall not degrade during the life of the accumulator. The accumulator shall be designed for a shelf life of 10 years after delivery.

3.4.4 Internal Cleanliness: Internal cleanliness shall be equal to or better than as specified in Class 5, Table 1 of NAS 1638 or AS4059 (for particles above 5 μm in size).

3.4.5 Leakage:

3.4.5.1 Gas Leakage: A new accumulator shall have an internal gas leakage of not greater than specified, or as specified in the procurement specification.

a. 2 mL/h of free gas for volumes up to 50 in^3
b. 3 mL/h of free gas for volumes from 50 to 200 in^3
c. 10 mL/h of free gas for volumes from 200 to 400 in^3

3.4.5.2 Fluid Leakage: There shall be no external leakage at the maximum rated pressures specified. Internal leakage shall not exceed 2 drops in 1 h or as specified in the procurement specification.

3.4.6 Endurance and Cycling: The accumulator shall be designed to withstand pressure cycling as specified in Table 2, steps 1-6.

3.4.7 Pressure Impulse: The accumulator shall be designed to withstand pressure impulse cycling as specified in Table 2, step 7 and ARP1383, Procedure III.

3.4.8 Fragmentation: When specified by the procurement specification, the accumulator shall be designed to pass the fragmentation requirements specified in 4.7.10.

3.4.9 Immersion Test: The unit shall meet test requirements after immersion in the operating fluid for a period of 72 h at a temperature of 275°F (135°C) or as specified in the procurement specification.

3.5 Marking:

3.5.1 Warning Label: Each accumulator shall be permanently marked with a legible warning in red letters stating:

RELEASE GAS AND FLUID PRESSURE BEFORE DISASSEMBLING, STORING, OR SHIPPING ACCUMULATOR.

3.5.2 Nameplate: Each accumulator shall be furnished with a nameplate marked in accordance with MIL-STD-130 and shall include the following information as a minimum:

a. Hydraulic Accumulator
b. Manufacturer's Name
c. Manufacture Date
d. Manufacturer's Part Number
e. Manufacturer's Serial Number
f. Operating Pressure
g. Proof Pressure
h. Precharge Gas Volume
i. Operating Fluid (ARP1288)

3.6 Corrosion Protection:

3.6.1 Internal Surfaces: The internal surfaces of the accumulator shall comply with the corrosion protection requirements as specified in 3.2.1 of MIL-H-8775.

3.6.2 External Surfaces: The external surfaces of the accumulator shall comply with the corrosion protection requirements as specified in 3.2.1 of MIL-H-8775 or be painted with a suitable primer and top coat that meets the fungus, sand and dust, and salt fog requirements as specified in MIL-H-8775.

3.7 Environmental:

3.7.1 Vibration: The accumulator shall function after being exposed to vibration in accordance with MIL-STD-810, Method 514.2, Procedure I, Curve L, or as specified in the procurement specification.

3.8 Physical Defect Inspection:

All magnetizable, highly stressed parts shall be subjected to magnetic inspection in accordance with MIL-STD-1949. Nonmagnetizable, highly stressed parts shall be subjected to liquid penetrant inspection in accordance with MIL-STD-6866. Cracks or other injurious defects disclosed by the inspection shall be cause for rejection.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

Unless otherwise specified in the procurement specification or purchase order, the supplier is responsible for performance of all inspection requirements as specified herein. Except as otherwise specified, the vendor may utilize his own facilities or any commercial laboratory acceptable to the customer. The purchaser reserves the right to perform any of the inspections set forth in this specification whenever it is deemed necessary to assure that the item conforms to prescribed requirements.

4.2 Classification of Tests:

The inspection and testing of accumulators shall be classified as:

a. Qualification tests (4.4)
b. Acceptance tests (4.5)

4.3 General Test Requirements:

Unless otherwise specified, the quality assurance provisions of specification MIL-H-8775 form a part of this specification.

4.4 Qualification Tests:

Two qualification samples shall be subjected to the testing as specified and in the order listed in Table 1.

TABLE 1 - Qualification Testing

Test	Required Paragraph	Test Method Paragraph	Unit A	Unit B
1. Acceptance tests		4.5	X	X
2. Fluid immersion	3.4.9	4.7.11	X	
3. Volumetric efficiency	3.3.7	4.7.1	X	X
4. Separator friction	3.4.2.2	4.7.2	X	X
5. Proof pressure	3.4.2.1	4.7.3.2	X	X
6. Gas and fluid leak test	3.4.5	4.7.5	X	X
7. Endurance cycling	3.4.6	4.7.6	X	
8. Pressure impulse	3.4.7	4.7.7	X	
9. Vibration	3.7.1	4.7.4	X	
10. Nondestructive inspect	3.8	4.7.8	X	
11. Burst Pressure	3.4.1.3	4.7.9		X
12. Fragmentation	3.4.8	4.7.10	X	

4.5 Acceptance Tests (Production):

Each accumulator that is submitted for acceptance shall be subjected to the following tests in the order listed:

a. Examination of product (4.6.1)
b. Nondestructive inspection (4.7.8)
c. Gas and fluid leak test (4.7.5)
d. Separator friction (4.7.2)
e. Proof pressure (4.7.3)

4.6 Examinations:

4.6.1 Examination of Product: Examination of product shall be in accordance with MIL-H-8775.

4.6.2 Packaging, Packing, and Marking: Preparation for delivery shall be examined for conformance to Section 5.

4.7 Test Methods:

All tests shall be conducted at an ambient temperature of 70°F ± 10 (21°C) unless otherwise specified.

4.7.1 Volumetric Efficiency: Fill the accumulator through the fluid port with hydraulic fluid. Expel the fluid from the accumulator. Measure the volume of the fluid used to fill the accumulator and the volume of the fluid expelled from the accumulator. The volumetric efficiency shall meet or exceed the requirement of 3.3.7.

4.7.2 Separator Friction: Starting with the hydraulic pressure at 0 psi, increase the pressure until the separator begins to move. The pressure at which the separator begins to move shall be per 3.4.2.2.

4.7.3 Proof Pressure: The accumulator shall be proof pressure tested as shown. There shall be no leakage or any sign of failure in any part of the accumulator.

4.7.3.1 Vessel Proof Pressure: With the piston in approximately midposition, completely fill both ends of each accumulator with fluid and plug the gas end. Fluid pressure shall be applied at the fluid port until a pressure per 3.4.1.2 is obtained and maintained for 5 min. There shall be no leakage of fluid, permanent deformation, or sign of failure in any part of the accumulator.

4.7.3.2 Separator Proof Pressure: With the accumulator mounted in a vertical position and with the gas port down, the accumulator separator shall withstand fluid pressure per 3.4.2.1 applied to the fluid port with the gas port open for 2 min without leakage or damage. Also, with the accumulator mounted in a vertical position and with the fluid port down, the accumulator separator shall withstand fluid pressure per 3.4.2.1 applied to the gas port with the fluid port open for 2 min without leakage or damage.

4.7.4 Vibration: With the accumulator mounted similar to the system installation and pressurized to the maximum operating pressure, it shall be vibration tested in accordance with MIL-STD-810, Method 514.2, Procedure I, Curve L, or as specified in the procurement specification.

4.7.5 Leakage Test:

4.7.5.1 Gas Leakage: With the fluid port open to the atmosphere, gas pressure shall be applied to the gas port for a period of 1 h at both 7 and 100% of rated pressure. There shall be no evidence of external leakage. Internal leakage shall be no greater than that allowed per 3.4.5.1.