



AEROSPACE RECOMMENDED PRACTICE

ARP6277™

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Commercial Aircraft Hydraulic System Sizing

RATIONALE

This document satisfies an industry need as it provides a methodology to establish the overall hydraulic system sizing requirements for commercial aircraft.

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Documents

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1. SCOPE

The purpose of this SAE Aerospace Recommended Practice (ARP) is to provide guidelines for determining the hydraulic flow demands for all phases of commercial flight including details of sizing of associated hydraulic components such as hydraulic pumps, hydraulic accumulators, hydraulic reservoirs, hydraulic filters, and hydraulic tubing.

2. REFERENCES

2.1 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.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AIR1739	Information on Antiskid Systems
AIR1922	Aerospace - System Integration Factors That Affect Hydraulic Pump Life
AIR5005	Aerospace - Commercial Aircraft Hydraulic Systems
AIR5372	Information on Brake-By-Wire Brake Control Systems
ARP994	Design of Tubing Installations for Aerospace Hydraulic Systems
ARP1280	Aerospace - Application Guide for Hydraulic Power Transfer Units
ARP4205	Aerospace Fluid Power - Hydraulic Filter Elements - Method for Evaluating Dynamic Efficiency with Cyclic Flow
ARP4752	Aerospace - Design and Installation of Commercial Transport Aircraft Hydraulic Systems
ARP4754	Guidelines for Development of Civil Aircraft and Systems
ARP4761	Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment
AS595	Aerospace - Civil Type Variable Delivery, Pressure Compensate, Hydraulic Pump
AS5586	Aerospace - General Requirements for Hydraulic System Reservoirs

2.1.2 ISO Publications

Copies of these documents are available online at <http://webstore.ansi.org/>.

ISO 18387	Aerospace - Linear hydraulic utility actuator - General specifications
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2.1.3 EASA Publications

Available from European Aviation Safety Agency, Konrad-Adenauer-Ufer 3, D-50668 Cologne, Germany (for visitors and for mail over 1 kg) and Postfach 10 12 53, D-50452 Cologne, Germany (for mail 1 kg or less); Tel: +49 221 8999 000, www.easa.europa.eu.

CS-25 Certification Specifications for Large Aeroplanes

2.1.4 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

14 CFR Part 25 Code of Federal Regulations, 14 CFR 1.1, part 25 Airworthiness Standards, Transport Category Airplanes

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AIR4543 Aerospace Hydraulics and Actuation Lessons Learned

AIR5451 A Guide to Landing Gear System Integration

ARP4925 Aerospace Design and Installation of Commercial Transport Helicopter Hydraulic Systems

AS4941 Aerospace - General Requirements for Commercial Aircraft Hydraulic Components

AS5440 Hydraulic Systems, Military Aircraft, Design and Installation, Requirements for

2.3 Abbreviations

EMP Electric Motor Pump

FC Flight Controls

FLEX Flexible Temperature Take-off Power Setting

FS Flight Spoiler

GPM U.S. Gallons per Minute

GS Ground Spoiler

LG Landing Gear

NWS Nose Wheel Steering

PTU Power Transfer Unit

RAT Ram Air Turbine

RPM Revolutions per Minute

T/R Thrust Reverser

3. HYDRAULIC PUMP SIZING

3.1 Generic Pump Sizing Process

The following section provides guidelines on the processes for the sizing of hydraulic pumps.

3.1.1 Determine Pressure and Flow Requirements for All Users

Early in the design phase, decisions are made related to the sizing of hydraulic user system and components. The hydraulic engineering department should record the hydraulic pressures and flows required by all the hydraulic consumers.

The following factors need to be understood:

- Evaluate all the hydraulic consumers flow needs in order to determine the minimum flow at a given pressure and temperature required for each hydraulic operation (or phase).
- Ensure that the greatest hydraulic system demand is understood.
- If unbalanced actuators are used, make certain that the pressure and flows for each direction of travel is recorded.

3.1.2 Develop a Timeline of Flow Rates per Flight Phase

Some hydraulic consumers need to function quickly and others can move more slowly. For example: devices that decrease lift after landing (ground spoilers) need to deploy quickly (usually about 1 second) to help the aircraft meet runway stopping distance. Other devices like flaps or landing gear can take longer to deploy. Most landing gear actuators are unbalanced, so it is necessary to make certain that the flows required in both directions are recorded.

When recording all the flow rates, include the quiescent leakages for all the components as well. Include the leakage expected for the components at the end of their lifetime as this ensures that sufficient hydraulic power is provided throughout the useful life of the aircraft and its systems.

3.1.3 Provide a Preliminary Schematic

ARP4752 provides guidance on the general concept and layout of the hydraulic systems.

Many aircraft have more than one hydraulic system. If there is more than one system, start allocating the hydraulic users to individual systems and include in a preliminary system schematic.

Examples of how this allocation has been applied to many aircraft platforms are shown in AIR5005.

For critical functions that require more than one power source, they should be allocated on separate systems. It is common to distribute the system users in each of the hydraulic systems such that flow balancing can optimize hydraulic pump size selection.

3.1.4 Establish a Timeline for Various Flight Phases

A timeline should be built for a typical flight identifying when each of the hydraulic consumers is active. Examples are shown in Figures 1 and 2.

For the Left System, the key flow requirement is for the ground spoilers as they extend and retract in 1 second.

For the Right System, again the key flow requirement is for the ground spoilers. The landing gear has a 9 second cycle time defined for it.