

Aerospace-Hydraulic Switching Valve,
Pressure or Pilot Operated

RATIONALE

This document provides guidance for the design and qualification test requirements for switching valves. These valves are typically utilized to provide secondary hydraulic power to circuits, whose primary supply source has failed. Also included is section covering relevant "Lessons Learned".

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1. SCOPE

This SAE Aerospace Recommended Practice (ARP) establishes the requirements for the design, manufacture, and qualification of four hydraulic switching valves used in airborne applications. Two are pressure operated, Type IA and IB and two are solenoid/pilot operated, Type IIA and IIB. They are applicable to four pressure classes 3000, 4000, 5000 and 8000 psi. The equipment as designed is intended to be installed in hydraulic systems designed to AS5440 for military applications or ARP4752 and ARP4925 depending on the type of aircraft for commercial applications. Additional or refined requirements shall be contained in the detail (procurement) specification and these shall take precedence over any potentially conflicting requirements of this ARP or documents referenced by this ARP.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AS568	Aerospace Size Standard for O-Rings
AS1241	Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft
ARP1383	Impulse Testing of Aerospace Hydraulic Actuators, Valves, Pressure Containers, and Similar Fluid System Components
AS3121 through AS 3128	Plug, Expansion - Aluminum, 2024-T4, Long, Standard and .010 Oversize Diameters
AS4059	Aerospace Fluid Power - Cleanliness Classification for Hydraulic Fluids
AS4716	Gland Design, O-Ring and Other Elastomeric Seals
ARP4752	Aerospace - Design and Installation of Commercial Transport Aircraft Hydraulic Systems
ARP4925	Aerospace - Design and Installation of Commercial Transport Helicopter Hydraulic Systems
AS4941	Aerospace - General Requirements for Commercial Aircraft Hydraulic Components
AS5440	Hydraulic Systems, Aircraft, Design and Installation, Requirements for
AS8775	Hydraulic System Components, Aircraft and Missiles, General Specification for
AS40401	Solenoid, Electrical, General Specification for
J24714	Fluid Systems - Connector Tubes - General Specification and Part Standard

2.2 RTCA Publications

Available from Radio Technical Commission for Aeronautics, Inc., 1828 L Street, NW, Suite 805, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

RTCA/DO - 160 Environmental Conditions and Test Procedures for Airborne Equipment

2.3 NAS Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NAS 847 Caps and Plugs, Protective, Dust and Moisture Seal, General Specification for

2.4 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, <http://assist.daps.dla.mil/quicksearch/>.

MIL-STD-7179 Finishes, Coatings and Sealants, for Protection of Aerospace Weapons Systems

MIL-PRF-5606 Hydraulic Fluid, petroleum based, Aircraft, Missile and Ordnance (inactive for new design)

MIL-PRF-83282 Hydraulic Fluid, Fire Resistant, Synthetic Hydrocarbon Base, Aircraft

MIL-PRF-87257 Hydraulic Fluid, Fire Resistant, Low temperature, Synthetic Hydrocarbon Base, Aircraft and Missile

MIL-STD-704 Aircraft Electric Power Characteristics

MIL-STD-810 Environmental Engineering Considerations and Laboratory Tests

MIL-STD-461 Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

MIL-HDBK-5 Metallic Materials and Elements for Aerospace Vehicle Structures Note: This HDBK, a long-time reference book, has been cancelled May 2004. See paragraph 2.6 for possible alternative.

2.5 Federal Aviation Agency 14 CFR Regulations

Available from the regulatory and guidance website <http://rgl.faa.gov>.

§§ 23.1435 Hydraulic Systems - normal airplane

§§ 25.1435 Hydraulic Systems - transport airplane

§§ 27.1435 Hydraulic Systems - normal rotorcraft

§§ 29.1435 Hydraulic Systems - transport rotorcraft

2.6 Other Documents

MIL-HDBK-5, referenced in section 2.4, was cancelled in May of 2004. This document is issued by the FAA as a suitable replacement. Users are cautioned to evaluate the MMPDS Handbook for their particular application before using it as a direct replacement document. The current edition of MMPDS may be obtained at www.mmpds.org or <http://projects.battelle.org/mmpds/> (not through the DAPS/ASSIST website).

MMPDS Metallic Materials Property Development and Standardization

2.7 ASME Publications

Available from American Society of Mechanical Engineers, 22 Law Drive, P.O. Box 2900, Fairfield, NJ 07007-2900, Tel: 973-882-1170, www.asme.org.

Y14.100 Engineering Drawing Practices

3. TECHNICAL REQUIREMENTS

3.1 Introduction

The switching valves covered in this ARP control the flow of hydraulic power from one or more hydraulic power sources to a load or subsystem. Switching points are usually controlled by the pressure differentials between the two supply systems using electrical or hydro-mechanical means to accomplish the switching. Four types of switching valve assemblies in four different pressure classes are covered under this specification and are defined as follows:

Type IA Pressure Operated Two Position Six-way Valve
 Type IB Pressure Operated Three Position Six-way Valve
 Type IIA Solenoid Controlled Two Position Six-way Valve
 Type IIB Solenoid Controlled Three Position Six-way Valve

Pressure classes are defined as shown in the first column of Table 1. The related system, proof and burst pressures are also listed.

TABLE 1 - PRESSURE CLASSES

Class	System Pressure		Proof Pressure		Burst Pressure	
	psi	(MPa)	psi	(MPa)	psi	(MPa)
3000	3000	(20.7)	4500	(31.0)	9000	(62.0)
4000	4000	(27.6)	6000	(41.3)	12,000	(82.7)
5000	5000	(34.5)	7500	(51.7)	15,000	(103.4)
8000	8000	(55.2)	12,000	(82.7)	16,000	(110.3)

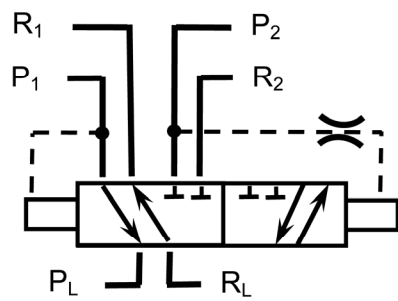
The detail requirements shall be as defined in the detail specification.

The following abbreviations are used throughout the text:

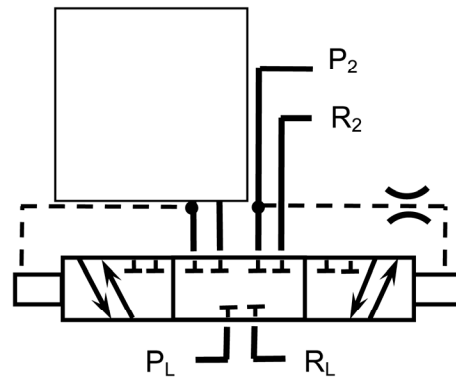
P_1 - Primary supply pressure
 PR_1 - Primary system return pressure
 P_2 - Secondary supply pressure
 PR_2 - Secondary system return pressure
 P_L - System or load pressure
 R_L - System or load return
 R_1 - Primary return
 R_2 - Secondary return
 ΔP - Value of Pressure differential between P_1 and P_2 used for switching

3.1.1 Schematic

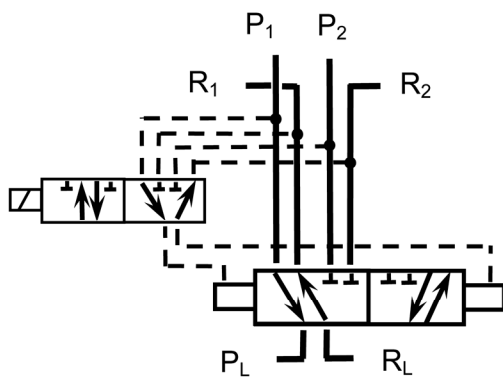
The schematic shall be as defined in Figure 1 or in the detail specification.



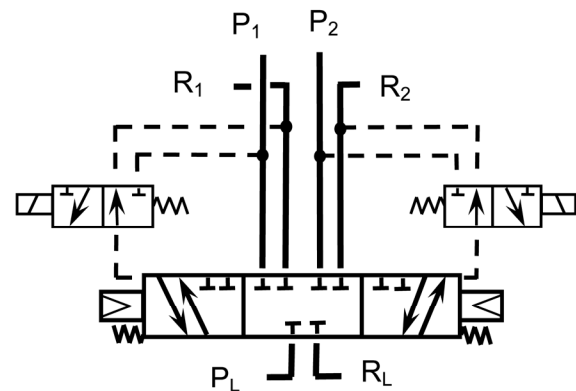
Type IA



Type IB



Type IIA



Type IIB

Note: Detail requirements for the solenoid valves needed for these types are not contained in this document

FIGURE 1 - DIFFERENT VALVE CONFIGURATION TYPES