



AEROSPACE RECOMMENDED PRACTICE

ARP6200

Issued

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Test Requirements and Means for Commercial Aircraft Hydraulic Systems

RATIONALE

There is a need to provide a document that recommends the tests and their associated test means that are required to demonstrate that a hydraulic system will comply with the applicable regulations of 14CFR Part 25 and EASA CS 25 as well as determining that the hydraulic system has the correct level of maturity at entry into service (EIS). This document addresses this need.

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1. SCOPE

This SAE Aerospace Recommended Practice (ARP) describes the recommended tests and their associated test means for commercial aircraft hydraulic systems at the system level that are required to demonstrate compliance with the 14 CFR Part 25 and EASA CS 25 airworthiness regulations, and to show that the required level of maturity at the aircraft entry into service (EIS) has been achieved.

1.1 Field of Application

This ARP is primarily intended for business and commercial aircraft that are designed to comply with 14 CFR Part 25 and EASA CS 25 airworthiness regulations.

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 724-776-4970 (outside USA), www.sae.org.

ARP24	Determination of Hydraulic Pressure Drop
AS595	Aerospace – Civil Type Variable Delivery, Pressure Compensated, Hydraulic Pump
ARP1084	External Hydraulic Leakage for In-Service Components
AS4059	Aerospace Fluid Power - Contamination Classification for Hydraulic Fluids
ARP4754	Guidelines for Development of Civil Aircraft and Systems
ARP4943	Ground Support Equipment Hydraulic Systems, Design and Installation, Recommended Practices For
ARP5376	Methods, Locations and Criteria for System Sampling and Measuring the Solid Particle Contamination of Hydraulic Fluids
AS5440	Hydraulic Systems, Military Aircraft, Design and Installation, Requirements For
AIR5829	Air in Aircraft Hydraulic Systems
ARP5891	Achieving Cleanliness Standards for Aircraft Hydraulic Systems During Manufacture
AIR5992	Descriptions of Systems Integration Test Rigs (Iron Birds) For Aerospace Applications

2.1.2 A4A Publications

Available from Airlines for America (A4A), 1301 Pennsylvania Avenue, NW, Suite 1100, Washington, DC 20004, Tel: 202-626-4000, www.airlines.org.

SPEC 100	Manufacturers' Technical Data
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2.1.3 EASA Publications

Available from European Aviation Safety Agency, Postfach 10 12 53, D-50452 Cologne, Germany, Tel: +49-221-8999-000, www.easa.eu.int.

Part 21	Certification of Aircraft and Related Products, Parts and Appliances, and of Design and Production Organizations, Commission Regulation (EU) No 748/2012
AMC 25.1435	Hydraulic Systems - Design, Test, Analysis and Certification
CS-25	Certification Specifications and Acceptable Means of Compliance for Large Aeroplanes.
PR.TC.00001-002	Type Certification

2.1.4 FAA Publications

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

14CFR Part 21	Certification Procedures for Products and Parts
14CFR Part 25	Airworthiness Standards: Transport Category Airplanes
8110.4	Type Certification
AC 21-16	RTCA, Inc. Document RTCA/DO-160, Environmental Conditions and Test Procedures for Airborne Equipment. Note: AC 21-16 identifies the DO-160 versions that are acceptable for environmental qualifications.
AC 25-7	Flight Test Guide for Certification of Transport Category Airplanes
AC 25-22	Certification of Transport Airplane Mechanical Systems
AC 25.1435	Hydraulic System Certification Tests and Analysis
TAIL	Transport Airplane Issues List

2.2 Definitions

AIRPLANE FLIGHT MANUAL (AFM): A formal document containing limitations within which the aircraft is considered airworthy, and instructions and information necessary to the flight crew members for the safe operation of the aircraft.

AIRPLANE MAINTENANCE MANUAL (AMM): A formal document which details the way in which all maintenance tasks carried out on an aircraft shall be accomplished.

CAT I/II APPROACH: A precision instrument approach and landing with specific decision height, visibility, and runway visual range requirements.

CYCLE: A cycle is a full travel of service from down to up and a return to the original down position. It is illustrated as a landing gear transitioning from a down and locked position to an up and locked position followed by a final transition to a down and locked position.

EMERGENCY OPERATION: When a hydraulic power system reverts from normal system pressure to emergency system pressure when the normal system pressure is reduced to an ineffective level.

ELAPSED TIME: The time duration taken to complete a prescribed operation from start to finish.

ENDURANCE TESTING: A test spectrum designed to validate the durability and maturity of a hydraulic system for a specified period of time or cycles. The test spectrum may include a range of environmental and external loading conditions.

FUNCTIONAL TEST: This is a test to ensure components and systems are in proper working order and their performance conforms to the specification.

HYDRAULIC GROUND SUPPORT EQUIPMENT: Hydraulic ground support equipment provides pressurized fluid to the aircraft hydraulic systems for functional testing or reservoir servicing while the aircraft is on the ground. The equipment may be portable or stationary.

HALF CYCLE: A half cycle is completion of 50% of a full travel of service. It is illustrated as a landing gear transitioning from a down and locked position to an up and locked position.

MASTER MINIMUM EQUIPMENT LIST (MMEL): The MMEL is prepared in accordance with applicable operating and flight rules. It is prepared by the airplane manufacturer and identifies which equipment may be inoperative and still permit dispatch.

NORMAL SYSTEM: The hydraulic system and components are functioning properly under the specified condition.

OPERATIONAL PROFILE: This is the demonstration of all satisfactory functions of a hydraulic system and components during ground, flight, and maintenance operations. A flight includes the satisfactory completion of operations from startup to shutdown.

POST-TEST INSPECTION: Inspection of components and installations following completion of a test.

SYSTEM INTEGRATION RIG: A test rig that utilizes aircraft hydraulic components to duplicate hydraulic system functionality. It may also include aircraft control, monitor, display, and avionics interfaces to assist in validating total system integration. The test rig may apply external loads and environmental conditions to replicate aircraft operational conditions.

2.3 Acronyms, Abbreviations, and Symbols

14 CFR Title 14 Code of Federal Regulations

AC Advisory Circular

AGL Above Ground Level

AMC Alternate Means of Compliance

CS Certification Specification

EASA European Aviation Safety Agency

ETOPS Extended Range Twin Operations

FAA Federal Aviation Administration

V1 The maximum speed in the takeoff at which the pilot must take the first action (e.g., apply brakes, reduce thrust, deploy speed brakes) to stop the airplane within the accelerate-stop distance.

3. TEST MEANS TO BE USED

3.1 System Integration Rig

3.1.1 Purpose of the Rig

A primary purpose of the rig, also commonly known as an Iron Bird, is validation of system integration. Some of the potential benefits of the system integration rig are to:

- a. Provide an early means to verify hydraulic component sizing, hydraulic demands and pressure drops, static and dynamic performance, thermal characteristics, analytical models, and integration with aircraft electrical and avionics systems.
- b. Provide a means for early identification of manufacturing, installation, servicing, accessibility, and maintainability issues.
- c. Provide a means for long term endurance tests that would be impractical to accomplish on a flight test asset.
- d. Provide an early means to evaluate new technological features and reduce development risk for the aircraft ground and flight test program.
- e. Provide a means for resolution of issues encountered during aircraft development, certification, and after the aircraft enters service if the test bed can be maintained for that purpose.
- f. Provide a means to collect data for certification credit if an approved certification process can be utilized and there is valid technical justification.

3.1.2 Overview of the Rig

AIR5992 provides a description of several historical system integration test rigs used for commercial aircraft development. A common theme of the descriptions is the achieved level of configuration fidelity between the test rig and the eventual production aircraft. Substitutes for actual aircraft hydraulic components, including tube and hose assemblies, may be utilized initially due to availability constraints. While that may be acceptable for some of the test objectives, there should be a plan to upgrade the substitutes to representative aircraft hardware when it becomes available in order to meet the overall testing goals and objectives. Aircraft representative control and monitoring systems (hardware and software) and approved software builds (when applicable) should be part of the integration rig configuration. Software tools used to simulate the aircraft operating environment (flight simulation aspects) should be validated, if such tools are in scope for the project.

Each hydraulic component should ideally be located in actual aircraft spatial coordinates. It is desirable that the rig be operational well in advance of the aircraft first flight date. This is to permit adequate time for issue resolution and configuration changes to be implemented that are deemed essential for first flight readiness.

Emergency safety stops should be located around the test rig and in the control room. Alternative means of controlling electrical power supplied to electrical controls, such as a circuit breaker with individual toggle switches, should be implemented. This is to prevent inadvertent startup and actuation of test rig hardware during system initialization.

The data acquisition system should be capable of recording at high sampling rates. It is beneficial to have hydraulic system user forms with live parameter feeds displayed during testing in the control room.

3.2 Aircraft Ground Testing

3.2.1 Overview of Adaptations Required

Hydraulic system prime mover adaptations may include hydraulic ground support equipment that is portable or stationary. Aircraft structural supports necessary to permit landing gear retraction/extension cycles may be necessary. Adaptations to simulate aircraft conditions such as landing gear "weight on wheels" conditions, wheel speed, and other parameters may be needed in order to test system control, monitor, and warning devices. Equipment necessary to accomplish hydraulic fluid monitoring, sampling, and analysis should be available.